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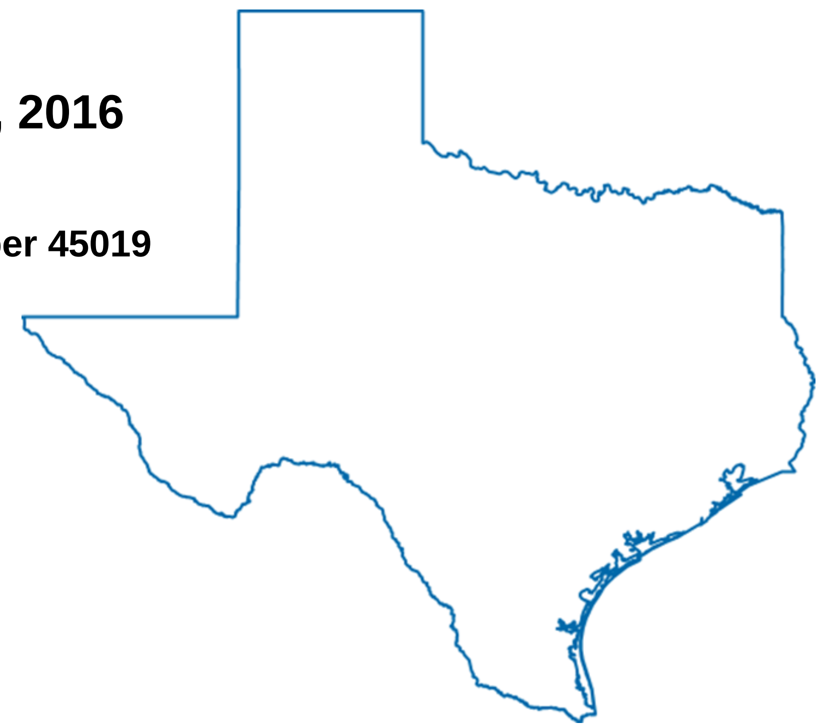
Public Utility Commission of Texas

Annual Statewide Portfolio Report for Program Year 2015—Volume I



August 15, 2016

Project Number 45019

CADMUS

Itron

Johnson CONSULTING GROUP

TEXAS ENERGY ENGINEERING SERVICES, INC. (www.teesi.com)

Public Utility Commission of Texas

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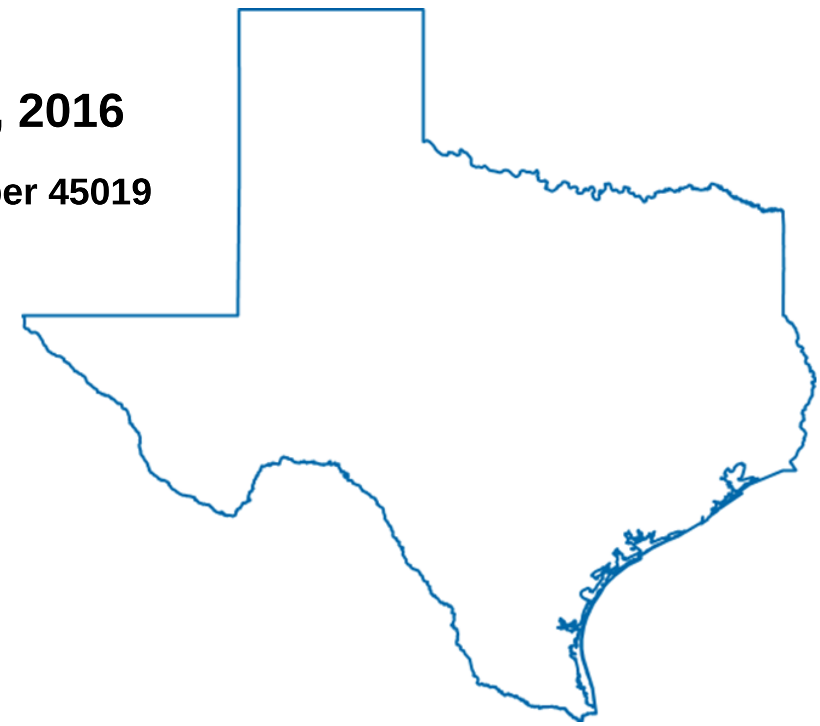

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Acknowledgements

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EM&V team primary report contributors include:

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	Rich Hasselman	Load management, behavioral and solar programs
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The Cadmus Group	Scott Reeves and Holly Farah	Residential standard offer programs and Hard-to-reach programs

Please send any questions or comments on the report to Katie Rich (katie.rich@puc.gov.tx) and Lark Lee (lark.lee@tetratech.com).

Acronyms

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
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)

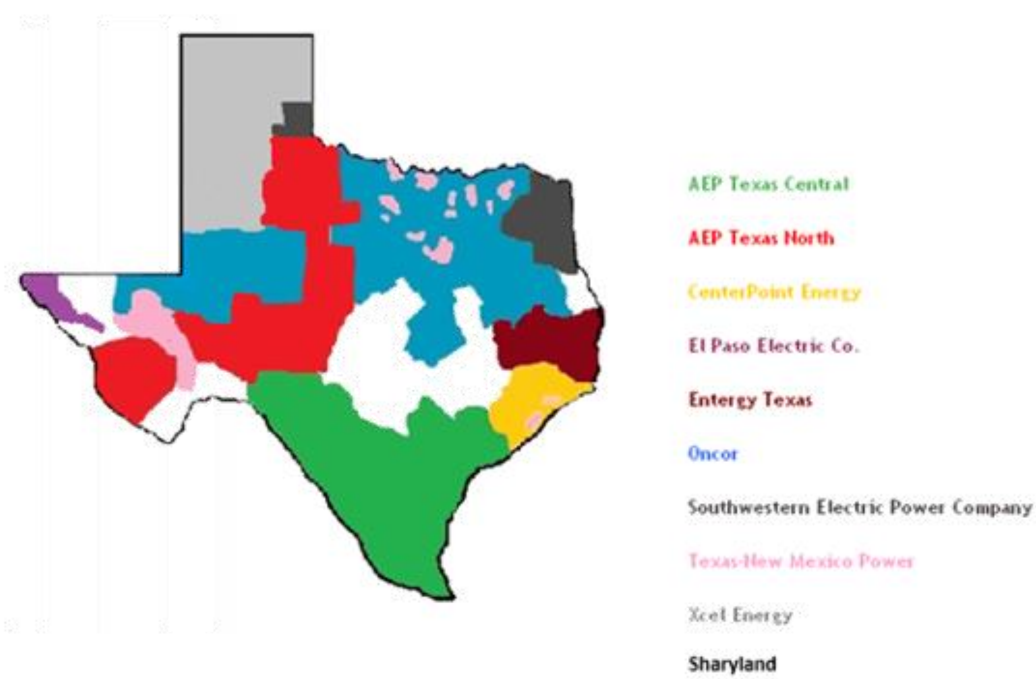
1. EXECUTIVE SUMMARY

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).

In program year 2015 (PY2015) the ten Texas electric utilities delivered statewide savings of 564,730,327 kWh and 391,969 kW at a lifetime evaluated savings cost of $0.011 per kWh and $17.59 per kW. These lifetime costs are slightly less than PY2014 which saw lifetime evaluated savings cost of $0.012 per kWh and $20.29 per kW. Nine of the ten utilities exceeded their energy and demand savings goals for PY2015. The one utility not meeting both goals recently started offering energy efficiency programs and saw increased participation in PY2015 meeting their energy savings goal, but did fall short of their demand reduction goal.

The utilities' service territories are shown in Figure 1-1 below:

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

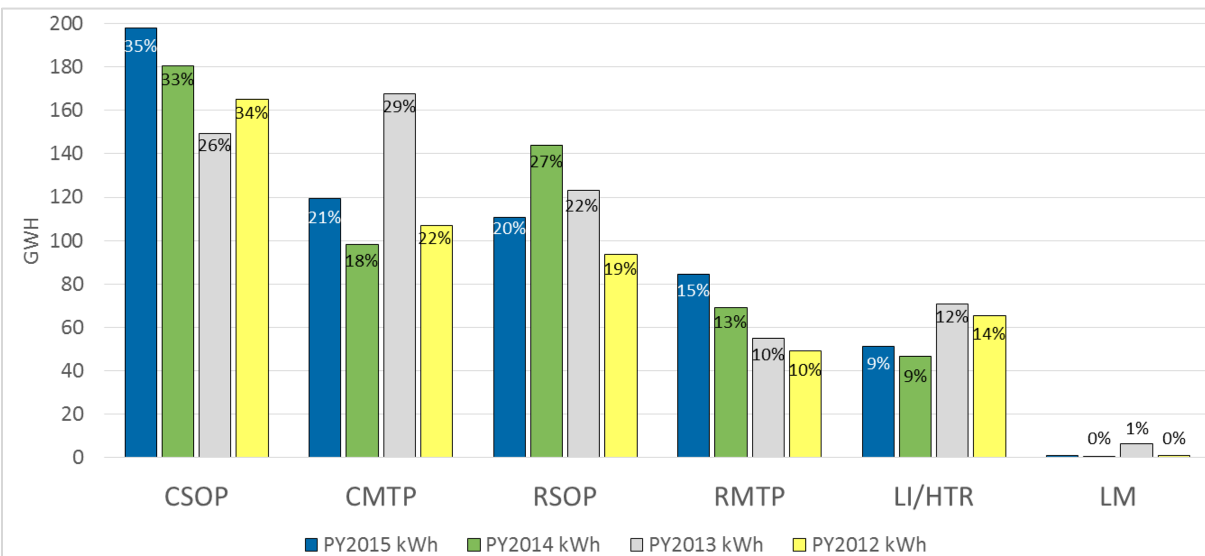


The Texas electric utilities' programs improve the energy efficiency of residential and commercial customers through Standard Offer Programs (SOPs) and Market Transformation Programs (MTPs). SOPs support an infrastructure of contractors ("energy efficiency service providers" (EESPs)) delivering equipment and services directly to customers. Over 100 unique EESPs participated in the commercial SOPs and over 200 unique EESPs participated across the residential SOPs. 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 below, commercial SOP accounted for about one-third of statewide gross energy savings and commercial programs combined accounted for more than half of total statewide savings.

Figure 1-2. Evaluated Gross Energy Savings by Program Type (PY2012--PY2015)

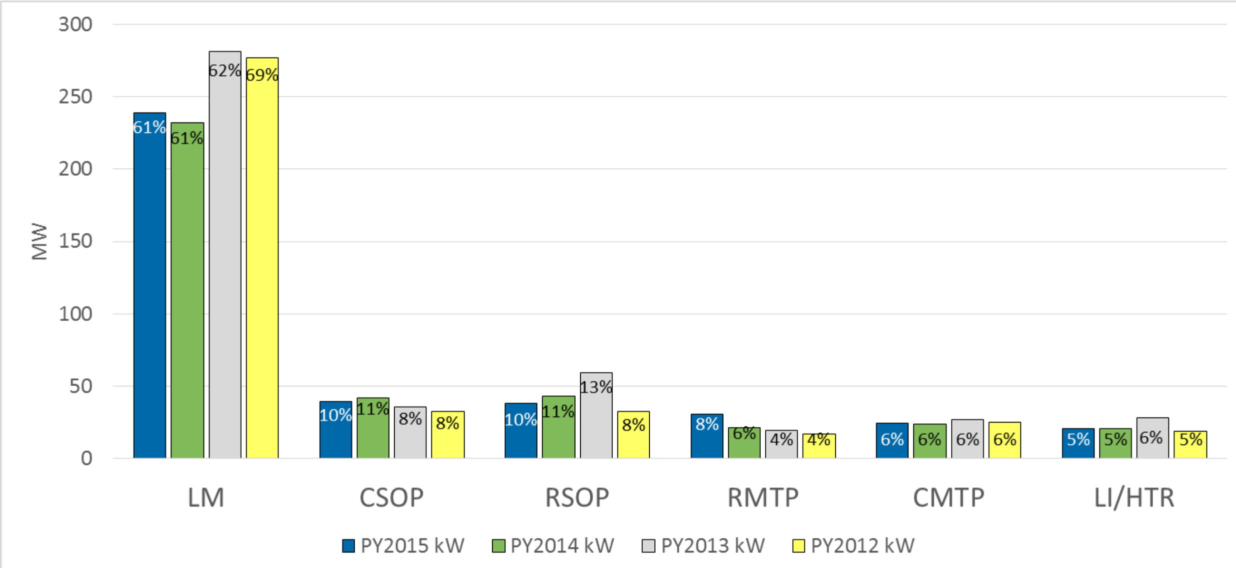
(Percent of Total Annual Statewide Savings Contained in Bar)



Load management programs accounted for more than 60 percent of the statewide gross demand reduction, as shown below (see Figure 1-3).

Figure 1-3. Evaluated Demand Reduction by Program Type (PY2012--PY2015)

(Percent of Total Annual Statewide Savings Contained in Bar)



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) 473-16-0003, Project No. 45019. This team is led by Tetra Tech and includes Texas Energy Engineering Services, Inc. (TEESI), The Cadmus Group, Itron, and Johnson Consulting Group (hereafter, "the EM&V team").

Independent EM&V was conducted for Texas electric utilities' PY2015 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]

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[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).

This Statewide Annual Portfolio Report presents the PY2015 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.

PY2015 is the fourth program year evaluated as part of the statewide EM&V effort. A distinct difference in the PY2015 scope compared to prior years is the targeting of impact evaluation activities to savings areas of the highest uncertainty. These areas were identified in the PY2012 through PY2014 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.

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	Tracking System Savings Calculation Review	Project Desk Reviews	On-site M&V	Interval Meter Data Analysis
Residential SOP and HTR Programs	High	Census	Census	255		Census
Load Management	High	Census	Census			Census
Commercial SOPs and select Commercial MTPs	Medium	Census	N/A	241	97	
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 the savings calculated in the deemed calculation tools or tables 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, 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 or hours of use may be corrected through the evaluation review and thus affect the 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 and for the utility portfolio overall. In each evaluation cycle, the documentation provided by utilities is rated as good, fair, or limited. For PY2015, program documentation provided to the EM&V team was rated “good” for all utilities for kW savings and “good” for nine of utilities for kWh savings and “fair” for one.

The EM&V team conducted cost-effectiveness testing applying the program administrator cost test to PY2015 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 gross realization rates that are close to 100 percent. The utilities’ responsiveness to the EM&V team for identified savings adjustments also supported the healthy realization rates. The EM&V recommended savings adjustments are identified in Table 1-4.

1.2.1 Portfolio results

For PY2015, evaluated gross demand reductions summed across all ten of the utilities’ programs were 391,968 kW. As indicated below, this is a small reduction from prior years.[2] PY2015 evaluated gross energy savings were 564,689,053 kWh. As indicated in Figure 1-5, this is a small increase compared to 2014 but below the peak year of 2013.[3]

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[2] 2014: 392,643 kW / 2013: 453,489 kW / 2012: 402,061 kW

[3] 2014: 539,192,555 kWh / 2013: 480,631,457 kWh / 2012: 480,631,457 kWh.

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

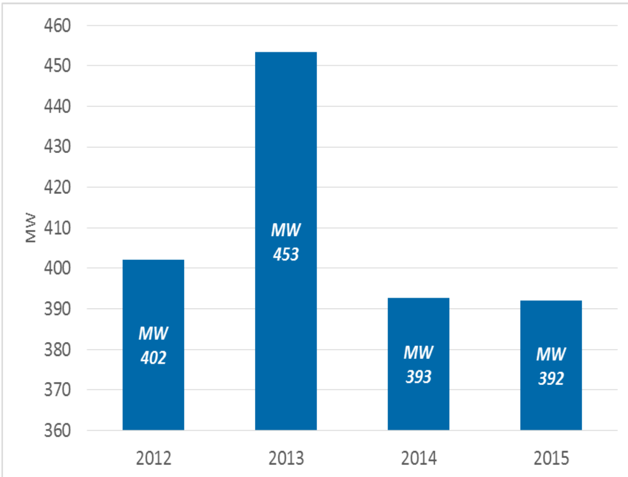
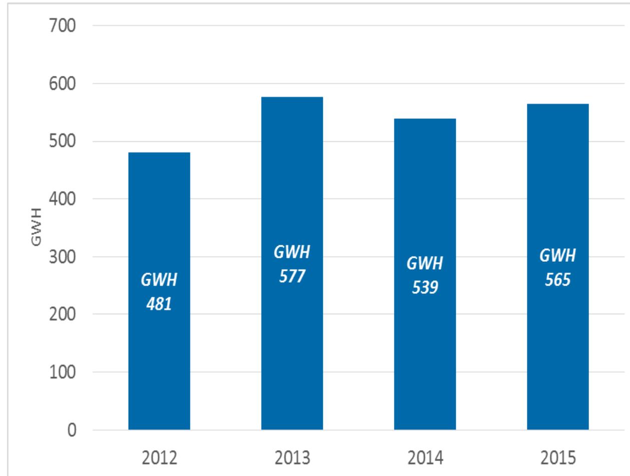


Figure 1-5. Total Statewide Portfolio: Evaluated Gross Energy Savings by Program Year



PY2015 evaluated gross energy savings were 564,689,053 kWh. As indicated in Figure 1-5, this is a small increase compared to 2014 but below the highest year of savings shown, 2013 (2014: 539,192,555 kWh; 2013: 480,631,457 kWh; 2012: 480,631,457 kWh).

Table 1-2 shows the claimed and evaluated gross demand reduction for each utility's portfolio for PY2015. 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 102 percent.

Table 1-2. Program Year 2015 Claimed and Evaluated Gross Demand Reduction, by Utility

Utility	Percent Statewide Reduction (kW)	2015 Claimed Demand Reduction (kW)	2015 Evaluated Demand Reduction (kW	Realization Rate	Precision at 90% Confidence
AEP TCC	11%	43,775	43,933	100%	< 0.5%
AEP TNC	1%	4,542	4,649	102%	3%
CenterPoint	43%	168,489	169,148	100%	1%
El Paso Electric	3%	12,305	12,331	100%	< 0.5%
Entergy[4]	5%	18,086	18,000	100%	4%

[4]Entergy's 2015 savings are understated due to a behavioral program component of their Commercial Market Transformation Program. For this program, only 40% of savings were claimed in 2015. The remainder of the savings will be claimed in 2016 once the M&V is completed, which requires a full year of post-participation consumption data.

Utility	Percent Statewide Reduction (kW)	2015 Claimed Demand Reduction (kW)	2015 Evaluated Demand Reduction (kW	Realization Rate	Precision at 90% Confidence
Oncor	30%	115,808	116,552	101%	< 0.5%
Sharyland	< 0.5%	603	600	99%	1%
SWEPCO	3%	9,876	9,893	100%	2%
TNMP	2%	8,662	8,660	100%	N/A**
Xcel SPS	2%	8,166	8,203	100%	< 0.5%
Total	**100%**	**390,312**	**391,969**	**100%**	**1%**

*Estimated precision value for each utility's programs based on average precision of observed programs.

**Realization rate is based on a census review of tracking data; no sampling was done.

Table 1-3 shows the claimed and evaluated gross energy savings for each utility's portfolio for PY2015. It also shows the relative precision of the estimates at a 90% confidence level. Overall, evaluated savings are quite close in value to claimed savings with a statewide realization rate of 101 percent. Utility portfolio realization rates for kWh ranged from 99 percent to 103 percent.

Table 1-3. Program Year 2015 Claimed and Evaluated Gross Energy Savings, by Utility

Utility	Percent Statewide Savings (kWh)	2015 Claimed Energy Savings	2015 Evaluated Energy Savings (kWh)	Realization Rate	Precision at 90% Confidence
AEP TCC	12%	68,482,226	69,456,702	101%	3%
AEP TNC	2%	12,289,271	12,649,387	103%	4%
CenterPoint	34%	188,255,212	189,551,011	101%	5%
El Paso Electric	4%	22,282,528	22,284,283	100%	3%
Entergy	7%	39,687,596	39,420,091	99%	3%
Oncor	32%	178,908,115	181,151,862	101%	< 0.5%
Sharyland	< 0.5%	2,528,355	2,515,302	99%	1%
SWEPCO	3%	15,261,951	15,417,461	101%	2%
TNMP	3%	17,451,871	17,441,009	100%	N/A**
Xcel SPS	3%	14,536,580	14,801,945	102%	2%
Total	**100%**	**559,683,704**	**564,689,053**	**101%**	**3%**

*Estimated precision value for each utility's programs based on average precision of observed programs.

**Realization rate is based on a census review of tracking data; no sampling was done.

As mentioned above, another contributor to the overall healthy realization rates was that the utilities responded to evaluation findings in their PY2015 claimed savings where the EM&V team recommended a correction in claimed savings. shows a summary of utility program claimed savings adjustments.

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 Solutions MTP	-7	-24,990
CenterPoint	Commercial MTP	-4	-20,572
CenterPoint	Energy Wise Resource Action MTP	33	-59,760
CenterPoint	Large Commercial Load Management SOP	0	318,057
CenterPoint	Large Commercial SOP	-2	-300,895
CenterPoint	Residential SOP	-83	0
CenterPoint	Retail Electric Provider Pilot MTP (Residential Demand Response)	0	41,877
El Paso	Commercial SOP	-5	-29,323
El Paso	Load Management SOP	12	33,555
El Paso	Solar PV Pilot MTP (Res)	-14	-31,984
El Paso	Texas SCORE MTP	0	1,619
Entergy	Commercial Solutions MTP	-7	-33,035
Entergy	SCORE/CitySmart MTP	-1560	-4,530,992
Oncor	Residential Demand Response Pilot MTP	8	0
Sharyland	Customized Commercial MTP	-5	-40,547
SWEPCO	Commercial Solutions MTP	-6	-50,284
SWEPCO	SCORE MTP	0	-19,232
TNMP	Commercial Solutions MTP	-13	-57,540
TNMP	Load Management SOP	41	0
Xcel	Large Commercial SOP	-6	-39812
Xcel	Small Commercial SOP	3	3,286

1.2.2 Commercial sector results

The statewide PY2015 evaluated gross energy savings from commercial sector programs were 316,989,835 kWh. This reflects a continuation of the steady increase in annual savings over time.[5] Statewide PY2015 demand reduction was 63,763 kW, again, representing an increase from prior years.[6]

The largest share of commercial demand reduction came from commercial SOPs (49 percent). As indicated in Figure 1-6, lighting measures accounted for the majority of the energy savings (77 percent) and demand reduction (65 percent), which is consistent with commercial programs through out the country.

Figure 1-6. Distribution of Statewide Evaluated Gross Energy Savings and Demand Reduction by Measure Category—Commercial Programs PY2015

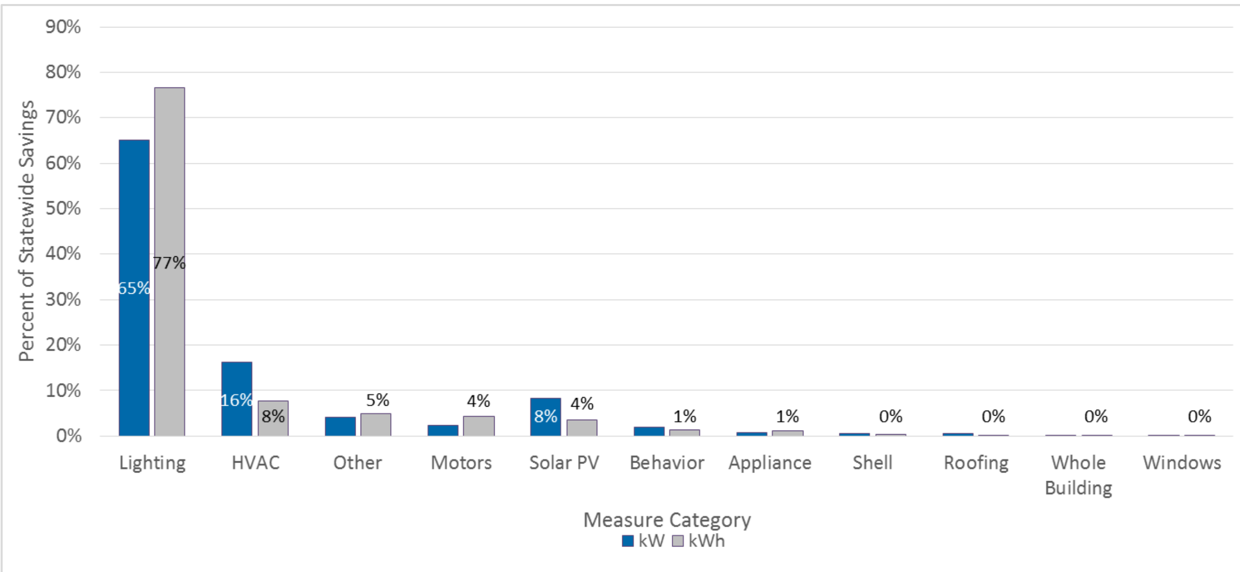


Figure 1-7 and Figure 1-8 show statewide evaluated demand reduction and energy savings, respectively, for commercial programs from PY2012 through PY2015. Statewide, realization rates for commercial programs were near 100 percent for both demand reduction and energy savings.

[5] PY2014: 271,089,099 kWh / PY2013: 263,638,864 kWh / PY2012: 254,241,172 kWh.
[6] PY2014: 58,221 kW / PY2013: 58,512 kW / PY2012: 56,114 kW.

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

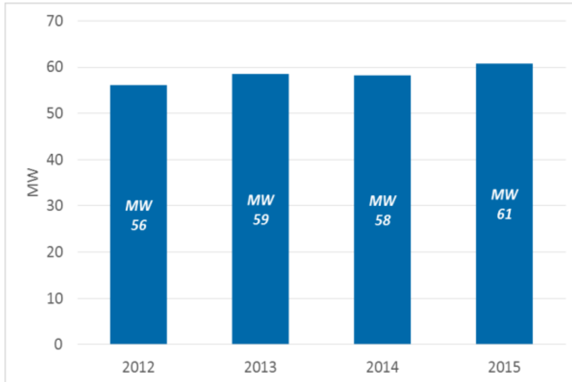
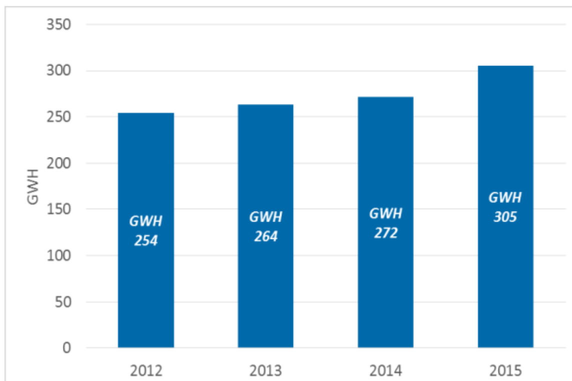


Figure 1-8. Total Statewide Evaluated Energy Savings by Program Year—Commercial Programs



Evaluated savings primarily differed from claimed savings because measure type, quantities, hours of operation, or equipment efficiency levels were found to be slightly different during desk reviews and/or on-site inspection. The 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 for PY2015. 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 were all within rounding error of 100 percent, with a low of 99.9 percent and a high of 100.3 percent.

Table 1-5. Program Year 2015 Claimed and Evaluated Gross Demand Reduction—Commercial Sector

Utility	Percent Statewide Reduction (kW)	2015 Claimed Demand Reduction (kW)	2015 Evaluated Demand Reduction (kW)	Realization Rate	Precision at 90% Confidence*
AEP TCC	13%	8,053	8,052	100%	< 0.5%
AEP TNC	3%	1,566	1,571	100%	3%
CenterPoint	29%	17,817	17,806	100%	< 0.5%
El Paso Electric	6%	3,522	3,523	100%	< 0.5%
Entergy	8%	4,566	4,562	100%	7%
Oncor	32%	19,245	19,228	100%	< 0.5%
Sharyland	< 0.5%	121	121	100%	N/A**
SWEPCO	2%	1,461	1,465	100%	< 0.5%
TNMP	3%	2,004	2,004	100%	N/A**
Xcel SPS	4%	2,416	2,417	100%	< 0.5%
Total	**100%**	**60,770**	**60,748**	**100%**	**1%**

Table 1-6 shows the claimed and evaluated gross energy savings for each utility's commercial portfolio for PY2015. Statewide, the gross demand reduction realization rate rounds to 100 percent, with a low of 99 percent and a high of 101 percent.

Table 1-6. Program Year 2015 Claimed and Evaluated Gross Energy Savings—Commercial Sector

Utility	Percent Statewide Savings (kWh)	2015 Claimed Energy Savings (kWh)	2015 Evaluated Energy Savings (kWh)	Realization Rate	Precision at 90% Confidence*
AEP TCC	13%	39,063,321	39,474,820	101%	1%
AEP TNC	3%	8,597,212	8,656,071	101%	1%
CenterPoint	34%	103,243,162	102,408,409	99%	1%
El Paso Electric	6%	17,183,088	17,182,430	100%	< 0.5%
Entergy	6%	19,476,033	19,389,481	100%	4%
Oncor	30%	90,170,515	90,094,714	100%	< 0.5%
Sharyland	< 0.5%	848,111	848,111	100%	2%
SWEPCO	3%	7,879,012	7,931,413	101%	< 0.5%

Utility	Percent Statewide Savings (kWh)	2015 Claimed Energy Savings (kWh)	2015 Evaluated Energy Savings (kWh)	Realization Rate	Precision at 90% Confidence*
TNMP	3%	9,203,954	9,203,954	100%	2%
Xcel SPS	3%	10,149,877	10,177,208	100%	< 0.5%
Total	**100%**	**305,814,286**	**305,366,612**	**100%**	1%

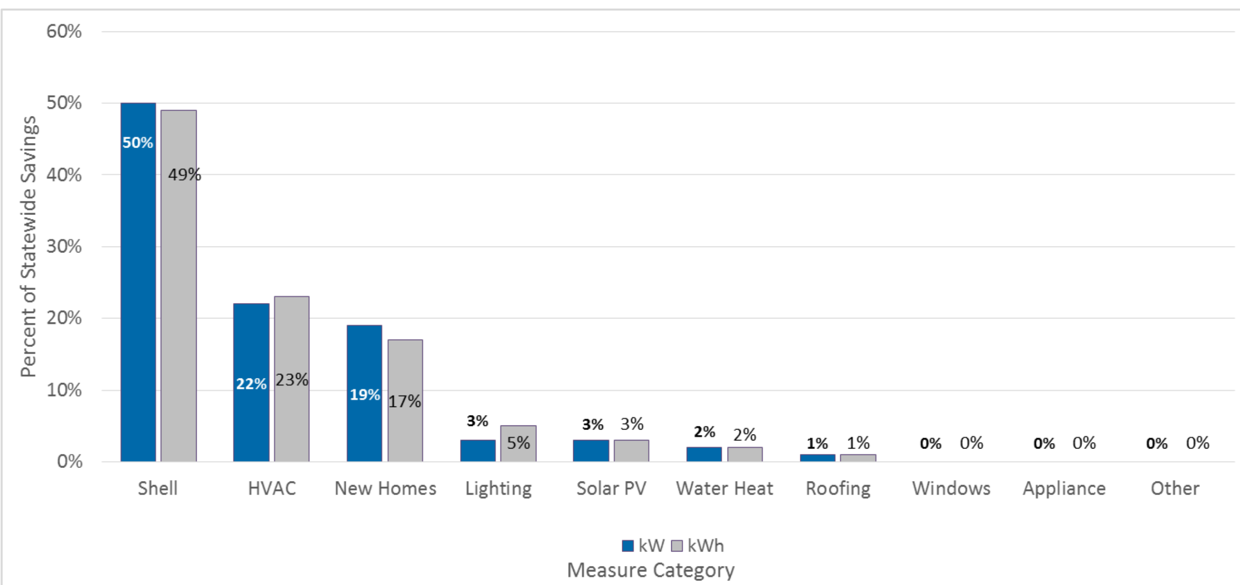
*Estimated precision value for each utility's programs is based on average precision of observed programs.

1.2.3 Residential sector results

The statewide PY2015 evaluated gross energy savings from residential sector programs were 245,339,394 kWh. This reflects a decrease in annual residential savings compared to PY2014, and the second successive year of residential energy savings declines.[7] Statewide PY2015 demand reduction from residential sector programs was 90,184 kW, again, representing a decrease from prior years.[8]

The majority of residential demand reduction and energy saving derived from shell measures (50 percent and 49 percent, respectively). The figure below shows the breakdown of savings by measure category.

Figure 1-9. Distribution of Statewide Evaluated Gross Energy Savings and Demand Reduction by Measure Category—Residential Programs PY2015



While realization rates were close to 100 percent, the EM&V team made adjustments to duct efficiency and air infiltration measures based on testing during on-site visits. The following two

[7] PY2014: 250,307,253 kWh / PY2013: 299,608,892 kWh / PY2012: 220,594,691 kWh
[8] PY2014: 95,271 kW / PY2013: 111,130 kW / PY2012 67,605 kW.

figures show statewide evaluated gross demand reduction and energy savings for residential programs between PY2012 through PY2015.

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

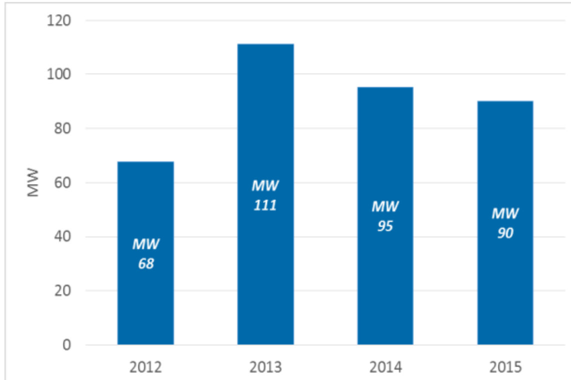


Figure 1-11. Total Statewide Evaluated Gross Energy Savings by Program Year—Residential Programs

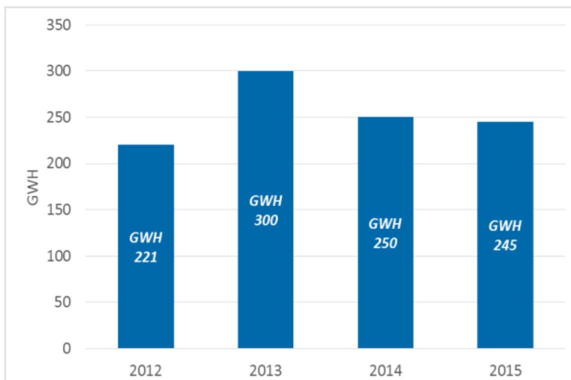


Table 1-7 shows the claimed and evaluated demand reduction for each utility's residential energy efficiency portfolio for PY2015. It also shows the precision levels around the evaluated savings estimates at a 90% confidence level. Overall, evaluated savings were close in value to claimed savings. Statewide, the gross demand reduction realization rate is 102 percent, with a low of 100 percent and a high of 107 percent.

Table 1-7. Program Year 2015 Gross Claimed and Evaluated Demand Reduction—Residential Sector

Utility	Percent Statewide Reduction (kW)	2015 Claimed Demand Reduction (kW)	2015 Evaluated Demand Reduction (kW)	Realization Rate	Precision at 90% Confidence*
AEP TCC	9%	8,288	8,446	102%	N/A**
AEP TNC	1%	1,227	1,311	107%	N/A**
CenterPoint	33%	29,155	29,501	101%	2%

Utility	Percent Statewide Reduction (kW)	2015 Claimed Demand Reduction (kW)	2015 Evaluated Demand Reduction (kW)	Realization Rate	Precision at 90% Confidence*
El Paso Electric	2%	1,777	1,802	101%	< 0.5%
Entergy	7%	6,200	6,118	99%	< 0.5%
Oncor	39%	34,775	35,536	102%	N/A**
Sharyland	1%	480	477	99%	1%
SWEPCO	3%	2,532	2,545	101%	2%
TNMP	3%	2,916	2,914	100%	N/A**
Xcel SPS	2%	1,498	1,534	102%	1%
Total	**100%**	**88,848**	**90,184**	**102%**	**2%**

*Estimated precision value for each utility's programs based on average precision of observed programs.

** Realization rate is based on a census review of tracking data; no sampling was done.

Table 1-8 shows the claimed and evaluated energy savings for each utility's residential energy efficiency portfolio for PY2015. Evaluated savings are similar to claimed savings, though minor adjustments were made across several utilities' values. Statewide, the gross energy savings realization rate is 102 percent, with a low of 99 percent and a high of 108 percent.

Table 1-8. Program Year 2015 Gross Claimed and Evaluated Energy Savings—Residential Sector

Utility	Percent Statewide Savings (kWh)	2015 Claimed Energy Savings (kWh)	2015 Evaluated Energy Savings (kWh)	Realization Rate	Precision at 90% Confidence*
AEP TCC	12%	29,329,483	29,892,460	102%	N/A**
AEP TNC	2%	3,663,410	3,964,659	108%	N/A**
CenterPoint	30%	72,266,886	74,195,556	103%	14%
El Paso Electric	2%	4,481,756	4,484,169	100%	14%
Entergy	8%	20,188,030	20,007,077	99%	< 0.5%
Oncor	37%	88,566,094	90,885,643	103%	N/A**
Sharyland	1%	1,673,181	1,660,128	99%	1%
SWEPCO	3%	7,322,547	7,425,656	101%	3%
TNMP	3%	8,244,175	8,233,312	100%	N/A**

Utility	Percent Statewide Savings (kWh)	2015 Claimed Energy Savings (kWh)	2015 Evaluated Energy Savings (kWh)	Realization Rate	Precision at 90% Confidence*
Xcel SPS	2%	4,352,698	4,590,732	105%	7%
Total	**100%**	**240,088,260**	**245,339,394**	**102%**	**9%**

*Estimated precision value for each utility's programs based on average precision of observed programs.

** Realization rate is based on a census review of tracking data; no sampling was done.

1.2.4 Load management results

Statewide PY2015 evaluated demand reduction from load management programs were 229,351 kW. As shown in Figure 1-12 and Figure 1-13, load management programs' demand reduction increased somewhat in PY2015 compared to the prior year, but were still lower than in PY2012 and PY2013. Energy savings claimed by the programs were higher in PY2015 compared to PY2014 largely due to the utilities working with the EM&V team to employ consistent methodologies to calculate and claim energy savings from load management programs.

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

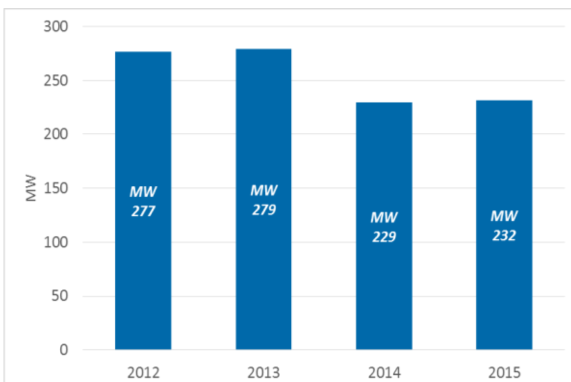


Figure 1-13. Total Statewide Evaluated Gross Energy Savings by Program Year—Load Management Programs

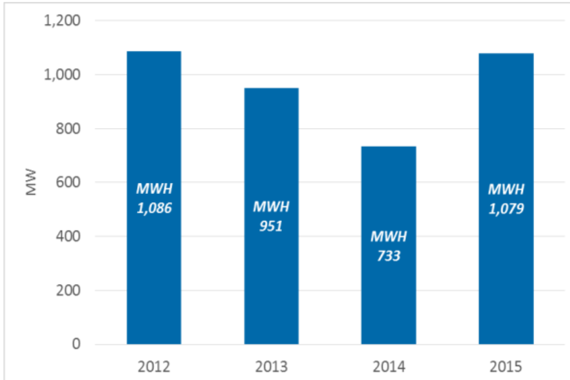


Table 1-9 shows the claimed and evaluated gross demand reduction for each utility's load management portfolio for PY2015. The EM&V Team evaluated a census of participants' interval meter data. Evaluated impacts were effectively the same as claimed impacts across all utilities.

Table 1-9. Program Year 2015 Claimed and Evaluated Gross Demand Reduction—Load Management

Utility	Percent Statewide Reduction (kW)	2015 Claimed Demand Reduction (kW)	2015 Evaluated Demand Reduction (kW)	Realization Rate
AEP TCC	12%	27,418	27,418	100%
AEP TNC	1%	1,744	1,762	101%
CenterPoint	52%	119,442	119,718	100%
El Paso Electric	3%	6,711	6,711	100%
Entergy	3%	7,320	7,320	100%
Oncor	24%	54,902	54,902	100%
SWEPCO	3%	5,883	5,883	100%
TNMP	2%	3,742	3,742	100%
Xcel SPS	2%	4,252	4,252	100%
Total	**100%**	**231,414**	**231,708**	**100%**

Table 1-10 shows the claimed and evaluated gross energy savings for each utility's load management portfolio for PY2015. As noted above, a census of projects was evaluated.

Table 1-10. Program Year 2015 Claimed and Evaluated Gross Energy Savings—Load Management

Utility	Percent Statewide Savings (kWh)	2015 Claimed Energy Savings (kWh)	2015 Evaluated Energy Savings (kWh)	Realization Rate
AEP TCC	3%	27,418	27,418	100%
AEP TNC	1%	6,252	6,259	100%
CenterPoint	67%	718,308	718,308	100%
El Paso Electric	3%	33,555	33,555	100%
Entergy	2%	23,533	23,533	100%
Oncor	16%	171,505	171,505	100%
SWEPCO	6%	60,392	60,392	100%
TNMP	< 0.5%	3,742	3,742	100%
Xcel SPS	3%	34,004	34,004	100%
Total	**100%**	**1,078,709**	**1,078,716**	**100%**

1.2.5 Pilot results

The statewide PY2015 evaluated gross energy savings from pilot programs were 12,904,332 kWh. This reflects a 24 percent decrease in annual savings compared to PY2014 but approximate parity with the PY2013 savings.[9] Statewide PY2015 demand reduction was 9,329 kW, representing a 5 percent decrease compared to PY2014.[10]

Figure 1-14 and Figure 1-15 show statewide evaluated gross demand reduction and energy savings, respectively, for pilot programs from PY2012 through PY2015.

[9] PY2014: 17,063,590 kWh / PY2013: 12,829,189 kWh / PY2012: 4,710,045 kWh.
[10] PY2014: 9,800 kW / PY2013: 4,674 kW / PY2012 1,710 kW.

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

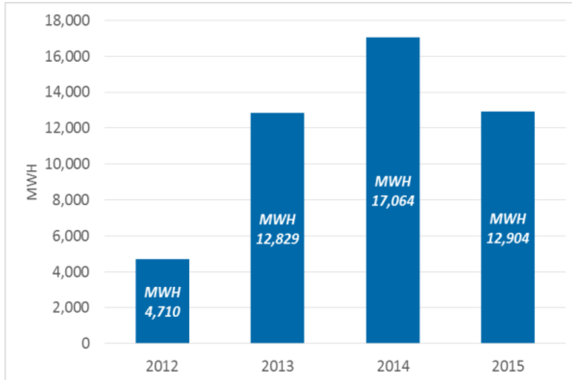


Figure 1-15. Total Statewide Evaluated Energy Savings by Program Year—Pilot Programs

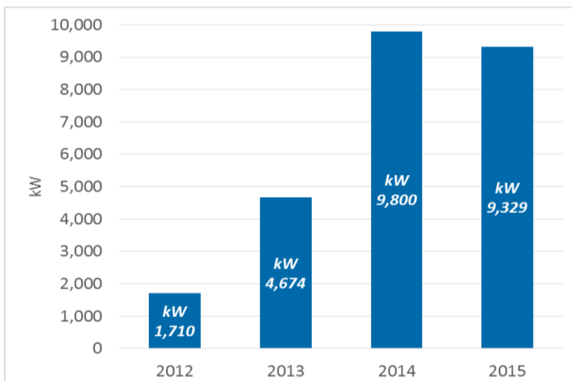


Table 1-11 shows the claimed and evaluated gross demand reduction for each utility's pilot programs for PY2015. No desk reviews or on-site visits were conducted for these programs so no precision estimates are presented. Evaluated savings are based upon a 100 percent review of tracking data.

Table 1-11. Program Year 2015 Claimed and Evaluated Gross Demand Reduction—Pilots

Utility	Percent Statewide Reduction (kW)	2015 Claimed Demand Reduction (kW)	2015 Evaluated Demand Reduction (kW)	Realization Rate
AEP TCC	< 0.5%	17	17	100%
AEP TNC	< 0.5%	5	5	100%
CenterPoint	23%	2,075	2,124	102%
El Paso Electric	3%	295	295	100%
Oncor	74%	6,886	6,886	100%
Sharyland	< 0.5%	2	2	100%

Utility	Percent Statewide Reduction (kW)	2015 Claimed Demand Reduction (kW)	2015 Evaluated Demand Reduction (kW)	Realization Rate
Total	**100%**	**9,280**	**9,329**	**101%**

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

Table 1-12. Program Year 2015 Claimed and Evaluated Gross Energy Savings—Pilots

Utility	Percent Statewide Savings (kWh)	2015 Claimed Energy Savings (kWh)	2015 Evaluated Energy Savings (kWh)	Realization Rate
AEP TCC	< 0.5%	62,004	62,004	100%
AEP TNC	< 0.5%	22,397	22,397	100%
CenterPoint	95%	12,026,856	12,228,738	102%
El Paso Electric	5%	584,130	584,130	100%
Oncor	0%	0	0	N/A
Sharyland	< 0.5%	7,063	7,063	100%
Total	**100%**	**12,702,449**	**12,904,332**	**102%**

1.3 COST-EFFECTIVENESS RESULTS

The EM&V team calculated PY2015 cost-effectiveness based on claimed savings, evaluated savings, and evaluated net savings[11] using the Program Administrator Cost Test (PACT). Overall cost-effectiveness of Texas energy efficiency programs based on evaluated savings was 2.49 including low-income programs and 2.71 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 2.68 excluding low-income programs. Finally, the cost-effectiveness when calculated using net savings is 2.10 including low-income programs and 2.28 excluding low-income programs. Cost-effectiveness ratios increased from PY2014 results in part because the avoided cost of energy increased from $0.046 to $0.053.

[11] 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).

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 2.18 to 4.00 based on evaluated savings results and from 1.85 to 3.52 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.[12] Cost-effectiveness without low-income programs ranged from 2.37 to 4.00 based on evaluated savings and from 2.00 to 3.52 based on evaluated net savings.

Table 1-13. Program Year 2015 Cost-effectiveness Benefit/Cost Ratio—Total Portfolio

Utility	Claimed Savings	Evaluated Gross Savings	Evaluated Net Savings	Claimed Savings w/o Low-income	Evaluated Gross Savings w/o Low-income	Evaluated Net Savings w/o Low-income
AEP TCC	2.52	2.55	2.17	2.74	2.78	2.36
AEP TNC	2.48	2.57	2.23	2.72	2.81	2.44
CenterPoint	2.56	2.58	2.12	2.77	2.8	2.29
El Paso Electric	3.99	4.00	3.52	3.99	4.00	3.52
Entergy	3.11	3.09	2.59	3.11	3.09	2.59
Oncor	2.16	2.19	1.87	2.42	2.45	2.09
Sharyland	2.70	2.68	2.28	2.99	2.98	2.51
SWEPCO	2.62	2.65	2.27	2.62	2.65	2.27
TNMP	2.18	2.18	1.85	2.37	2.37	2.00
Xcel Energy	2.57	2.61	2.23	2.81	2.87	2.42

Table 1-14 summarizes the cost of lifetime kWh and kW for each utility. The cost per kWh ranges from $0.008 to $0.012, and the cost per kW ranges from $11.98 to $18.83. 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.

[12] 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 1-14. Program Year 2015 Cost-effectiveness Results—
Cost of Lifetime Savings**

Utility	kWh	kW
AEP TCC	$0.012	$18.68
AEP TNC	$0.012	$18.15
CenterPoint	$0.011	$17.65
El Paso Electric	$0.008	$11.98
Entergy	$0.009	$13.89
Oncor	$0.012	$18.83
Sharyland	$0.010	$14.35
SWEPCO	$0.011	$17.02
TNMP	$0.011	$16.92
Xcel Energy	$0.011	$17.22

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 3.05 statewide based on evaluated savings and 2.57 based on net savings. Utilities' results ranged from 2.29 to 5.33 based on evaluated gross savings and 2.04 to 4.61 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. Program Year 2015 Cost-effectiveness Benefit/Cost Ratio —
Commercial Sector**

Utility	Claimed Savings	Evaluated Gross Savings	Evaluated Net Savings
AEP TCC	3.15	3.17	2.73
AEP TNC	2.68	2.70	2.34
CenterPoint	3.31	3.28	2.67
El Paso Electric	5.33	5.33	4.61
Entergy	3.43	3.42	3.01
Oncor	2.62	2.62	2.21
Sharyland	3.47	3.47	2.95
SWEPCO	2.74	2.76	2.32
TNMP	2.29	2.29	2.04
Xcel Energy	3.35	3.36	2.80

*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 $0.006 to $0.012, and the cost per kW ranges from $9.60 to $18.02. 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. Program Year 2015 Cost-effectiveness Results—
Cost of Lifetime Commercial Sector Savings

Utility	kWh	kW
AEP TCC	$0.010	$14.10
AEP TNC	$0.012	$18.02
CenterPoint	$0.009	$14.01
El Paso Electric	$0.006	$9.60
Entergy	$0.009	$13.39
Oncor	$0.011	$15.29
Sharyland	$0.009	$12.61
SWEPCO	$0.012	$17.72
TNMP	$0.012	$17.78
Xcel Energy	$0.010	$14.02

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 2.65 based on evaluated savings and 2.18 based on evaluated net savings. The residential sector had the widest variability between utilities, with evaluated savings results ranging from 2.46 to 3.23 and net savings results ranging from 2.01 to 2.79. 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. Program Year 2015 Cost-effectiveness Benefit/Cost Ratio — Residential Sector

Utility	Claimed Savings	Evaluated Gross Savings	Evaluated Net Savings
AEP TCC	2.46	2.52	2.06
AEP TNC	2.99	3.23	2.79
CenterPoint	2.79	2.87	2.27
El Paso Electric	2.76	2.78	2.48
Entergy	3.00	2.97	2.37
Oncor	2.40	2.46	2.09
Sharyland	2.88	2.87	2.40
SWEPCO	2.59	2.62	2.26
TNMP	2.53	2.53	2.01
Xcel Energy	2.44	2.57	2.19

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

Table 1-18 summarizes the cost of lifetime kWh and kW for each utility's residential sector programs. The cost per kWh ranges from $0.009 to $0.012, and the cost per kW ranges from $12.79 to $17.71. 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. Program Year 2015 Cost-effectiveness Results—Cost of Lifetime Residential Sector Savings

Utility	kWh	kW
AEP TCC	$0.012	$17.71
AEP TNC	$0.009	$13.23
CenterPoint	$0.009	$13.76
El Paso Electric	$0.011	$14.96
Entergy	$0.009	$13.26
Oncor	$0.010	$15.70

Utility	kWh	kW
Sharyland	$0.009	$13.08
SWEPCO	$0.010	$15.22
TNMP	$0.009	$12.79
Xcel Energy	$0.010	$14.81

1.3.4 Low-income results

Table 1-19 summarizes the cost-effectiveness of each utility's low-income energy efficiency portfolio.[13]

As expected due to the higher program costs associated with serving this residential sector, low-income programs had a statewide cost-effectiveness ratio of 1.33.[14] 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.

Table 1-19. Program Year 2015 Cost-effectiveness Benefit/Cost Ratio — Low-income Sector

Utility	Claimed Savings	Evaluated Gross Savings
AEP TCC	1.40	1.27
AEP TNC	1.12	1.12
CenterPoint	1.69	1.69
El Paso Electric	N/A	N/A
Entergy	N/A	N/A
Oncor	1.01	1.04
Sharyland	2.78	2.65
SWEPCO	N/A	N/A
TNMP	1.81	1.77
Xcel Energy	2.27	2.27

1.3.5 Load management results

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

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

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

Load management programs had the lowest cost-effectiveness of non-low-income or pilot programs at 1.61, 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 1.13 to 3.34. 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. Program Year 2015 Cost-effectiveness Benefit/Cost Ratio — Load Management Sector

Utility	Claimed Savings	Evaluated Gross Savings
AEP TCC	2.24	2.24
AEP TNC	3.31	3.34
CenterPoint	1.62	1.62
El Paso Electric	1.66	1.66
Entergy	1.63	1.63
Oncor	1.38	1.38
Sharyland	N/A	N/A
SWEPCO	2.13	2.13
TNMP	1.45	1.45
Xcel Energy	1.13	1.13

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 1.64 based on evaluated savings and 1.42 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. The AEP utilities' Efficiency Connection Pilot programs did not pass cost-effectiveness in 2015 and was in the first year of operation. The other utilities' pilot programs collectively passed.

Table 1-21. Program Year 2015 Cost-effectiveness Benefit/Cost Ratio — Pilot Sector

Utility	Claimed Savings	Evaluated Gross Savings	Evaluated Net Savings
AEP TCC	0.42	0.42	0.42
AEP TNC	0.17	0.17	0.17
CenterPoint	1.6	1.63	1.36
El Paso Electric	2.89	2.89	2.79
Entergy	N/A	N/A	N/A
Oncor	1.51	1.51	1.51
Sharyland	1.71	1.71	1.59
SWEPCO	N/A	N/A	N/A
TNMP	N/A	N/A	N/A
Xcel Energy	N/A	N/A	N/A

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 PY2015 evaluation research, which was completed in calendar year 2016, are expected to be implemented in PY2017.

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 PY2015 EM&V scope, the EM&V team provides the following recommendations for the residential and commercial programs, and for issues that jointly affect both residential and commercial sector programs ("cross-sector").

1.5 RESIDENTIAL PROGRAMS

1.5.1 **Recommendation:** Residential new construction programs should consider new program design strategies in response to code changes.

Texas, through HB 1736, has now adopted the 2015 IRC as the state minimum residential new construction code, effective September 1, 2016. Due to Texas operating under "home rule," which requires each local jurisdiction to implement and enforce building codes, there may be a delay or lag-time between state adoption and local implementation of energy codes. To recognize both this lag-time as well as the adoption of the new code, it is currently planned that the 2018 TRM (version 5.0) will move the baseline for the residential new construction programs to the 2015 IRC code.

The Energy Efficiency Rule allows utilities to calculate savings using a baseline below existing energy codes if codes are not fully-enforced, and to implement a program to encourage code adoption or compliance (16 TAC § 25.181 (m) (f)). Historically, utility programs have incentivized builders to exceed the energy code. However, the 2015 IRC code is likely significantly more energy efficient than current building practice. Therefore, there may be opportunity in the near-term for utility programs to provide incentives and education for the building community to realize the efficiency of 2015 IRC in practice, in addition to obtaining savings beyond 2015 IRC.

Action Plan: Utilities who want to continue to offer residential new construction programs need to consider program re-designs to address the baseline code change. Utilities choosing to pilot a new residential new construction program will include the pilot in their 2017 EEPRs for PY2018. If utilities are not able to file a pilot in their 2017 EEPR, they will need to file a program template for the program to be offered in 2018.

1.5.2 **Recommendation:** While the EM&V team's consumption analysis shows RSOP and HTR programs are delivering substantial average household savings, there is an opportunity to encourage more HVAC participation in the residential programs.

Energy savings relative to pre-program household usage for both RSOP and HTR SOP programs are strong, with the average household saving 8 percent of their energy annually as a result of program participation. This percent of savings is comparable to programs in other jurisdictions that are designed specifically to address homes' energy efficiency needs comprehensively. The EM&V team's consumption analysis and comparison of results to other programs throughout the U.S. demonstrates the effectiveness of the Texas RSOP and HTR programs.

At the same time, the EM&V team's consumption analysis shows an opportunity for continued delivery of substantial savings through the programs by increasing the number of HVAC measures implemented. For RSOP, central AC and heat pump replacements (averaging a Seasonal Energy Efficiency Ratio—SEER--around 15-16) achieved an estimated 9 percent and 16 percent energy savings, respectively, though they were installed in less than 2 percent of the program population. Furthermore, for these measures, TRM savings estimates were remarkably close to model estimates. Given the savings potential and relatively low frequency of installation, there appears to be an opportunity to increase EESP solicitation, incentive levels, or marketing to optimize equipment replacement through these programs.

Action Plan: The utilities will consider program design strategies to increase HVAC measures in the residential programs.

1.5.3 **Recommendation:** Facilitate collaboration between contractors to encourage increased services to individual participating customers.

This is a repeated recommendation from the PY2013 EM&V research as the PY2015 EM&V research. It remains a strategy that utilities should consider to benefit residential customers and is related to the recommendation above to increase HVAC participation. Currently, participating residential contractors are specialized (e.g., HVAC, insulation and air sealing) and focus on only a few measure offerings within the program. A customer could potentially participate in the program multiple times as contractors would come back to deliver one-off measures. In addition, utilities report having difficulty promoting the installation of HVAC measures as there are a limited number of contractors with the necessary certifications actively participating in the program. The single measure focus and limited HVAC contractor participation decreases the potential for the programs to provide a comprehensive approach.

A potential design change could include the coordination of a general contractor who is responsible for pulling in program-qualified HVAC, weatherization, and air sealing contractors to perform the work in a home. Another option is offering a referral bonus to encourage networking and cooperation between contractors. Alternatively, an initial home audit/inspection could serve to identify other qualifying measures and provide a roadmap for subsequent work. This audit could be performed by the contractor who is the initial point of contact, or (for instance, in the case a very specialized contractor, like HVAC, who was initially solicited by the customer) the contractor could encourage participants to take the next step in receiving a free home audit through a subsequent visit. Similar modifications to design would help ensure the customer receives more qualifying measures and services during their program participation. These types of strategies are likely market transformation efforts. The EM&V team also recognizes difficulties of more comprehensive approaches given electric only goals.

Action Plan: The utilities will consider the feasibility and relevance for their portfolio of cost-effective residential program design strategies intended to increase services to households.

1.5.4 **Recommendation:** Update the 2017 TRM deemed savings for duct sealing, air infiltration and ceiling insulation measures to improve the accuracy of the savings estimates for these measures.

Duct sealing, air infiltration, and ceiling insulation measures account for the majority of savings for residential, hard-to-reach, and low-income programs in Texas. In PY2015, these measures alone accounted for approximately 90 percent of energy and demand savings in these three residential programs. During its site inspection activities in PY2013 and PY2014, the EM&V team observed notable variation in air and duct leakage rates relative to the reported values, with these site visit findings significantly influencing realization rates. Given the large proportion of program savings derived from these measures, the PY2015 EM&V scope included a robust approach to assess the impacts of these and other program measures in the RSOP and HTR programs through a consumption analysis. The consumption analysis also supports the need to update the TRM values to estimate savings from these measures more accurately.

Action Plan: The PY2017 TRM will include updates for these measures based on simulation modeling results assessed for reasonableness against the EM&V team's consumption analysis results.

1.5.5 **Recommendation:** For Duct Efficiency, savings should be calculated with respect to the pre-leakage cap when applicable.

The PY2015 TRM (version 2.1) contains an eligibility requirement for the duct efficiency improvement measure, the application of which led to a difference in reported and evaluated savings for several measures across the utilities. The TRM applies a cap to the initial leakage rate against which contractors can claim savings. For homes with an initial leakage rate greater than 35 percent of total fan flow, savings are awarded with respect to this cap rather than the initial leakage (RSOP and HTR at utilities' discretion).

Action Plan: Utilities will check for compliance with this recommendation in their QA/QC efforts for PY2016 claimed savings as well as compliance with additional updates occurring for this measure in the PY2017 TRM (version 4.0).

1.5.6 **Recommendation:** Include in the 2017 TRM (version 4.0) the M&V Methodology for Residential Demand Response Programs, which are new offerings in Texas, to improve the consistency and transparency of savings calculations going forward.

Two Texas utilities operated residential demand response programs in PY2015—one utility offered a residential demand response program for the first time and the other continued to offer it as a pilot. The PY2015 analysis process was the first conducted using the TRM baseline methodology, known as the "High 3 of 5" method. This method selects three of five prior non-holiday weekdays with the highest loads during event hours as the baseline days, representing what would have happened if an event had not been called. Adjustments for the day of the event are made to either increase or decrease the baseline by comparing loads prior to the event on the event day with the same hours on baseline days. The EM&V team worked with the utilities to bring all parties to consensus on application of the TRM calculation method going forward, and to identify and resolve minor analytic differences not addressed by the PY2015 TRM (version 2.1).

Action Plan: Utilities will provide residential demand response interval meter kWh data to the EM&V team, without modification. Data rounding will occur only at the event level. Utilities will provide documentation on its entire calculation approach to arrive at program-level annual savings and will document any data retention or other data issues affecting savings calculations.

1.5.7 **Recommendation:** Utilities should strive to consistently apply either TRM stipulated efficiency levels or actual field values.

TRM V2.1 specifies stipulated baseline values for SEER of 13 and Heating Seasonal Performance Factor (HSPF) of 7.7, to provide an average in-situ equipment efficiency used in residential deemed savings calculations across projects. In some cases, the claimed savings appear to be calculated based on actual efficiency values in place of the defaults. Given the possibility of selectively applying actual efficiencies or stipulated efficiencies in order to maximize savings, only one approach should be used consistently by a utility for a measure input. The EM&V team does recognize there can be exceptions when field data is chosen to be used such as age of a unit, but it cannot be collected and therefore a default value has to be used.

Action Plan: Utilities will educate EESPs on the approach they have chosen to be consistently applied for their residential programs' measure inputs, clearly indicate in program documentation which approach they have chosen, and check for compliance with this recommendation in their QA/QC. If a utility chooses field data for a measure input and an exception is needed, the reason the default has to be used instead of a field value will be documented.

1.6 COMMERCIAL PROGRAMS

1.6.1 **Recommendation:** Commercial behavioral programs should fully document the activities taken to achieve savings at the site-level. Consistent with other M&V projects that span program years, commercial behavioral programs should only claim 40 percent of savings the first program year with the remainder of the project savings claimed the next program year, once the M&V is complete.

Behavioral programs are an energy efficiency offering allowed in Texas through their inclusion in the current Energy Efficiency Rule (16 TC 25.181 (c) (12)). One Texas utility offered a commercial behavioral program for the first time in Texas in PY2015. The program targets independent school districts (ISDs) to encourage activities that promote energy reduction through behavior and operational changes.

To better understand how the behavioral program was being conducted in the field, on-site visits were conducted at six sites across two ISDs. To provide further assessment of and recommendations for the method used to estimate savings, the EM&V team worked with the utility and their implementation contractor to review a regression analysis in detail. A final census savings and documentation review was completed for all behavioral savings reported in PY2015. The utility, implementation contactor, and EM&V team then worked together to agree on a robust approach for commercial behavioral programs, which have informed updates for the PY2017 TRM (version 4.0).

Action Plan: Utilities offering commercial behavioral programs will follow the updated TRM M&V methodology and consult the detailed specific recommendations for this type of program included in this PY2015 Statewide Annual Portfolio Report.

1.6.2 **Recommendation:** Include in the 2017 TRM (version 4.0) the M&V Methodology for Commercial Load Management Programs to improve the consistency and transparency of savings calculations going forward and to provide additional guidance on other issues that have arisen during program implementation.

Nine of the ten utilities offered commercial load management programs during PY2015. These are mature programs in Texas. The EM&V team worked with each utility to develop and verify the claimed savings. Despite the common TRM calculation framework, it emerged that subtle differences in the calculations drove initial discrepancies. Examples include:

- Differences in calculation order-of-operations that caused rounding differences.
- Identifying sponsors on interruptible tariff and events in which both interruptions and load management programs were simultaneously occurring
- As a matter of utility policy whether to include scheduled/test events in demand savings
- Different meter data time stamps (in one case, the time stamp represented the forward-looking interval, whereas all other utilities had time stamps that reflected the preceding interval).

During the course of the PY2015 EM&V effort, the EM&V team also provided guidance on areas not addressed in the TRM. The first was related to rounding practices. The EM&V team recommended that rounding occur at the sponsor level for each event. The second was assessment of when it is reasonable to substitute utility meter data with sponsor-owned meter data for purposes of calculating event-level savings. It was agreed that in the event a utility-owned meter failed to record interval data for a baseline or event period, data from a customer-owned meter or sub-meter could be used if:

- The data were substantially similar to utility meter data; and,
- The data would be used consistently for an entire event's baseline and event-day time periods (i.e., not mixing utility and sponsor meter data).

Finally, the EM&V team requested data that would support the calculation of PY2015 savings using the PY2016 TRM (version 3.1) method to support utilities' understanding and correct calculation of savings for PY2016 in advance. Thus, any issues or lessons learned could be identified proactively prior to the PY2016 control season. This precaution arises because the PY2016 TRM (version 3.1) method for calculating a baseline demand, called *High 5 of 10*, requires more data than the previous method, and the use of pre-event notification hours on the event day and baseline days to adjust for current-day conditions. In particular, the *High 5 of 10* method requires a clear identification of each event's start and end time (the full range of the event), as well as when sponsors were given notification that an event was occurring (particularly for unscheduled events). Additionally, it will become important to identify the sponsors or ESIIDs that participated in each event, indicating whether for that event their meter data should be used in calculating event or sponsor savings. It is possible that a non-controlling sponsor would show a higher demand during an event. Without this information, at the sponsor or ESIID level, the calculated savings could underrepresent the programs' impact.

Action Plan: Utilities will provide comprehensive and complete information about each event. Data rounding should occur in only two instances – sponsor-level savings and final program savings summaries. Utilities will document standard practices if sponsors on interruptible tariffs have overlapping interruptions and load management program participation. Each utility will provide documentation on its entire calculation approach to arrive at program level annual savings.

1.6.3 **Recommendation:** Update the 2017 TRM (version 4.0) for Cool Roofs to provide consistency and improvements to the eligibility, baseline condition, and high-efficiency conditions of the measure.

The EM&V team performed a review of the four roofing calculators currently used throughout the commercial programs in Texas, as well as a newly developed calculator. Overall, the EM&V team found a variety of differences between the calculators, including limitations of parameter entry and selections, unclear direction on their use, and the fact that some roofing projects are using site-specific assumptions while others are using default conditions stipulated in the TRM. The measure description and requirements within the TRM were also found to be in need of clarification and updates in the following areas: applicable building types, eligibility criteria, baseline condition, high-efficiency condition and one consistent energy and demand savings methodology.

Action Plan: Utilities will update Cool Roof calculators to comply with the PY2017 TRM (version 4.0). Utilities should implement the measure consistently across their portfolio, choosing one calculator and using either field or TRM default values for this measure.

1.6.4 **Recommendation:** Project savings for measures that did not receive an incentive should only be claimed if they can be demonstrated to be attributable to the utility program[15].

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

The EM&V team has some concern regarding claiming all savings in projects where an incentive cap is reached. Since some of the project savings are being incentivized, there is less certainty that those savings would have occurred without the program. Claiming all of the project savings may result in increased free-ridership. A free-rider is, “a program participant who would have implemented the program measure or practice in the absence of the program.” (16 TAC § 25.181 (c) (24))[16].

Action Plan: If utilities are planning to claim savings beyond those incentivized for an individual commercial EESP or project, they will inform the EM&V team and supply project documentation for the specific project. The EM&V team may conduct additional research to determine the influence of the program on the total project savings. The EM&V team’s recommendation should be used to adjust the utilities’ claimed savings for the project(s).

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

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

1.7 CROSS-SECTOR

1.7.1 **Recommendation:** Fully recognizing that pilots are an important method for utility portfolios to introduce new program concepts and/or technologies, utilities should transition pilots to programs after two years if cost-effectiveness is demonstrated.

16 TAC § 25.181 allows utilities to pilot new program concepts without passing cost-effectiveness the first year. This is in keeping with standard industry practice given the first year start-up costs make it difficult to be cost-effective in the short term. Recently piloted program concepts have included offerings targeting specific customer segments such as small business, multi-family and data centers; new technologies such as pool pumps and AC tune-ups; and new delivery concepts such as working with Retail Electric Providers (REPs) to deliver energy efficiency offerings to customers.

While offering pilots is an industry best practice, in Texas there have been no clear criteria or consistent delineation of when a “pilot” program transitions to a full program in a utility’s portfolio. While the transition is clearly articulated in utilities’ EEPRs, the drivers of this transition often are not. Documenting and systematizing the “pilot to program” transition is an area for improvement. The Commission does expect pilot programs to pass a cost-effectiveness test the second year. Therefore, the EM&V team asserts that if pilots pass cost-effectiveness the second year of implementation, and if the utility plans to continue to offer them, they should be designated as a program. At the same time, we realize a pilot may not be cost-effective in the second year and a utility will have to consider re-design strategies for the pilot to be cost-effective. In these cases, the offering would continue as a pilot until it demonstrates it is a viable, cost-effective offering. Otherwise, it needs to be discontinued.

Action Plan: Utilities will begin following this recommendation regarding pilot or program status with the 2017 EEPRs.

1.7.2 **Recommendation:** Upstream lighting programs should allocate 5 percent of savings and costs to the commercial sector and 95 percent to the residential sector, based on industry research on which customer sectors receive discounted upstream bulbs.

An increased number of utilities are offering or planning to offer upstream lighting programs in Texas. It is important that savings are calculated and reported consistently across utilities and in agreement with industry standard practice and the Energy Efficiency Rule 16 TAC § 25.181. The industry refers to the installation of residentially targeted program light bulbs in commercial applications as “cross-sector sales.” Industry standard practice is to allocate a percentage of upstream program bulbs to the commercial sector to account for cross-sector sales.

The EM&V team reviewed 12 upstream lighting evaluation reports or Technical Reference Manuals (TRMs), each of which touched on the topic of cross-sector sales. Overall, the percentage of commercial sales attributed to upstream lighting programs ranged from three percent to just under thirteen percent.

Action Plan: Utilities offering upstream lighting programs will consult the April 2016 guidance memo *Upstream Lighting Claimed Savings* for guidance on savings calculations and claiming savings and costs.

1.7.3 **Recommendation:** Multi-family master-metered customer savings should be claimed for the commercial sector. Individually metered multi-family customer savings should be claimed for the residential sector.

During the course of the evaluation effort, there were several situations where utilities requested guidance on how savings from multi-family projects should be claimed. The general guidance is that if a multi-family customer is master-metered, they are a commercial account and savings should be claimed for the commercial sector. If a multi-family customer is individually metered, savings should be claimed for the residential sector. From discussions with Texas utilities, this is their standard practice and is the standard practice in other states, based on the EM&V team's experience.

However, two specific situations were discussed that have additional complexities. In the first, a multi-family customer was completing major renovations of their facility including moving from master-metered to individually metered units. In this situation, the savings should be claimed by the residential sector since benefits will accrue to residential customers. Another utility program encourages multi-family natural gas space heating and water heating through the installation of a central boiler system as opposed to individual electric space and water heating. In these cases, the boiler is a commercial account and the measure is a commercial application. However, savings should be claimed at the residential sector as the benefits accrue to the residential customer.

Action Plan: Utilities will consult the March 2016 guidance memo *Multi-family Claimed Savings* for guidance on claiming multi-family savings and costs.

1.7.4 **Recommendation:** Utilities may want to consider requesting EM&V team early reviews of savings calculations updated in the PY2017 TRM.

The PY2017 TRM (version 4.0) will have substantial updates to a few measures, including solar PV, commercial HVAC, commercial cool roofs, and the residential envelope measures. Commercial measures have savings calculated within excel-based spreadsheets whereas residential measures are calculated within program tracking systems.

Action Plan: Utilities will determine individually if they would like to request savings reviews by the EM&V team in advance of interim EM&V results.

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' responsiveness to the EM&V effort. The utilities have demonstrated a willingness to work with the EM&V contractor both when EM&V results identify an adjustment to claimed savings that is needed and upfront when M&V reviews or additional technical assistance or input can reduce uncertainty in savings estimates. At the same time, the PY2015 EM&V research identified a number of substantial savings improvements, in particular for the residential envelope measures. The EM&V team is working with the utilities to integrate these savings improvements into the PY2017 TRM.

The utilities' responsiveness to EM&V, an energy efficiency best practice,[17] also extends to the implementation of prior year EM&V recommendations. Utilities responded to recommendations identified from the PY2013 EM&V effort, summarized below, which has resulted in: more accurate savings estimates, increased consistency in savings calculations, a more diversified measure mix, increased compliance with TRM requirements, continued maximization of net savings, and sharing of best practices across the ten utilities to improve program implementation across the state.

- **More accurate savings estimates.** A number of opportunities to improve savings estimates identified in the PY2013 research such as part load efficiencies for HVAC and heating/cooling interaction factor (HCIF) to the savings calculation for lighting measures were incorporated in the PY2016 TRM. Another priority set of updates including for solar photovoltaics (PV), residential envelope measures, commercial HVAC, residential new construction and cool roofs are currently in progress for PY2017.
- **Increased consistency in savings calculations.** A consistent peak demand definition and baseline methodologies for load management programs were incorporated into the annual TRM update for PY2016 and applicable program savings tools. Utilities also collaborated with the EM&V team on a number of guidance memos to improve consistency.[18] Lighting projects still represent the majority of commercial savings and the PY2015 EM&V found significant improvement over the PY2013 research. In that year the team saw several examples of inconsistency in lighting projects related to mixed building types and outdoor lighting projects as well as M&V methods to calculate lighting hours of use (HOU) and coincidence factors (CF).
- **More diversified measure mix.** Since PY2013, the utilities have improved the diversity of the measures offered. They developed deemed savings for additional measures recommended by the EM&V team including: HVAC tune-ups, residential LEDs and shower auto-shutoff thermostatic valve. In addition, utilities are currently collecting M&V information for the additional recommended measures of pool pumps and ductless "mini-split" heat pumps. The utilities have also increased the percentage of total savings from custom projects and collaborated with the EM&V team to develop standardized M&V protocols that were integrated into the TRM for 'enhanced' HVAC tune-ups, commercial behavioral programs and solar shingles.

[17] National Action Plan for Energy Efficiency (NAPEE), Department of Energy, 2006.

[18] The EM&V contractor drafts guidance memos for the electric utilities' energy efficiency programs in order to provide clear direction on calculating or claiming savings. Guidance memos are consistent with the Energy Efficiency Rule 16 TAC 25.181 and the Texas Technical Reference Manual (TRM), but address areas where additional direction is needed for consistency and transparency across utilities' claimed savings from the programs. Guidance memos have included technology-specific calculation recommendations such as for LEDs; implementation recommendations such as practices in order to claim savings for early retirement of residential HVAC; and sector recommendations such as where to claim savings for multi-family customers.

- **Increased compliance with TRM requirements.** In the PY2013 research, the EM&V team found multiple examples of incentives being awarded for non-qualified LEDs. The TRM requires third-party certification of LEDs to ensure quality and the persistence of energy savings. While a few non-qualified LEDs were still found in the 2015 EM&V, these cases were fewer than in previous years and utilities adjusted claimed savings to remove non-qualifying LEDs. The utilities also worked with the EM&V team on a guidance memo that establishes a process for new construction projects with a small percent of non-qualifying LEDs if the square footage of the non-qualifying lighting cannot be isolated (isolation of square footage is the preferred approach, but is not always feasible)[19].
- **Continued maximization of net savings.** Utilities have continued activities to maximize net savings including workshops and trainings to EESPs to support their effective delivery of SOPs. In addition, utilities have continued to offer direct customer technical assistance through MTPs for areas where there is a defined need and are targeting hard-to-reach customer segments where freeridership is relatively low, such as small business and multi-family.
- **Shared best practices and lessons learned.** Utilities are learning how their program designs compare to the other utility offerings through program manager meetings. Initially, the standard offer programs (SOPs) were designed to meet statewide commission requirements, but most utilities' programs have evolved to better serve their specific service territory. In the PY2013 EM&V recommendations it was identified that program managers would benefit from open communication between utilities about best practices and lessons learned. This communication has been taking place so that utilities can share information that helps them improve programs.

[19] *PY2013 Recommendation #1a additional guidance: Non Qualifying LEDs nonresidential savings calculations,* June 1, 2015, from Lark Lee and Kim Baslock to the Texas Electric Utilities.

2. 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 2015 (PY2015).

PY2015 is the fourth program year evaluated as part of the statewide EM&V effort. A distinct difference in the PY2015 scope from prior years is targeted impact evaluations for the savings areas of the highest uncertainty identified in the PY2012 through PY2014 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, a combination of desk reviews 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. Documentation reviewed were tracking data, project files, energy savings calculations (including a review of input assumptions and algorithms to verify claimed program savings), utilities' existing M&V information and interval meter data where appropriate.

The PY2015 EM&V plans[20] were based on the prioritization for the EM&V effort[21] presented and distributed for comment to the utilities and the Energy Efficiency Implementation Project (EEIP) and approved by PUCT staff. To summarize briefly, the EM&V team identified program types across utilities that have similar program design, delivery, and target markets. After reviewing each program type, programs were prioritized (high, medium, low) based on the following considerations (Request for Proposals 473-16-0003, Project No. 45019, Scope of Work Task 1B (n)):

- 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.

[20] *Public Utility Commission of Texas Evaluation, Measurement, and Verification (EM&V) Plans for Texas Utilities' Energy Efficiency and Load Management Portfolios—Program Year 2015*, November 30, 2015.

[21] *EM&V Prioritization for Program Year 2015* to Katie Rich and Therese Harris, PUCT, and the Texas Electric Utilities, from Lark Lee, EM&V project manager, March 11, 2015.

2.1 EVALUATION ACTIVITIES

The following EM&V activities were completed statewide:

- Tracking system deemed savings review
- 496 desk reviews
- 97 on-site M&V
- Calculation of load management impacts using interval meter data.
- Consumption data analysis for Residential Standard Offer and Hard-to-Reach program participants[22]

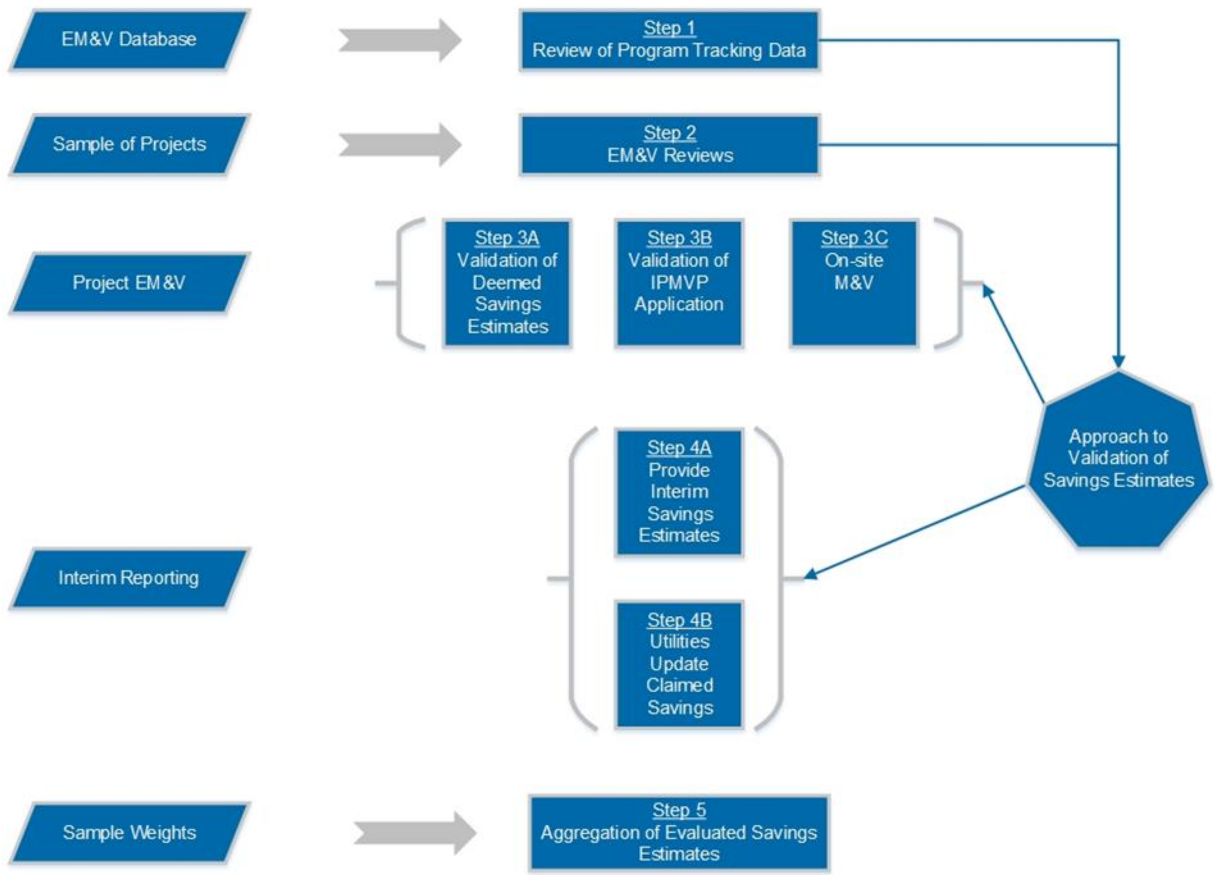
The EM&V activities:

- 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 the savings calculated in the deemed calculation tools or tables 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 PY2017 TRM

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 or 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.

[22] The consumption data analysis was limited to the following utilities that have a smart meter infrastructure: AEP TCC, AEP TNC, CenterPoint, Oncor, and TNMP.

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 PY2015 claimed and evaluated results. Low-income programs were also calculated using the Savings-to-Investment Ratio (SIR).

2.2 REPORT ORGANIZATION

Section 3 includes three statewide *residential* savings assessments: a residential consumption analysis of shell and HVAC measures, an impact evaluation of load management programs, and a review of new homes programs in light of building code changes. Section 4 includes program-specific results for three *commercial* programs or measures: a pilot behavioral program, the commercial cool roofs measures, and commercial load management programs. Section 5 provides process assessments of the schools market transformation program and piloting new pilot program concepts designation. A separate report volume (Volume II) details the EM&V results for each utility's portfolio.

3. RESIDENTIAL SAVINGS ASSESSMENTS

This section documents the EM&V team's results for a residential consumption analysis, load management programs and new homes programs.

3.1 RESIDENTIAL CONSUMPTION ANALYSIS

The EM&V team performed a consumption analysis of the Residential Standard Offer Program (RSOP) and the Hard-to-Reach Standard Offer Program (HTR SOP) to evaluate energy and demand impacts. RSOP and HTR SOP were categorized as high evaluation priorities for the PY2015 EM&V effort because of their significant contribution to overall portfolio savings and because of variability found in the PY2013-PY2014 on-site results for envelope measures.

It was discussed and agreed during PY2015 evaluation planning that a consumption analysis could help the EM&V team, the PUCT, the Texas electric utilities, and other stakeholders better understand the savings resulting from the measures installed through the RSOP and HTR programs. Another primary goal of the analysis was to inform prospective updates to the TRM for PY2017. Findings from this analysis are to be used as a point of comparison against simulation modeling concurrently being developed by the Electric Utilities Marketing Managers of Texas (EUMMOT) to revise measure savings estimates for the PY2017 TRM.

3.1.1 Key findings

There are several key findings from the PY2015 residential EM&V research:

1. Energy savings relative to pre-program household usage for both RSOP and HTR SOP are substantial, with the average household saving 8 percent of their energy annually due to the program. This percent of savings is comparable to programs in other jurisdictions that are designed specifically to address homes' energy efficiency needs comprehensively and therefore demonstrates the effectiveness of the RSOP and HTR programs in Texas.

2. Demand reduction compared to pre-program household usage is also substantial, with the consumption analysis showing 8 percent reduction of summer peak and 10 percent and 12 percent reduction, respectively, for RSOP and HTR for winter peak.

3. The residential HVAC TRM deemed savings are reasonable estimates of HVAC savings. Central AC and heat pumps are showing savings in the consumption data analysis very similar to the TRM estimated savings.

4. TRM updates for envelope measures, which are already prioritized and planned for the PY2017 TRM (version 4.0), are in fact needed to improve the accuracy of claimed savings. The consumption analysis showed that duct sealing, air infiltration, and ceiling insulation, which are the top three energy saving measures contributing to each program's savings based on TRM estimates, are in need of updates to improve accuracy of savings estimates in future years.

5. The application of TRM values on projects is significantly affected by the measurement of airflow reduction (i.e., cubic feet per minute [CFM]) and baseline R-values. Both sets of measurements need to be closely monitored in utility QA/QC.

3.1.2 Methodology

The EM&V team performed a consumption analysis of the RSOP and HTR SOP to evaluate energy and demand impacts on participating homes. We tested multiple model specifications for robustness, including combined fixed-effects models and individual, household-level, Princeton Scorekeeping Method (PRISM)-like regressions. The analysis required approximately two years of household energy consumption—one year before and one year after participation—to estimate the difference in consumption before and after the installation of energy efficiency measures. Where data were available, the team assessed a census of participants rather than a sample.

Regression-based consumption analysis is considered the industry best practice for estimating impacts associated with programs that offer multiple measure installations (e.g., shell improvements, equipment replacement), as noted in the Uniform Methods Project.[23] The consumption analysis provides an estimate of the actual program impacts, controlling for interactive effects between measures as well as changes in occupants or use behavior (e.g., takeback effect). Accounting for these factors is particularly beneficial when estimating the impacts of shell and HVAC measures offered through the programs, whether installed in isolation or in combination with other measures.

3.1.3 Data sources

The EM&V team used the following data sources in performing the consumption analysis:

1. ***Program tracking data*** for RSOP and HTR SOP, provided by the Texas utilities for all electric participants from January 2013 through December 2015.

   These data included participant names, contact information (e.g., address), unique customer identifiers, participation dates, and total reported *TRM* savings estimates per participant. These data also included detailed measure information such as measure names, descriptions, per-unit measure savings, and assumptions (such as quantities and efficiency levels) associated with savings calculations consistent with the Texas Technical Reference Manual (TRM).

2. ***Consumption data*** for RSOP and HTR SOP participants, provided by the Texas utilities, for all electric use at the 15-minute-interval level through advanced metering infrastructure meters.

   These data included time signatures for each interval reading and all kWh consumption, by participant account, from January 2013 through December 2015.

[23] National Renewable Energy Laboratory. The Uniform Methods Project Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol. Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol. Prepared by Ken Agnew and Mimi Goldberg, DNV KEMA. April 2013. https://www1.eere.energy.gov/wip/pdfs/53827-8.pdf.

3. ***Texas weather data***, including hourly average temperatures from January 2013 through December 2015 for 13 Weather Bureau Army Navy weather stations. The team used ZIP codes to match hourly heating and cooling degree days to respective hourly use read dates. We obtained TMY3 (typical meteorological year) 15-year normal weather values from 1991 to 2005 from the National Oceanic and Atmospheric Administration, and used these to assess energy use under normal weather conditions.

3.1.4 Participant group

For the impact analysis, the EM&V team gathered data from a participant (treatment) group composed of RSOP and HTR SOP customers who had measure installations between January 1, 2014, and December 31, 2014. The utilities included in the consumption analysis are: American Electric Power Texas Central Company (AEP TCC), American Electric Power Texas North Company (AEP TNC), CenterPoint Energy Houston Electric, LLC (CNP), Oncor, and Texas New Mexico Power Company (TNMP).

3.1.5 Comparison group

It is best practice to use a comparison group for consumption analysis to control for exogenous factors--e.g., rate changes, changes in economic conditions, non-programmatic effects--allowing us to observe the counterfactual: what would have happened absent the program intervention. For this study we created a comparison group of customers who participated in RSOP and HTR SOP but with installation dates after our study period, i.e., in mid to late 2015. Thus, comparability between the participant group and the comparison group was established. That is, if there are unspecified, unknown factors that make participating households different than a general cross-section of households, for instance differences in attitude or lifestyle, such differences are preserved in the control group through this method. Selecting a comparison groups using *future* participants rather than selecting a random sample of non-participants is a best practice to approximate the similarity between customers with self-selection tendencies.[24]

3.1.6 Final treatment and comparison samples

The team started with a census of participants and filtered those who did not pass a number of validation or data requirements. The following table provides the final analysis samples for the participant (i.e., treatment) and comparison groups.

[24] Ibid.

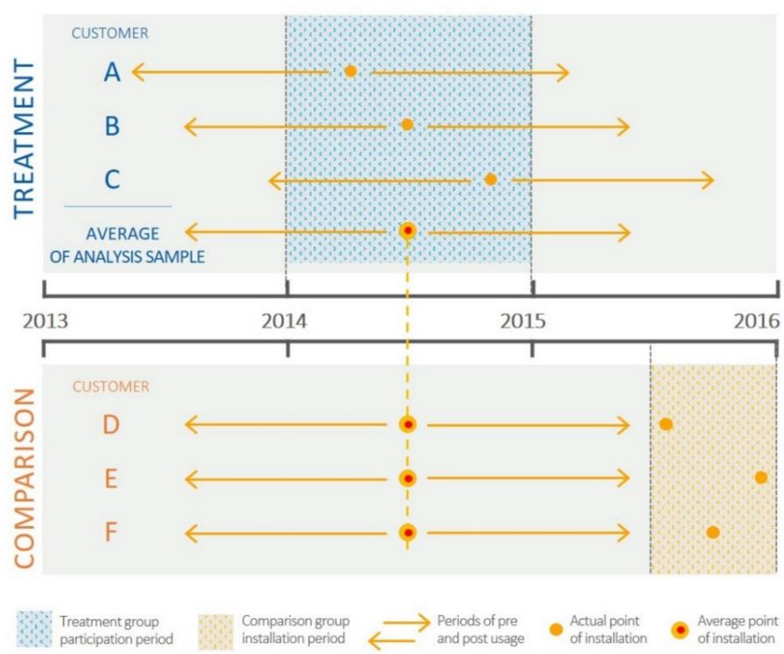
Table 3-1. Final Treatment and Comparison Groups, by Program

Utility	RSOP		HTR SOP	
	Treatment	Comparison	Treatment	Comparison
AEP TCC	1,566	1,843	389	53
AEP TNC	335	266	106	8
CNP*	409	0	521	0
Oncor	12,036	7,575	3,413	2,731
TNMP	732	107	64	0
Total	**15,078**	**9,791**	**4,493**	**2,792**

* The EM&V team did not receive consumption data for the CNP comparison group.

Figure 3-1 illustrates the approach to identifying the analysis period and defining pre- and post-treatment periods for the treatment and control groups.

Figure 3-1. Analysis Periods for Treatment and Comparison Groups



As Figure 3-1 indicates, the analysis period was defined by participants in RSOP and HTR SOP who received installations during calendar year 2014. We analyzed consumption data for this group starting at least 12 months before treatment and at least 12 months following treatment.

All participants in the treatment group were designated as either a pre- or post-treatment period based on the unique installation date for that customer. For example, if a customer received installations in January 2014, we would identify that period of installation and select the 12 month-period of available consumption data on either side of that date. As such, these pre and post periods for all customers in the treatment group vary by household.

For the comparison group we selected households in RSOP and HTR SOP who participated during PY2015 after the end of our study period. For this group, there is no *participation* occurring during our analysis period, and we assign *pre-* and *post*-treatment periods relative to the treatment group. Changes in this group's energy consumption represent what would have been observed during this period absent any program effect. To do this, we select a period that represents the *average* time of treatment across all treatment group participants. This occurred in June 2014. We designate that as the *point of delineation* for defining pre- and post-treatment periods for all comparison group customers.

3.1.7 Savings calculation

The EM&V team derived gross energy savings using the following equation to adjust the evaluated participant savings based on changes in the comparison group energy use. This adjustment accounted for exogenous factors that occurred outside of the program effect (all terms in the equation are averages).

$$Adj.\,Gross\ Savings = (Pre\ Usage_{Treat.})\left(\frac{Change\ In\ Usage_{Treat.}}{Pre\ Usage_{Treat.}} - \frac{Change\ In\ Usage_{Comp.}}{Pre\ Usage_{Comp.}}\right)$$

For estimating demand impacts, the team developed combined models that integrated effects from both treatment and comparison groups. Distinctions in models resulted in a slight difference in calculating the adjusted gross impacts, using a difference-of-difference approach (described in more detail in Detailed Methodology for Demand Modeling): Both approaches provide similar adjustments to the treatment group change in usage to account for the counterfactual (i.e., the effect of what would have happened absent program intervention).

A. Regression models

The team developed different models to use for estimating energy and demand impacts. We ultimately selected estimates from the most robust models for final reporting. These models were:

- ***Household-level PRISM models.*** The team ran account-level regression models comparing weather-normalized consumption pre- and post-measure installation, then averaged the results across the sample to determine utility specific and statewide program findings.
- ***Combined program-level fixed-effects models.*** The team ran fixed-effects models, which controls for household-specific factors—such as home size and age, and participant demographics—that do not vary over time. This approach accounts for pre-existing differences in energy use between homes. Unlike PRISM models that are constructed for each home individually, fixed-effects models use entire samples of participants and nonparticipants.
- ***Combined measure-level fixed-effects models.*** The team ran measure-level fixed-effects models, which incorporate indicator variables for measure groups to differentiate use patterns and estimate impacts for specific measure categories.
- ***Hourly demand impact models.*** The team estimated demand impacts using two approaches (for more detail on demand methodology see Detailed Methodology for Demand Modeling):

- First, we developed a combined program-level fixed-effects model, featuring indicator variables for peak hours, participants, and the post-treatment period. This model provided estimates of the average peak hour demand reduction per household for each utility and both statewide programs.
- Second, the team aggregated hourly data by weather station and utility/program to develop load shapes for each, then we identified the demand reductions during the coincident peak for each weather station/utility.

3.1.8 Analysis sample and measure distribution

A. Data screening

Starting with a census of participants for both treatment and comparison groups, the team identified the final analysis samples after cleaning the data and screening for several criteria. We conducted the consumption analysis using participants who had not moved since participating and for whom we had at least ten months of pre-period and post-period billing data. We performed account-level reviews of all individual participant pre- and post-period monthly consumption to identify anomalies (e.g., periods of unoccupied units) that could bias the results.

The EM&V team used the following screenings to remove anomalies, incomplete records, and outlier accounts that could bias savings estimates:

- Inability to merge the participant program tracking data with the consumption data (e.g., missing records or accounts)
- Insufficient consumption data for accounts with fewer than 300 days (approximately 10 months) of use data in the pre- or post-period
- Accounts that changed electric use from the pre- to post-period by more than 70 percent. Changes in use of this magnitude are likely due to vacancies, home remodeling or addition, seasonal occupation, or fuel switching, and not due to program effects
- Accounts with low annual use in the pre- or post-period (e.g., less than 1,000 kWh)[25]
- Customers for whom the *TRM* savings estimate exceeds the pre-period use or where the *TRM* savings estimate is less than 1 percent of the pre-period use
- Comparison group members with higher per-unit use than the maximum participant per-unit use
- Other extreme values, including vacancies in the billing data (outliers), heating or cooling system changes (e.g., adding or removing heating or cooling loads), base

[25] The average RSOP and HTR SOP households use approximately 1,534 kWh and 1,400 kWh each month, respectively; therefore, an annual use of less than 1,000 kWh is very low for residential households in Texas.

load equipment changes, or changes in occupancy.[26] This included screening for accounts with large gaps in interval data (i.e., zero consumption across months, distinct from missing values).

B. Model attrition

The screened results consisted of cleaned, matched, analytic samples consisting of 15,078 treatment and 9,791 comparison group accounts for RSOP and 4,493 treatment and 2,792 comparison group accounts for HTR SOP. The main sources of attrition for each program were an insufficient number of months of pre- and post-period usage data and consumption outliers. Because we believe these screens also take into account sites with "bad fit" (e.g., low R^2), no additional statistical screening was applied.

The following tables provide details of the screening process for RSOP and HTR SOP, respectively.

Table 3-2. RSOP Model Screening—Statewide Program

	Treatment Group		Comparison Group	
Screen	**Accounts Remaining**	**Percentage Remaining**	**Accounts Remaining**	**Percentage Remaining**
Original electric accounts	23,249	100%	13,556	100%
Did not match to billing data provided	22,989	99%	13,159	97%
Insufficient pre- and post-period days of use	19,787	85%	12,668	93%
Changed use from the pre to post by >70%	19,201	83%	12,186	90%
Wrong signs on PRISM parameters	18,957	82%	11,821	87%
TRM savings higher than or <1% of pre-use	18,738	81%	11,797	87%
Pre- or post-period use less than 1,000 kWh	18,717	81%	11,797	87%
Participated in another program	18,532	80%	11,657	86%
Inspection of pre/post use (e.g., vacancies)	15,078	65%	9,791	72%
Final analysis group	**15,078**	**65%**	**9,791**	**72%**

[26] Baseload changes could include adding or removing appliances (such as a refrigerator or water heater) or changes in occupancy; in either case, this may convolute the analysis for distinguishing program effects.

Table 3-3. HTR SOP Model Screening—Statewide Program

Screen	Treatment Group		Comparison Group	
	Accounts Remaining	Percentage Remaining	Accounts Remaining	Percentage Remaining
Original electric accounts	7,744	100%	4,429	100%
Did not match to billing data provided	7,637	99%	3,553	80%
Insufficient pre- and post-period days of use	6,144	79%	3,460	78%
Changed use from the pre to post by >70%	5,953	77%	3,307	75%
Wrong signs on PRISM parameters	5,881	76%	3,243	73%
TRM savings higher than or <1% of pre-use	5,812	75%	3,243	73%
Pre- or post-period use less than 1,000 kWh	5,806	75%	3,242	73%
Participated in another program	5,715	74%	3,183	72%
Inspection of pre/post use (e.g., vacancies)	4,493	58%	2,792	63%
Final analysis group	**4,493**	**58%**	**2,792**	**63%**

The following tables provide the utility specific attrition levels for RSOP and HTR SOP, respectively.

Table 3-4. RSOP Account Attrition—Utility Program

	AEP TCC	AEP TNC	CNP*	Oncor	TNMP
Treatment Group					
Original Accounts	4,169	740	544	15,944	1,852
Final Accounts	1,566	335	409	12,036	732
Percentage Retained	38%	45%	75%	75%	40%
Comparison Group					
Original Accounts	2,647	353	325	9,868	363
Final Accounts	1,843	266	0	7,575	107
Percentage Retained	70%	75%	0%	77%	29%

* The EM&V team did not receive consumption data for the CNP comparison group.

Table 3-5. HTR SOP Account Attrition—Utility Program

Account Attrition	AEP TCC	AEP TNC	CNP*	Oncor	TNMP
Treatment Group					
Original Accounts	1,523	245	712	4,685	579
Final Accounts	389	106	521	3,413	64
Percentage Retained	26%	43%	73%	73%	11%
Comparison Group**					
Original Accounts	80	11	756	3,582	0
Final Accounts	53	8	0	2,731	0
Percentage Retained	66%	73%	0%	76%	0%

* The EM&V team did not receive consumption data for the CNP comparison group.

** In several cases, PY2015 program installations happened prior to June, resulting in a limited number of customers who could be included in the comparison group samples. In the case of TNMP, there were no HTR SOP participants in June 2015 or later.

3.1.9 Measure distribution of final analysis sample

The following table shows the frequency distribution of measure installations occurring in the participant analysis samples, by program, along with the average reported *TRM* savings per measure type. These details of the measures and associated savings assumptions provide context for understanding the model results.

Additionally, tables comparing measure distributions between the analysis sample and program populations are provided in demonstrating that despite higher model attrition for some utility programs, the sample sufficiently reflects the population measure mix and does not appear biased.

Table 3-6. Measure Distributions of Final Treatment Samples, by Statewide Program

Category	Measure	Percentage of Sample		Average *TRM* Savings by Measure (kWh per Participant)	
		RSOP	HTR SOP	RSOP	HTR SOP
Lighting	Lighting	N/A	6%	N/A	238
Shell	Ceiling Insulation	30%	55%	3,831	3,041
	Infiltration	85%	65%	1,546	1,302
	Solar Screen	<1%	<1%	145	708
	Wall Insulation	<1%	<1%	1,042	2,336
	Windows	1%	<1%	898	175
HVAC	Duct Sealing	61%	40%	3,735	3,414
	Central Air Conditioning	2%	N/A	1,973	N/A
	Heat Pump	<1%	N/A	3,849	N/A
	Ground-Source Heat Pump	<1%	N/A	5,535	N/A
Water Heat	Domestic Hot Water*	3%	2%	278	222
Sample (n)		**15,078**	**4,493**		

* Domestic hot water (DHW) measures include energy-efficient showerheads and faucet aerators.

The following tables provide measure distributions by utility for the RSOP and HTR SOP, respectively, comparing the distributions within the analysis samples and program populations.

Table 3-7. RSOP Measure Distribution Comparison, by Utility

Measure	AEP TCC		AEP TNC		CNP		Oncor		TNMP		Statewide	
	n	Pop.	n	Pop.	n	Pop.	n	Pop.	n	Pop.	n	Pop.
Ceiling Insulation	9%	9%	19%	17%	30%	31%	35%	34%	6%	27%	30%	28%
Infiltration	59%	61%	58%	54%	N/A	N/A	92%	92%	78%	66%	85%	81%
Solar Screen	N/A	N/A	N/A	N/A	N/A	N/A	<1%	<1%	N/A	N/A	<1%	<1%
Wall Insulation	<1%	<1%	<1%	<1%	N/A	N/A	N/A	N/A	N/A	N/A	<1%	<1%
Windows	N/A	N/A	N/A	N/A	41%	42%	<1%	<1%	N/A	N/A	1%	1%
Duct Sealing	92%	92%	71%	76%	N/A	<1%	57%	55%	83%	78%	61%	63%
Central AC	2%	2%	5%	4%	27%	25%	<1%	<1%	13%	6%	2%	2%
Heat Pump	<1%	<1%	6%	5%	1%	1%	<1%	<1%	1%	<1%	<1%	<1%
Ground-Source Heat Pump	N/A	N/A	1%	<1%	N/A	N/A	N/A	N/A	N/A	N/A	<1%	<1%
DHW	N/A	N/A	N/A	N/A	N/A	N/A	1%	<1%	54%	29%	3%	3%
Total Participants	**1,566**	**4,177**	**335**	**746**	**409**	**550**	**12,036**	**15,944**	**732**	**1,852**	**15,078**	**23,269**

Table 3-8. HTR SOP Measure Distribution Comparison, by Utility

Measure	AEP TCC		AEP TNC		CNP		Oncor		TNMP		Statewide	
	n	Pop.	n	Pop.	n	Pop.	n	Pop.	n	Pop.	n	Pop.
Lighting	35%	38%	24%	16%	15%	16%	1%	<1%	N/A	N/A	6%	10%
Ceiling Insulation	10%	11%	17%	20%	99%	94%	55%	53%	6%	15%	55%	45%
Infiltration	64%	72%	44%	52%	4%	5%	75%	74%	83%	82%	65%	67%
Wall Insulation	3%	2%	N/A	<1%	N/A	N/A	N/A	N/A	N/A	N/A	<1%	<1%
Solar Screen	N/A	<1%	N/A	N/A	N/A	N/A	<1%	<1%	N/A	N/A	<1%	<1%
Windows	N/A	N/A	N/A	N/A	N/A	N/A	<1%	<1%	N/A	N/A	<1%	<1%
Duct Sealing	72%	72%	86%	83%	N/A	N/A	40%	39%	97%	92%	40%	47%
DHW	13%	14%	N/A	N/A	N/A	N/A	1%	<1%	36%	30%	2%	5%
Total Participants	**389**	**1,525**	**106**	**245**	**521**	**745**	**3,413**	**4,686**	**64**	**581**	**4,493**	**7,782**

3.1.10 Findings: Energy impacts

A. Overall results

This section presents evaluated savings estimates for RSOP and HTR SOP, for both the statewide program and measure-level results.

The EM&V team included weather-normalized annual consumption in the pre-program period (PRENAC) in these results to characterize the average energy consumption of the participant and comparison groups prior to any program treatment. Additionally, considering program impacts in terms of savings as a percentage of PRENAC is a helpful metric for comparison and for assessing the magnitude of program impacts. The EM&V team used this metric to compare the annual savings from RSOP and HTR to other programs in other jurisdictions.

Finally, model savings are compared to the planning estimates reported in the utility tracking databases that are required to be consistent with the statewide TRM (which values are referred to as "TRM" in the tables below). It is important to note that there are differences in the methods used to calculate the evaluated estimates here and those methods used to estimate savings via TRM. Specifically:

- ***Interactive Effects*** – Billing analysis offers the advantage of taking interactions between measures (installed in combination) into account, while TRMs are typically designed to estimate savings for a given measure in isolation.
- ***Weather*** – There may be some slight distinctions in weather data that may result in minor differences: as noted, this study uses data from the 13 WBAN stations specifically located nearest to each household in the analysis, while the TRM primarily uses seven to nine regional stations to cover the state more broadly.

B. Measure-level findings

Table 3-9 provides measure savings compared to TRM values for RSOP and HTR SOP that achieved precision better than ±35 percent. To maximize sample sizes and model precision, these models are at the statewide program level.

Table 3-9. Measure-Level Savings Summary—Statewide RSOP and HTR SOP

Program	Measure	n	PRENAC	Average Participant Savings (kWh)		Model Precision at 90%	Percent Savings Compared to TRM	Savings as Percentage of Pre-Use	
				Model	*TRM*			Model	*TRM Values*
RSOP	Ceiling Insulation	4,529	20,330	1,380	3,831	±6%	36%	7%	19%
	Infiltration	12,753	18,289	821	1,546	±7%	53%	4%	8%
	Windows	189	17,851	724	898	±30%	81%	4%	5%
	Duct Sealing	9,131	18,982	443	3,735	±15%	12%	2%	20%
	Central AC	288	17,101	1,579	1,973	±13%	80%	9%	12%

Program	Measure	n	PRENAC	Average Participant Savings (kWh)		Model Precision at 90%	Percent Savings Compared to TRM	Savings as Percentage of Pre-Use	
				Model	*TRM*			Model	*TRM Values*
	Heat Pump	48	21,662	3,470	3,849	±24%	90%	16%	18%
HTR SOP	Ceiling Insulation	2,456	17,854	1,455	3,041	±7%	48%	8%	17%
	Infiltration	2,915	16,589	634	1,302	±16%	49%	4%	8%
	Duct Sealing	1,813	17,315	413	3,414	±32%	12%	2%	20%

The key measures that characterize both programs (duct sealing, air infiltration, and ceiling insulation) showed lower savings than estimated with the TRM. Both cooling equipment replacements (central AC and heat pumps) in the RSOP demonstrated accurate savings when estimated with the TRM, and had the highest modeled savings as percentage of pre-usage (9 percent and 16 percent, respectively).

Although TRM savings calculations have caps on the pre-installation CFM and overall reduction (to limit measurement error, gaming, and freeridership), the modeled savings from this analysis did not apply these caps, and reflect actual changes in usage for average participants. Even taking the more conservative TRM approach, it appears that the PY2015 TRM overestimated impacts for the duct sealing, air infiltration, and ceiling insulation measures.

C. Measure-specific diagnostics

The team assessed detailed characteristics for those measures comprising the majority of savings.

Table 3-10 provides the frequency distributions for specific measures. For air infiltration and duct sealing, we provide average CFM reduction percentages by customer across sample quartiles, and for ceiling insulation, we provide average baseline R-values by quartile ranges. These measure attributions, including pre/post CFM and R-values, are sourced from utility program track data. Implementation contractors collect these data during program delivery, many of which are then inputs in calculating claimed savings adhering to methods outlined in the TRM.

Table 3-10. Distribution of Measure Input Frequencies by Quartile, by Measure and Program

Measure	Quartile	Units	HTR SOP		RSOP	
			n	Average	n	Average
Duct Sealing	Q1	% CFM Reduction	451	61%	2,258	62%
	Q2		453	74%	2,284	74%
	Q3		456	81%	2,296	81%
	Q4		453	90%	2,293	90%

Measure	Quartile	Units	HTR SOP		RSOP	
			n	Average	n	Average
	Overall		**1,813**	**77%**	**9,131**	**78%**
Infiltration	Q1	% CFM Reduction	727	26%	3,180	24%
	Q2		727	40%	3,187	47%
	Q3		729	56%	3,185	59%
	Q4		732	67%	3,201	69%
	Overall		**2,915**	**48%**	**12,753**	**55%**
Ceiling Insulation	Q1	Baseline R-Value	447	0.6	1,148	2.1
	Q2		782	3.2	1,101	3.8
	Q3		614	5.0	1,147	5.3
	Q4		613	8.3	1,133	9.4
	Overall		**2,456**	**4.1**	**4,529**	**4.3**

The overall average reduction in CFM was 48 percent for the HTR SOP and 55 percent for the RSOP for air infiltration, and was 77 percent for the HTR SOP and 78 percent for the RSOP for duct sealing. As noted above, the TRM applies savings caps that may have reduced the percentage reduction for certain projects; even still, these reported CFM reductions represent fairly high assumptions with regard to work associated with air and duct sealing projects.

The majority of ceiling insulation projects appear to have claimed savings using the lower baseline R-value bins (R-0 and R-1 to R-4). While this is possible, it is unlikely that the average insulation in these participating homes was that low.

Table 3-11 and Table 3-12 provide savings comparisons by measure for RSOP and HTR SOP, respectively, using quartile distributions of measure assumptions discussed above, along with efficiency levels of the cooling equipment replacement for RSOP.

Table 3-11. Distribution of Measure Input Frequencies, by Measure and Quartile—RSOP

Measure	Quartile/ Distribution	n	Savings (kWh)		Percent Savings Compared to TRM	Savings Percentage of PRENAC	
			Model	*TRM*		Model	*TRM*
Duct Sealing	Q1: 62% CFM	2,258	384	2,786	14%	2%	15%
	Q2: 74% CFM	2,284	405	3,691	11%	2%	20%
	Q3: 81% CFM	2,296	399	3,718	11%	2%	20%
	Q4: 90% CFM	2,293	627	4,729	13%	3%	25%
	Overall: 78% CFM	**9,131**	**442**	**3,735**	**12%**	**2%**	**20%**
Infiltration	Q1: 24% CFM	3,180	687	552	125%	4%	3%
	Q2: 47% CFM	3,187	773	1,254	62%	4%	7%
	Q3: 59% CFM	3,185	821	1,774	46%	4%	9%
	Q4: 69% CFM	3,201	912	2,598	35%	5%	14%
	Overall: 55% CFM	**12,753**	**819**	**1,546**	**53%**	**4%**	**8%**
Ceiling Insulation	Q1: 2.1 R-Value	1,148	1,489	4,536	33%	8%	23%
	Q2: 3.8 R-Value	1,101	1,387	4,708	29%	7%	23%
	Q3: 5.3 R-Value	1,147	1,499	4,112	36%	7%	20%
	Q4: 9.4 R-Value	1,133	1,275	1,980	64%	6%	9%
	Overall: 4.3 R-Value	**4,529**	**1,377**	**3,831**	**36%**	**7%**	**19%**
Central AC	SEER 14	135	1,263	1,552	81%	8%	10%
	SEER 15	61	1,543	2,105	73%	9%	12%
	SEER 16-18	92	2,040	2,502	82%	11%	14%
	Overall	**288**	**1,576**	**1,973**	**80%**	**9%**	**12%**
Heat Pump	SEER 14-15	28	3,231	3,449	94%	16%	17%
	SEER 16-18	20	3,774	4,410	86%	16%	18%
	Overall	**48**	**3,462**	**3,849**	**90%**	**16%**	**18%**

For duct sealing, savings by percentage of CFM reduction are relatively constant, as are the comparison of savings percentage of pre usage for both model and TRM estimates. Air infiltration shows a different trend, with savings over 100 percent in the first quartile, while higher tiers of percentage CFM reduction show decreased savings. While model savings for air infiltration does increase as percentage CFM reduction increases (going from 687 kWh in Q1 to 912 kWh in Q4, with approximately a 1 percent increase in savings percentage), it does not increase at the same rate as average *TRM* savings, which was 3 percent in Q1 and 14 percent in Q4.

Ceiling insulation depicts an intuitive trend in impacts, with percentage savings increasing as the baseline R-value decreases. Still, lower tiers of baseline R-value show stark differences in quartiles between model and *TRM* savings (8 percent to 23 percent in Q1, compared to 6 percent to 9 percent in Q4). This suggests that savings for projects reporting lower baseline R-values are more substantially overestimating true impacts.

Both central AC and heat pump measures have high realization rates, and both model and *TRM* savings estimate are increasing, intuitively reflecting increased efficiency levels.

Table 3-12. Distribution of Measure Input Frequencies, by Measure and Quartile—HTR SOP

Measure	Quartile	n	Savings (kWh)		Percent Savings Compared to TRM	Savings Percentage of PRENAC	
			Model	*TRM*		Model	*TRM*
Duct Sealing	Q1: 61% CFM	451	289	2,463	12%	2%	14%
	Q2: 74% CFM	453	425	3,172	13%	2%	19%
	Q3: 81% CFM	456	424	3,644	12%	2%	21%
	Q4: 90% CFM	453	548	4,373	13%	3%	26%
	Overall: 77% CFM	**1,813**	**411**	**3,414**	**12%**	**2%**	**20%**
Infiltration	Q1: 26% CFM	727	454	532	85%	3%	3%
	Q2: 40% CFM	727	712	897	79%	5%	6%
	Q3: 56% CFM	729	697	1,498	47%	4%	8%
	Q4: 67% CFM	732	592	2,276	26%	3%	13%
	Overall: 48% CFM	**2,915**	**632**	**1,302**	**49%**	**4%**	**8%**
Ceiling Insulation	Q1: 0.6 R-Value	447	1,182	2,921	40%	8%	20%
	Q2: 3.2 R-Value	782	1,468	3,554	41%	8%	20%
	Q3: 5.0 R-Value	614	1,820	3,620	50%	9%	18%
	Q4: 8.3 R-Value	613	1,322	1,895	70%	7%	10%
	Overall: 4.1 R-Value	**2,456**	**1,450**	**3,041**	**48%**	**8%**	**17%**

HTR SOP showed similar measure trends for duct sealing, air infiltration, and ceiling insulation as noted above for RSOP.

Table 3-13 provides a comparison of the average values for these measures' attributes by utility. Some of the average values are based on very few observations. Utility results are shown as an informational piece only as they represent different weather zones in the TRM.

Table 3-13. Distribution of Measure Input Frequencies, by Measure and Utility Program

Program	Measure	Value	AEP TCC	AEP TNC	CNP	Oncor*	TNMP
RSOP	Duct Sealing	CFM Reduction	77%	79%	N/A	78%	72%
		Sample n	1,441	239	N/A	6,917	609
	Air Infiltration	CFM Reduction	32%	47%	N/A	57%	18%
		Sample n	928	193	N/A	11,150	574
	Ceiling Insulation	Baseline R-Value	0	3	3	4	3
		Sample n	136	65	123	4,175	43
HTR SOP	Duct Sealing	CFM Reduction	80%	73%	N/A	77%	59%
		Sample n	281	92	N/A	1,386	64
	Air Infiltration	CFM Reduction	38%	45%	27%	51%	25%
		Sample n	250	48	19	2,567	57
	Ceiling Insulation	Baseline R-Value	12	3	3	4	4
		Sample n	37	18	514	1,884	4

* During the 2014 analysis period, several changes occurred in Oncor's QA/QC service provider practices to improve savings estimates, which may have had an impact on average percentage CFM reduction or baseline R-values.

D. Statewide program results

Table 3-14 and Table 3-15 provide model results for the programs looking statewide and compare changes in energy consumption from the pre- to post-program periods for the participant and comparison groups. These tables include estimated adjusted gross savings, which the team calculated based on the "percentage of pre" approach discussed in the Savings calculation section of the methodology.[27]

Table 3-14 shows, RSOP participants decreased their usage by 1,491 kWh (an 8.1 percent reduction in normalized use). During the same period, comparison group customers decreased their use by 69 kWh (or 0.4 percent of the pre-usage average level). Absent the program, the participants would likely also have experienced a similar modest decrease in usage. After adjusting to reflect what would have happened absent the program, the overall impact of RSOP is estimated at 1,418 kWh (7.7 percent reduction in use).

[27] For both RSOP and HTR SOP, the team compared these PRISM model results against combined fixed-effects regressions to cross-check impact estimates. For both programs, the estimated model savings showed less than a 1 percent difference relative to PRENAC, with precision similarly at ±4%. Such close similarity provides an excellent point of validation for the reported model estimates.

Table 3-14. Statewide Program-Level Model Savings—RSOP

Group	n	PRENAC	Model Savings (kWh)	Savings as Percentage of Pre-Use	Relative Precision at 90%	Savings Lower 90% (kWh)	Savings Upper 90% (kWh)
Participant	15,078	18,407	1,491	8.1%	±2%	1,456	1,525
Comparison	9,791	17,338	69	0.4%	±62%	26	112
Adjusted gross	**15,078**	**18,407**	**1,418**	**7.7%**	**±4%**	**1,363**	**1,473**

As Table 3-15 shows, HTR SOP participants decreased their use by 1,381 kWh (8.2% of pre usage). During the same period, the comparison group decreased their use by 40 kWh. However, this decrease was not significantly different from zero (as evidenced by the precision of ±212 percent) and, as such, the team did not include this adjustment in the final impact calculation.

Table 3-15. Statewide Program-Level Model Savings—HTR SOP

Group	N	PRENAC	Model Savings (kWh)	Savings as Percentage of Pre-Use	Relative Precision at 90%	Savings Lower 90% (kWh)	Savings Upper 90% (kWh)
Participant	4,493	16,761	1,381	8.2%	±4%	1,324	1,438
Comparison	2,792	13,960	40	0.3%	±212%	-45	125
Adjusted gross	**4,493**	**16,761**	**1,381**	**8.2%**	**±4%**	**1,324**	**1,438**

Table 3-16 provides a savings comparison based on the adjusted gross savings for each programs.

Table 3-16. Statewide Program-Level Percentage Savings Summary—RSOP and HTR SOP

Program	n	PRENAC	Average Participant Savings (kWh)		Savings as Percentage of Pre Use	
			Model	*TRM*	Model	*TRM*
RSOP	15,078	18,407	1,418	4,791	8%	26%
HTR SOP	4,493	16,761	1,381	3,911	8%	23%

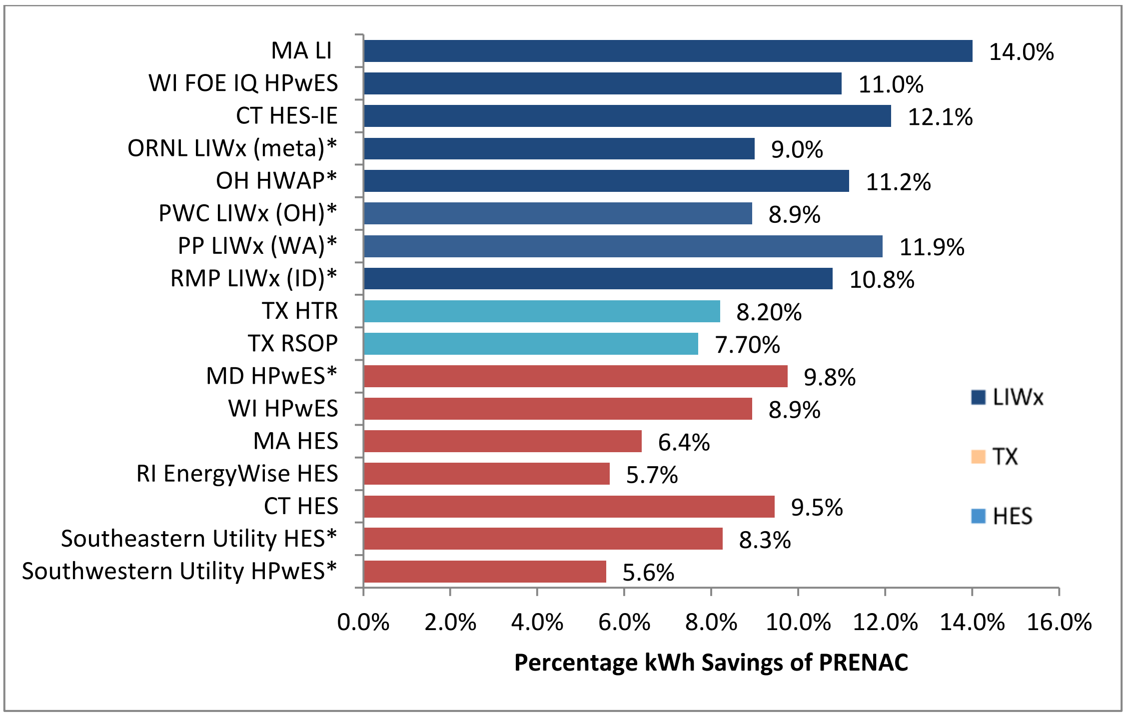
In each case, model savings as a percentage of pre usage rounds to approximately 8 percent; the same metric using average *TRM* savings is significantly higher, at 23 percent and 26 percent for HTR SOP and RSOP, respectively. As a point of comparison, comprehensive whole-house programs delivered nationally (i.e., the U.S. Department of Energy's Weatherization Assistance Program) typically observe between 8 percent and 10 percent electric savings. Therefore, the Texas programs are performing favorably in comparison to these comprehensive programs. Additional benchmarking is provided in Figure 3-2.

E. Benchmarking

To provide context for the program's savings estimates, the EM&V team benchmarked impacts against similar residential programs across the country. RSOP and HTR SOP are unique in their design, differing from stand-alone rebate programs, as well as from comprehensive whole house and other audit-based programs. We provided comparisons against home energy services (HES)-style audit programs, comprehensive low-income weatherization programs, and comparisons specific to evaluated impacts for cooling equipment.

Figure 3-2 shows the results from other similar energy efficiency programs. The figure illustrates several low-income weatherization (LIWx) programs, which delivery audits and comprehensive energy efficiency upgrades (including direct install, equipment, and shell measures). The figure also shows several non-low-income programs, characterized as HES-type programs (similar to Home Performance with ENERGY STAR), which also offer an initial home audit with direct installation and options for add-on measures (e.g., equipment, insulation).

Figure 3-2. Benchmarking of Savings Percentage of Pre-Installation Period Consumption



* Savings for noted programs are gross and do not include a nonparticipant adjustment.

As shown in the figure, the electric savings percentages for the Texas RSOP and HTR SOP are similar to either HES or LIWx programs, the majority of which offer a more comprehensive bundle of measures than the Texas programs.[28]

The 2005 Oak Ridge National Laboratory meta-evaluation of six states' low-income weatherization programs reported savings percentages (relative to pre-installation weatherization usage) ranging from 6.6 percent to 11.5 percent for electric-heat participants (average 9 percent) and ranging from -2.9 percent to 17.8 percent for non-electric-heat participants (average 7.5 percent).[29] In comparison, the Texas RSOP and HTR SOP are within a few percentages of these ranges for electrically heated (RSOP: 8 percent , HTR SOP: 9 percent) and non-electrically heated (RSOP: 6 percent, HTR SOP: 6 percent) homes.

3.1.11 Findings: Demand impacts

A. Statewide program results

The EM&V team estimated peak demand savings by comparing pre and post-usage in the top 20 peak hours for each season. The top twenty hours were defined as the peak hours with the highest average usage across comparison group households within each Weather Bureau Army Navy (WBAN) station area.

Since the top 20 hours are defined for each of the stations by season, each WBAN may have different peak hours. For example, peak hour 1 for station 3927 is at 5:00 p.m. on September 2, 2014, while peak hour 1 for station 12912 is at 4:00 p.m. on August 25, 2014. The peak pre-usage is the average usage per-household and average change in usage across all 13 WBAN stations for each ranked peak hour.

Winter peak demand was estimated looking at the usage of participant group homes with electric heat.

Table 3-17 model results for the statewide top 20 peak hours by season and shows a comparison of changes in energy consumption from the pre- to post-program periods for the participant and comparison groups for each program. The table includes the peak reduction for both groups and the combined, adjusted gross peak demand reduction, as well as the average peak-hour usage in the pre-period and the percentage reduction for each hour. The overall reduction is an average across all top 20 peak hours for each season.

[28] The majority of benchmarked HES and LIWx programs include a high percentage of installing insulation, air sealing, duct sealing, and efficient lighting, with slightly higher instances of equipment replacement and base load measures in some cases that the Texas programs. A full list of measure distributions by program is provided in RSOP and HTR SOP Program Benchmarking of Measure Distributions. RSOP and HTR SOP Program Benchmarking of Measure Distributions.

[29] Schweitzer, Martin. Estimating the National Effects of the U.S. Department of Energy's Weatherization Assistance Program with State-Level Data: A MetaevaluationMeta Evaluation Using Studies from 1993 to 2005. 2005. Available online: http://weatherization.ornl.gov/pdfs/ORNL_CON-493.pdf

Table 3-17. Top 20 Peak Hour Savings by Program and Season

Program	Group	Summer			Winter		
		Peak Pre-Usage (kW)	Model Savings (kW)	Savings as Percentage of Pre-Usage	Peak Pre-Usage (kW)	Model Savings (kW)	Savings as Percentage of Pre-Usage
RSOP	Treatment	4.08	0.15	4%	6.13	1.38	23%
	Comparison	3.85	-0.17	-4%	5.98	0.76	13%
	Adjusted Gross	**4.08**	**0.32**	**8%**	**6.13**	**0.62**	**10%**
HTR SOP	Treatment	3.72	0.18	5%	5.80	1.40	24%
	Comparison	3.47	-0.12	-3%	4.93	0.70	14%
	Adjusted Gross	**3.72**	**0.30**	**8%**	**5.80**	**0.70**	**12%**

Summer peak consumption decreased for both the RSOP and the HTR SOP households in the post-period for treatment households while peak hour consumption increased for comparison group households. The adjusted gross savings for the summer peak period were 0.32 kW for RSOP households and 0.30 for HTR SOP households. In both programs, the adjusted gross demand savings represent a reduction of 8 percent of pre-period peak hour usage.

The demand savings were greater in the winter peak period. Both treatment and comparison group households decreased peak hour consumption in the post-period. The adjusted gross savings for RSOP households were 0.62 kW and 0.70 for HTR SOP households. The peak savings represent 10 percent and 12 percent of pre-period peak hour usage for RSOP and HTR SOP households, respectively.

B. Utility program results

Table 3-18 shows a comparison of the average usage across the top 20 peak hours by season for RSOP participants within each utility, as well as the average *TRM* demand reduction per household by utility. The table also includes the modeled and *TRM* demand savings as a percentage of pre-period usage. It is important to note that the TRM demand savings were not calculated based on the method used by the EM&V team since the definition of peak demand was just agreed upon and incorporated into the PY2016 TRM. It was agreed that peak demand updates would then take place as part of measure updates. Therefore, this is an “apples to oranges” comparison, but is shown to inform future TRM updates.

Table 3-18. Top 20 Peak Hour Savings by Utility—RSOP

Program	Utility	Pre Period Average Peak Usage (kW)	Average Participant Savings (kW)		Savings as Percentage of Pre-Use	
			Model	*TRM*	Model	*TRM*
Winter	AEP TCC	5.51	0.62	4.65	11%	85%
	AEP TNC	3.90	0.62	5.94	16%	152%
	CNP	5.78	0.62	4.38	11%	76%
	Oncor	6.84	0.62	4.59	9%	67%
	TNMP	3.76	0.62	2.02	17%	54%
	Overall	**6.13**	**0.62**	**4.49**	**11%**	**70%**
Summer	AEP TCC	3.99	0.32	4.58	8%	115%
	AEP TNC	3.76	0.32	4.56	9%	121%
	CNP	4.40	0.32	3.21	7%	73%
	Oncor	4.04	0.32	3.91	8%	97%
	TNMP	2.84	0.32	2.12	11%	75%
	Overall	**4.08**	**0.32**	**3.90**	**8%**	**98%**

The *TRM* as a percent of pre-usage demonstrates how high the *TRM* savings are relative to pre-period usage, between 54 percent and 152 percent for winter and between 73 percent and 121 percent for summer peak hours. The percentage reduction in peak hour demand is similar to energy savings in proportion of peak pre-period usage, between 7 percent and 11 percent for RSOP participants.

Table 3-19 shows a comparison of the average usage across the top 20 peak hours by season for HTR participants within each utility, as well as the average *TRM* demand reduction per household by utility. The table also includes the modeled and *TRM* demand savings as a percentage of pre-period usage.

Table 3-19. Top 20 Peak Hour Savings by Utility—HTR

Program	Utility	Pre Period Average Peak Usage (kW)	Average Participant Savings (kW)		Savings as Percentage of Pre-Use	
			Model	*TRM*	Model	*TRM*
Winter	AEP TCC	4.40	0.70	3.72	16%	85%
	AEP TNC	3.81	0.70	4.73	18%	124%
	CNP	6.87	0.70	4.92	10%	72%
	Oncor	6.34	0.70	3.97	11%	63%
	TNMP	3.68	0.70	2.03	19%	55%
	Overall	**5.80**	**0.70**	**4.05**	**18%**	**67%**

Program	Utility	Pre Period Average Peak Usage (kW)	Average Participant Savings (kW)		Savings as Percentage of Pre-Use	
			Model	*TRM*	Model	*TRM*
Summer	AEP TCC	2.95	0.30	3.57	8%	121%
	AEP TNC	3.39	0.30	3.76	8%	111%
	CNP	3.72	0.30	4.54	7%	122%
	Oncor	3.72	0.30	3.43	9%	92%
	TNMP	2.63	0.30	2.20	14%	84%
	Overall	**3.72**	**0.30**	**3.56**	**9%**	**98%**

For HTR SOP participants, the savings are greater in the top 20 winter hours. The *TRM* winter demand reduction was lower than the average pre-period peak hour usage for four of the utilities. The percentage reduction in peak hour demand is greater than energy savings in proportion of peak pre-period usage, between 10 percent and 19 percent for HTR SOP participants in the top 20 winter hours.

Similar to the RSOP participants, the model savings relative to *TRM* estimates are low for HTR SOP participants when looking at summer peak savings. The demand reduction as a proportion of pre-period peak usage was again similar to energy savings, between 8 percent and 11 percent. However, the *TRM* reduction was close to or greater than the peak hour pre-period usage.

3.1.12 Recommendations

The EM&V team developed several recommendations for utilities to consider in future program delivery, data collection, and planning estimates for claimed savings.

Recommendation #1: ***Revisit TRM estimates for key program measures*** and consider revising the algorithmic approach or applying adjustments to account for factors related to inaccurate *TRM* estimates. The EM&V team is currently running additional diagnostics that may help clarify some of these discrepancies; we are comparing evaluated estimates against specific savings bins by measure, climate zone, and heating type developed in recent simulation modeling for the PY2017 TRM. Several key factors may be driving the discrepancies between actual modeled savings and planning estimates, some of which require different approaches for EM&V calculations accounting for:

- Measure interactions
- Accuracy of baseline conditions and measurement
- Persistence of savings (e.g., takeback, uninstallation)
- Quality of installation
- Household-specific conditions (i.e., pre energy consumption, conditioned square footage)

Recommendation #2: .***Explore methods to better assess baseline conditions for key program measures***. As noted, baseline assumptions (i.e., percentage savings reduction, existing R-value) appeared particularly extreme for the analysis sample and the nature of the work being performed. Several actions may help verify the accuracy of these tracked measure inputs:

- ***Pre-installation site visits*** to take preliminary measurements of baseline conditions for a sample of homes
- ***Ride-alongs*** to review contractor assessment and measurement procedures to determine if there are any systematic issues
- ***Improved and increased documentation*** regarding measurement approaches or existing conditions, such as photographs of pre-insulated areas to verify R-values or images of the blower door and duct blaster tests. In addition, while methods used for decreasing air leakage can be difficult to verify during post-inspection, there are protocols guides that require checklists, which provide a more systematic and transparent approach to this process.[30]

Recommendation #3: ***Consider program design revisions***, such as:

- ***Promote HVAC contractor participation.*** For RSOP, central AC and heat pump replacements (averaging around 15-16 SEER) achieved 9 percent and 16 percent energy savings, respectively, though was installed for less than 2 percent of the program population. Furthermore, *TRM* savings estimates were remarkably close to model estimates. Given the savings potential and relatively low frequency of installation, there appear to be an opportunity to increase contractor solicitation, incentive levels, or marketing to optimize equipment replacement through these programs.
- ***Integrate delivery to optimize installations within a household and avoid lost opportunities***. Due to the contractor-driven programs' design, individual households may be served by a discrete type of contractor who fails to diagnose other energy efficiency opportunities at the time of participation. Consider a program mechanism that channels participants to other contractors to address subsequent issues or encourages more comprehensive treatment of homes.

For example, a participating household may receive a new air conditioner from an HVAC contractor, but not be assessed for shell or infiltration upgrade needs. For RSOP, 258 of 288 participants who received central AC replacements ONLY received that measure, no others. With respect to weatherization contractors, sealing and shell measures occurred in greatest frequency, and between 10 percent and 20 percent of participants who received air sealing, duct sealing, or ceiling insulation ONLY received those specific measures.

Both RSOP and HTR SOP differ from audit-based programs, such as HES-style or comprehensive LIWx initiatives, where there is an initial audit to assess all household energy needs, then participants are put in touch with contractors to address those installations. In these examples, the program design optimizes the diagnosis of need and limits lost opportunities, removing the barrier for homeowners who do not know about the need for

[30] http://www.bpa.gov/EE/Policy/IManual/Documents/WeatherizationSpecifications.pdf

additional energy efficiency repairs, and those who need to coordinate with various contractors to address those needs.

Recommendation #4: *Consider future study opportunities:*

- ***Baseline studies***. Along with pre-installation site visits or ride alongs, a broader study may help put baseline characteristics in context and help revise parameters for TRM calculations.
- ***Trade ally interviews.*** Contractor interviews may also help to characterize baseline conditions, or help better understand the measurement process and other installation protocols that may affect realized energy savings.

3.2 RESIDENTIAL LOAD MANAGEMENT IMPACT ASSESSMENT

This section summarizes the key findings and recommendations from the PY2015 evaluation of the Residential Load Management programs offered by two utilities.

3.2.1 Background

Two Texas utilities, Oncor and CenterPoint, operated residential demand response programs in PY2015. The EM&V team applied the method prescribed in TRM 2.1 to calculate energy savings and demand reduction for each utility.

3.2.2 Findings

The total evaluated savings between the two programs were 20,569 kW and 123,368 kWh. Oncor's program had not operated prior to 2015. CenterPoint's program was operated as a pilot program as in the past several years. These results for each utility and in combination are shown in the following two tables.

Table 3-20. Program Year 2015 Claimed and Evaluated Demand Savings—Residential Demand Response

Utility	Percent Statewide Savings (kW)	2015 Claimed Demand Savings (kW)	2015 Evaluated Demand Savings (kW)	Realization Rate (kW)	Precision at 90% Confidence
CenterPoint	66.1%	13,407	13,683	102.1%	0.0%
Oncor	33.9%	6,886	6,886	100.0%	0.0%
Total	**100.0%**	**20,293**	**20,569**	**101.4%**	**0.0%**

Comparing the evaluated savings to the utility claimed savings shows a very close agreement. In the case of Oncor, the EM&V team worked with Oncor at a detailed level to resolve minor differences in the initial kW results. In the case of CenterPoint, the EM&V team applied the same calculation practices used to calculate Oncor's results, with the source of differences between the evaluated and utility-claimed savings not resolved. The result is an overall statewide realization rate of 101.4 percent for kW.

Table 3-21. Program Year 2015 Claimed and Evaluated Energy Savings—Residential Demand Response

Utility	Percent Statewide Savings (kWh)	2015 Claimed Energy Savings (kWh)	2015 Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Precision at 90% Confidence
CenterPoint	66.5%	82,098	82,098	100.0%	0.0%
Oncor	33.5%	0	41,270	N/A	0.0%
Total	**100.0%**	**82,098**	**123,368**	**150.3%**	**0.0%**

The kWh savings shown in Table 3-21 were driven by EM&V team calculations. In the case of kWh, CenterPoint initially only calculated savings for one of the two demand response events and subsequently accepted the EM&V team's kWh calculations, resulting in a 100.0 percent realization rate. In the case of Oncor, the utility did not claim any kWh savings. The EM&V team did assign energy savings for this program, however, resulting in a total realization rate for kWh at the statewide level was 150.3 percent.

In working with the two utilities offering residential demand response programs, the EM&V team was able to apply the TRM 2.1 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 2.1 calculation method going forward and to identify and resolve minor analytic differences not addressed by TRM 2.1.

3.2.3 Recommendations

The evaluation process was the first conducted by either utility or the EM&V team using the 2.1 method, known as the "High 3 of 5" method. This method selects three of five prior non-holiday weekend day with the highest loads during event hours as the baseline days. Day of adjustments are made to either increase or decrease the baseline by comparing loads prior to the event on the event day and baseline days, though with minor differences. From this experience, the EM&V team makes several recommendations.

Recommendation #1: ***Utilities should provide the interval meter kWh data to the EM&V team, without modification.*** In one case, the utility provided 15-minute kW data, which resulted in rounding. While not fundamentally an issue, the process required that the EM&V team determine that kW data had been provided, though the results matched those of the utility. When the utility provided updated results, the utility calculated savings using kWh data, removing the rounding effect and leading to a difference from the EM&V team's calculations. While the difference was minor, it leads to additional research to understand the source of the difference. By consistently providing the kWh data, the utilities and EM&V team can be assured of starting their analysis from the same point, reducing uncertainty regarding minor differences in calculations.

Recommendation #2: ***Data rounding should occur only at the event level or program year level.*** Residential programs have a very large number of participants, with the potential for rounding at the participant level driving substantial differences in savings at the event or program level. By consistently rounding only at the event level (summing individual participant savings), potential discrepancies between the EM&V team and utility calculations can be reduced.

Recommendation #3: ***Each utility should provide documentation on its entire calculation approach to arrive at program level annual savings*.** The EM&V team did not find that either utility was conducting calculations in error, though there were differences that led to differences in initial calculations. By using meter data to perform the evaluation across events, the EM&V team should be able to replicate each utility's results. Full documentation will facilitate the process for both the utilities and EM&V team. To the degree possible, the EM&V team will provide guidance in the PY2017 TRM (version 4.0).

Recommendation #4: ***Utilities should document data retention or other data issues affecting savings calculations.*** For one utility, the transition to a new data system caused several participants' meter data to be unusable. While meter failures and data management systems can cause a loss of data to occur, it was not made clear to the EM&V team which participants were affected by the data system change, but were discovered through the analysis process. In these cases, the EM&V team calculates residential demand response savings using the average of all other participants' savings so long as the total number of participants does not exceed one percent of all participants. Knowing that these issues are present in advance will streamline the evaluation process and help reduce discrepancies between EM&V team and utility calculations.

3.3 NEW HOMES

Next, we summarize changes in the state residential building code and how those changes will affect the New Homes program, and we offer a recommendation about how programs might respond.

3.3.1 Background

Texas, through HB 1736, has now adopted the 2015 IRC as the new state minimum residential new construction code effective September 1, 2016. Due to Texas operating under "home rule," which requires each local jurisdiction to implement and enforce building codes, there may be a significant delay or lag-time between state adoption and local implementation of energy codes. In addition, counties have the authority to adopt an energy code, but recent research conducted by the South-Central Partnership for Energy Efficient Resources (SPEER) indicates they rarely do, as they have no authority to collect fees or enforce these codes.[31] The Energy Efficiency Rule allows utilities to calculate savings using a baseline below existing energy codes if codes are not fully-enforced and implement a program to encourage code adoption or compliance (16 TAC § 25.181 (m) (f)).

Historically, utility programs have incentivized builders to exceed the energy code. However, the 2015 code is likely significantly more energy efficient than current building practice or PY2015 Texas statewide code, 2009 IRC. Therefore, there may be opportunity in the near-term for utility programs to provide incentives and education for the building community to realize the efficiency of 2015 IRC in practice. The EM&V team met with the utilities that offer new homes programs and their implementation contractor to discuss possible program design strategies in response to the baseline code. It was discussed that a new homes re-design

[31] https://eepartnership.org/program-areas/energy-codes/texas-energy-code-compliance-collaborative/

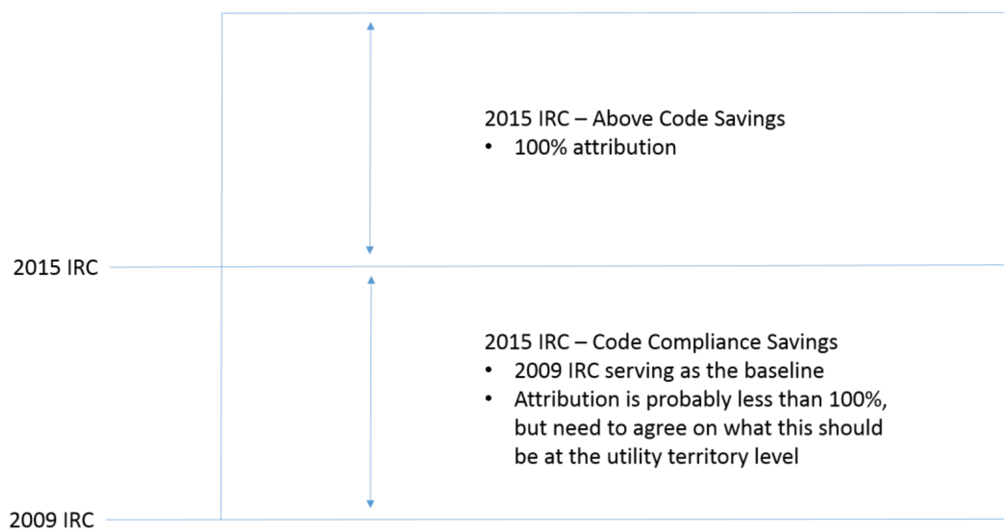
could both include code compliance to ‘push’ the market toward 2015 IRC code as well as continue to ‘pull’ the market through incentivizing savings beyond code.

3.3.2 Recommendation

Residential new construction program can continue to offer incentives for homes built above the 2015 IRC. However, a sub-program component should be considered for PY2018, as a code “lift” incentive program. Utilities could offer incentives to builders constructing homes in local jurisdictions that have adopted the 2015 IRC to encourage jurisdictions to establish the new code, and builders could be incentivized to meet this new standard. Utilities are well situated to encourage builders to build homes to the new code and offering the builders incentives to get to the 2015 IRC code could reduce builders’ resistance to the new code.

The figure below illustrates a possible program design for PY2018. Research would be needed to determine the attribution of savings to the program from 2009 to 2015 IRC. Based on discussions with the utilities and implementation contractor acknowledging both the differences across territories but the complexities of tracking this at the municipal level as was done for the PY2016 program, one option is to set attribution at the utility territory level.

Figure 3-3. Possible Residential New Construction Program Design



4. COMMERCIAL SAVINGS ASSESSMENTS

- This section presents results for the following programs that had additional research in PY2015:
- Commercial Behavior program
- Commercial Cool Roofs program
- Commercial Load Management program

4.1 COMMERCIAL BEHAVIORAL PROGRAM

This section summarizes the key findings and recommendations from the PY2015 evaluation of the commercial behavioral-based program. Since the program was in the launch stage during PY2015, the evaluation goals were focused to include:

- Assess the methodology contemplated for determining program energy and demand savings
- Review the data collected thus far and recommend improvements to data collection
- Identify potential needs for future evaluation efforts

The results of this preliminary assessment and review served as the basis for the EM&V team's recommendations for improving the TRM Methodology for behavioral programs in Texas.

4.1.1 Introduction

The behavioral program is currently provided to public schools through one Texas utility. The program currently encourages activities that promote energy reduction through behavior and operational changes related to energy use.

Examples of the activities and tools provided by the program include:

- Regular meetings with key management and facility level staff
- Ongoing training, on-site walkthroughs, after hours exterior lighting audits, and facility performance reviews
- Energy accounting software for tracking monthly billing data and site actions
- Roll out of standardized templates and sample materials: meeting agendas, shutdown checklists (e.g., summer, spring break), end of day checklists, resource scheduling example, energy awareness campaigns and examples (e.g., flyers, posters, emails), and site walkthrough examples
- Other technical support such as energy performance benchmarking and energy master planning efforts.

Examples of the behavioral and operational change actions anticipated by the program include:

- Equipment operational adjustments (e.g., turning off lights, thermostat set point adjustments, adjusting occupancy schedules)
- Early identification and repair of equipment malfunctions
- Developing and/or improving facility shutdowns (e.g., daily classroom shutdowns, holiday shutdowns, summer shutdowns)
- Making sure facilities are only used when needed and consolidate district's needs outside of regular operations (i.e., internal and external facility usage forms)
- Increasing regular discussions and involvement regarding site energy use and identifying a key responsible party for tracking and managing site use and activities.

For PY2015, the program launched in March 2015 at three independent school districts (ISD) within Entergy Texas utility service area as part of its Schools Concerned with Reducing Energy (SCORE®) Market Transformation Program component. These customers represent 75 primary and secondary (e.g., K-12 school) educational facilities.

Table 4-1. PY2015 Behavioral Program Savings and Participant Summary

Utility	Behavioral Program	Energy Savings		Participant Count (Sites)
		Claimed kW	Claimed kWh	
Entergy	SCORE – RMS Measures[32]	1,041	3,025,862	75

Behavioral programs are an allowed type of energy efficiency offering as specified in the Energy Efficiency Rule 16 TC 25.181 (c) (12). Guidance for Behavioral Programs' M&V protocols was first integrated into the PY2016 TRM (version 3.1). The EM&V team worked with the implementation contractor to obtain program materials and data for PY2015 participants to assess further the programs actions and to better understand the methodologies and their influences on program energy savings.

4.1.2 Overview

The EM&V team conducted evaluation activities at multiple stages during implementation of the program. At the start of the PY2015 program launch, the EM&V team reviewed and commented on the programs initial M&V plan. Next, the EM&V team requested and reviewed program data after quarter three and at the close of the program year. Using the tracking data extract from the statewide EM&V database, the EM&V team conducted a tracking system data review and reviewed a census of the behavioral program projects as part of the overall data request process. This was then followed by in-depth engineering and documentation reviews for the 75 facilities engaged in the program in PY2015.

Total annual savings were based on a portion (40 percent) of initial estimated savings, as 12 months of post-period monthly billing data for each site was not available at the time of reporting. This was also based on recommendations made by the EM&V team and is consistent with how savings are claimed for other M&V projects that cross program years. Final reported savings for PY2015 across the three ISDs within one utility program are

[32] Entergy refers to its behavior-change component and measures resulting as Resource Management Services (RMS) found in the 2016 Energy Efficiency Plan and Report (EEPR) dated April 1, 2016.

summarized in Table 4-2.

Table 4-2. PY2015 Behavioral Program Savings and Participant Summary by ISD

ISD Group	Energy Savings			Sites	
	Reported kW	Reported kWh	% of Baseline kWh	Count	% Count
ISD 1	784	2,113,330	2.6%	45	60%
ISD 2	60	163,822	0.7%	15	20%
ISD 3	197	748,862	2.8%	15	20%
Total	**1,041**	**3,025,862**	**2.3%**	**75**	**100%**

The behavioral programs energy savings methodology was described in an M&V plan, which employed International Performance Measurement and Verification Protocol (IPMVP) Option C – Whole Facility regression analysis. A regression analysis was used to estimate gross electricity impacts for each participating site, using the data collected by each facility's existing utility meters. The baseline consisted of the period from March 2014 through February 2015. The PY2015 reporting period contains the 12 months of data beginning with the program starting month (March 2015 – February 2016).

The regression analysis was created for individual sites taking into account each site's factors influencing energy consumption and energy-use sensitivities with respect to program effects, weather and occupancy. The models included terms for non-initiative factors that typically affect energy usage patterns to explain how weather and facility operations affect usage. The first set of non-initiative factors identified were energy-governing variables that included cooling degree days (CDD), heating degree days (HDD), and school days. A second set of non-initiative factors identified were engineering estimates of energy savings due to energy-efficiency retrofit based projects. A third set of non-initiative factors identified—which were not included in PY2015, but will be identified further in PY2016--are energy-impacting events such as changes to square footage, changes to existing equipment, changes to metering, changes to space use, and changes in building operation.

To better understand how the behavioral program was being conducted in the field and provide further assessment of and recommendations for the regression analysis and results, the EM&V team worked with the implementer to review the regression analysis detail for a sample of 31 facility level results. Schools were selected by the implementer with input from the EM&V team to assess a mix of school types and sizes which included smaller schools (e.g., elementary) versus mid-sized schools (e.g., middle, junior high) versus larger schools (e.g., high) and schools with summer sessions versus schools without summer sessions. In addition, regression results for several sites that had unexpected parameter values were identified by the implementer and provided to the team. The regression data reviewed included both the raw data and the post tuning data and also included scatter plots, line fit plots, regression coefficients, point-by-point deviation between predicted and actual values, and key statistical information for each site's results.

In addition to the regression analysis sample, on-site visits were conducted at six sites across two ISDs. A final census savings and documentation review was completed for all behavioral savings reported in PY2015.

Based on the EM&V team's review of the initial program methodology and detailed sample results, the EM&V team identified concerns with regard to the savings methodology used, lack of program and site-specific documentation provided, and assumptions for these program measures. Further discussions were held between the EM&V team and the implementer to develop a more robust approach. The major changes that resulted from this effort included:

- Energy demand (kW) was shifted from a regression analysis to a probability-based method[33] using a load shape approach to applying the peak probability analysis (PPA).
- Energy savings (kWh) were developed for each of the individual 12 months using the Energy Center 4.0 software for the regressions as opposed to completing the regressions for only seven months and extrapolating savings for the remaining five months of the calendar year.
- Regressions were completed using only one regression software as opposed to using two different modeling software.
- Current year reported energy savings were changed to represent 40 percent of the estimated annual savings. Once 12 months of post-intervention data was available, then the remaining annual savings were finalized.
- The current year regression analysis consists of at least 12 months of both pre- and post-period monthly billing data for each site.
- The measure life was changed from three to one year.
- The M&V plan and report included multiple updates described further in the next section.

4.1.3 Key findings and recommendations

Key findings and applicable recommendations are presented below based on the information gathered of program data and documentation as well as discussions with the implementation contractor.

A. *Key Finding #1: While sites included sufficiency of pre-intervention billing data, the post-intervention data was found incomplete. Also, use of extrapolation in filling these gaps was found to be inappropriate for calculating annual energy and demand savings.*

The regressions initially included less than one year (i.e.12 months) of post-intervention period billing data. The initial analysis had relied on only seven months of monthly post-intervention data and extrapolated savings for the remaining five months of the PY2015 calendar year. Having 12-months of data is the recognized industry-standard practice as specified in the Department of Energy's Uniform Methods Project (UMP): "these [behavioral] programs may influence weather-sensitive energy uses, such as space heating or cooling, so collecting less than 1 year of data to reflect every season may yield incomplete results."

[33] Public Utility Commission of Texas TRM 3.1 Volume 1.

Recommendation #1: For calculating annual savings, capture at a minimum 12 months of pre- and post-period monthly billing data to compare and determine actual monthly savings.

Recommendation Status: The implementer has already executed this recommendation.

B. Key Finding #2: All or 100 percent of the sites PY2015 annual savings and incentives were initially determined based on estimated results and limited PY2015 post-intervention period data and results.

- In Texas, a precedence has been established for awarding incentives and claiming savings for custom commercial programs where the required M&V to calculate savings spans program years. In these cases, 40 percent of the incentives are awarded and savings claimed the first program year based on initial estimated savings. Then in the subsequent program year when M&V is completed, the remaining 60 percent or 'true-up' of estimated savings is paid and incentives are awarded. The EM&V team recommended that a similar process should be used to estimate behavioral program annual savings.
- **Recommendation #2:** Behavioral programs should award incentives and claim savings for 40 percent of projected savings in the first program year and award the remaining incentives and claim savings the next program year once 12 months of post-intervention period data is available.

Recommendation Status: The implementer has already executed this recommendation.

C. Key Finding #3: Program level and ISD level baseline information and assumptions were found to be comprehensive and well documented, overall; however, a gap was found in capturing and documenting site level baseline conditions.

- The programs M&V plan documents much of the baseline information at the program level that is common across all ISDs and sites such as identification of the baseline period, baseline energy use and demand, and the independent variables used for the regression analysis. However, documenting the baseline conditions for factors that are assumed to be static, but may change over time should also be gathered. These are items that may have a significant effect on a site's particular energy use (favorable and/or unfavorable to energy impacts) outside the program initiatives if they were to change. Improving documentation of these elements would allow participants, program implementers and evaluators to know when such changes may have occurred and make decisions on whether adjustments to the baseline or post-intervention period data may be necessary.

Recommendation #3: *Work to capture more detailed participation data including site characteristics (e.g., square footage, sites with remote access to a building automation system (BAS)) and the major drivers of energy use (e.g., current operating schedules, major equipment). Provide this information to the energy modeling team for model decision-making purposes.*

Recommendation Status: The PY2016 M&V Plan was edited to describe the need to capture this data. The site characteristics are currently being collected and documented within Energy Center. These details are planned to be incorporated into future M&V Plans so that they are available to the modeler.

D. *Key Finding #4: Behavioral and operational actions leading to savings were captured at the ISD level; however, some gaps remain in capturing and documenting site level actions as well as consistency in such details across facilities and ISDs.*

- The program's M&V plan and other materials shared by the implementer documents many of the program initiatives at the ISD level such as: sample meeting agendas, sample shutdown checklists (e.g., summer, spring break), sample end of day checklists, resource scheduling example, energy awareness campaigns and examples (e.g., flyers, posters, emails), site walkthrough examples, and program timeline. Each ISD was also provided an initial assessment summary and details on the results of the energy performance benchmarking and/or energy master planning efforts. A current assessment (based on a 1 to 4 scale) of five key focus areas were provided including: planning and decision making, evaluation and monitoring, funding, facility operations, and awareness. An initial score for each ISD was given for each of the focus areas along with descriptions of the areas current strengths and three phases of action items. In addition, the M&V plan appendix included an action log for each ISD that documented district wide efforts completed each month (e.g., meetings, trainings, materials distributed, facility performance reviews/actions) and site efforts completed each month (e.g., on-site walkthroughs, after hours exterior lighting audits).
- Throughout the year, the implementer greatly improved the details captured in the PY2015 action logs provided within the final M&V plan. Because these actions are listed by month, ISD, and at times by facility, the tracking of initiatives that likely led to the savings are improved. However, it is still unclear whether an ISD level activity was actually introduced into all particular ISD facilities. There is however, evidence that even further facility level details exist on changes made to major energy use systems (e.g., HVAC, lighting) as a direct result of the program participation. The EM&V team's on-site visits at six sites across two ISDs show that further documentation is available for adjustments made to HVAC system setback times and temperature set points, and on/off times for lighting systems for all facilities within one of the ISDs. According to site personnel, typically these are modified on an annual basis as needed, since the district's operation changes from year to year. However, these adjustments are now also occurring prior to major facility shutdowns and further reviewed when high energy users are identified through the monthly performance reviews.
- Comparing the equipment level details between the two ISD facilities visited, there were gaps identified in the type, level, and consistency of the information captured and detail between facilities and between ISDs. As the behavioral program continues to engage participants in future program years, knowing major changes that occurred and the timeframe of that change will become even more critical to capture. Documenting every change made is a daunting task. Therefore, guidance may be necessary to help participants prioritize what documentation elements are key, which should align with those most impactful to sites. This would allow for the program to best identify and document the key drivers for behavioral and operational based energy savings at sites, which then can be prioritized for duplication at lower performing facilities. Currently, on-site audits are used by the program to capture many of these best practices, however, as the program progresses with repeat participants, adjustments in how these best practices are documented may need to transform.

- Also, in the future as savings are derived monthly, making this documentation of key actions taking place available to energy modellers and evaluators throughout the year would further assist generating preliminary savings estimates and providing regular feedback on program progression.

Recommendation #4: *Work to provide guidance to ISDs on how to prioritize and capture actions at the site level that leads to more consistency in action deployment and tracking across facilities. Provide this information to the energy modeling team for model decision-making purposes.*

Recommendation Status: Solutions to implement this recommendation are still in development.

E. Key Finding #5: The RMS program initially estimated a three-year life for behavioral measures.

The PUCT TRM 3.1 Volume 4 Behavioral Program M&V Protocol states that measure life/lifetime savings are not applicable to behavioral programs (p. 2-40) as only annual savings are to be claimed. The persistence of behavioral savings after the intervention has ended is still widely debated in the industry and it is recognized that additional research is needed on the persistence of behavioral savings[34]. While there has been some, though still limited, research for home energy reports for residential programs, there is less research on savings persistence for nonresidential behavioral programs.

Recommendation #5: *Utilities should only claim annual savings for behavioral programs until M&V demonstrates measure persistence after the intervention has ended. Further research is needed to determine whether persistence after intervention ceases might be warranted. Ongoing annual savings are possible if the program continues to work with the customer and those actions result in measureable reduction in energy consumption.*

F. Key Finding #6: One ISD resulted in nearly neutral energy savings results.

- During PY2016, once 12 months of post-period data was available and the PY2015 regression analysis was updated, one ISD was found to result in less than one percent negative (i.e. neutral) savings for PY2015. Although neutral savings indicate no change in energy use, further information and research is needed to better understand the slight increase, determine whether it is a result of the program (or not), and provide clear recommendations for program improvements and resulting performance. Negative or neutral savings could result from a number of possibilities, such as:
- The respective ISD had a site with a large lighting retrofit where the project installation coincided with the post-intervention period of the behavioral program. The retrofit savings were excluded from the behavioral energy and demand savings. If the retrofit savings estimates were overestimated, they could bias the behavioral savings downward. The details of the retrofit within the M&V plan was limited.

[34] The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 17: Residential Behavior Protocol, page 14.

- There may have been other unobserved or unaccounted for changes at the 15 facilities within the respective ISD that caused consumption to increase during the post-intervention period. As described above in Key Finding #3, documentation was limited to identify and know when such changes may have occurred.

- The behavioral changes were ineffective. While success may occur one month, it may not occur repeatedly. On-site walk-throughs conducted by the evaluation at two high performing facilities, identify many behavioral and operational (no-cost) ways to further improve the building operation and save energy.

Recommendation #6: *Review prescriptive retrofits for accuracy in deemed and/or engineering estimates and if necessary, alternative measurements or approaches in those savings development may be needed. Work to capture more detailed participation data including site characteristics (e.g., square footage, space use) and the main drivers of energy use (e.g., major equipment, current operating schedules). Provide this information to the energy modeling team for model decision-making purposes.*

Recommendation Status: The PY2016 M&V Plan was edited to describe the need to capture this data. The site characteristics are currently being collected and documented within Energy Center. These details are planned to be incorporated into future M&V Plans so that they are available to the modeler.

G. Key Finding #7: Continue to work with the EM&V team to refine the regression modeling while also documenting the specific modeling choices used for individual sites.

- The M&V analysis procedures, including details of the final algorithms and assumptions used for the savings determinations, were described in the M&V plan. However, documentation is currently lacking regarding model testing, handling of errors and the information for validating the regressions. While many of these modelling steps and decisions were completed by the implementer and discussed in detail with the EM&V team, documenting these procedures would allow for improved transparency of the calculations and unique considerations taken. Particular procedures taken and their respective results that could be better documented include:

- Explain energy drivers and the test results for statistical significance. An explanation should be provided when an energy driver(s) is used in the model, but the energy driver(s) was not found to be statistically significant.

- Describe the process for how the initial review for outliers was completed and whether erroneous entries were identified. Describe how any missing data points or data entry errors were corrected and document such corrections made. Any outliers that are ultimately removed from the baseline data set should be annotated with the assignable cause.

- Clarify the guidelines used to test for the significance of each independent variable. Assessing statistical significance of independent variables is a critical step in the model review process, as the inclusion of erroneous variables will introduce error in the model. Likewise, the omission of critical energy driver variables will negatively affect the ability of the model to accurately characterize variation in energy use.

- Statistical criteria used for model fitness should be specified and results provided. Any tests used for determining if auto-correlation is statistically significant should be clearly described and documented.
- **Recommendation #7:** Improve the description and documentation of model testing undertaken and results of such tests.

Recommendation Status: Solutions to implement this recommendation are still in development.

H. Key Finding #8: Continue to work with the EM&V team to identify future program needs and considerations for supporting accurate savings determinations, persistence of savings, and further evaluation needs where identified.

<u>Control Group:</u> While the current method controls for a number of factors, it does not fully account for other influences that are potentially correlated with behavioral activity, such as naturally occurring energy efficiency trends or patterns of business activity. Determining the best approach for controlling for such influences are still under discussion with the program implementer. Use of a comparison group is currently limited due to two major constraints:

1. Current implementation of the behavioral program across a school district does not allow for comparisons within the school district.
2. Heterogeneity of the population makes it difficult to use a nonparticipant population for comparison of energy performance over time.

For large school districts, random selection of schools being considered for participation and segmenting those into treatment and control may be one way to do this. Although, it may be harder for small school districts. A large program might allow multiple school districts to have a mix of treatment/control, but may create program design or utility service territory challenges. Further discussion of strategies to evaluate controls is necessary to complete this valuable analysis.

<u>Persistence of Savings Study:</u> The EM&V team encourages the program implementer to work with clients to update data release forms and procedures to potentially be able to track savings beyond intervention. The implementer was not able to commit to provide this study beyond their implementation contracts with clients (beyond intervention). It may be possible, however, to work with current program materials and update data release forms to include a longer-term release for future study beyond program implementation and/or intervention by utility companies or others contracted to do so. This will support the development of programs and measures of this nature.

<u>Smart Meters:</u> Modeling may need to adapt as participants include those with smart meters and for which more granular interval data exists. Daily or weekly time interval data typically provide better insight into the process being modeled, and thus models that are more accurate are typically created when compared to data of longer durations such as monthly data, which is currently used to estimate savings.

Recommendation #8: *Consider use of a control group for capturing longer-term program influences and support efforts to further study persistence of savings.*

Recommendation Status: Solutions to implement this recommendation are still in development.

4.1.4 Conclusion

In PY2015, the EM&V team worked with the implementation contractor through many changes to the savings methodology and identified how to close the gap in providing improvements in the transparency of data collection and documentation needs for the behavioral program. Many recommendations described above are already complete while others are still in development. The most important of these recommendations is that the behavioral program needs to consider how to capture longer-term program influences for future study beyond program implementation and/or intervention. Such research is needed to determine savings and measure life beyond the first year.

4.2 COMMERCIAL COOL ROOFS

This section summarizes the key findings and recommendations from the PY2015 evaluation of the Commercial Cool Roofs measure, which was implemented across both CSOP and CMTP programs.

4.2.1 Background

In PY2015, all roofing projects reported deemed savings. Of the 44 roofing projects in PY2015, 32 were analyzed in-depth by the EM&V team. The EM&V team performed a review of the four roofing calculators currently used throughout the commercial programs in Texas. We then compared these current calculator methodologies and assumptions to those of the newly developed high performance roofing (HPR) calculator.

The EM&V team conducted analysis to estimate prospective realization rates. As in previous years, the main objective was to provide a qualitative assessment to identity any potential issues with the deemed values and calculation methods to assess a new savings methodology for roofing projects. Prospective realization rates (PRR) were calculated for all roofing projects where an existing M.S. Excel based calculator was sampled and collected. The analysis was based on transferring the existing roof calculators to the HPR calculator. The new HPR calculator appears to yield considerably higher savings for all existing approaches except the Cool Roof Savings Estimator, which yielded only slightly higher savings (See Table 4-3).

Overall, the EM&V team found a variety of differences between the calculators, including limitations of parameter entry and selections, unclear direction on their use, and the fact that some roofing projects are using site-specific assumptions while others are using default conditions stipulated in the TRM. The measure description and requirements within the TRM were also found to be in need of clarification and updates. While the new HPR calculator is somewhat complex from the standpoint of the calculations such as those used for determining a load profile of the building, these calculations are hidden and the calculator tool from a user perspective is similar to the others and relatively easy to use. The HPR calculator also offers improvements that currently do not exist in the other calculators. A further description of these roofing calculator findings and recommendations are provided next.

Table 4-3. Commercial Roofing Measures PY2015 Prospective Realization Rates

Calculator Type	Utility	Number of Roofs	*Claimed Demand Savings (kW)	Prospective Demand Savings (kW)	*Claimed Energy Savings (kWh)	Prospective Energy Savings (kWh)	Prospective RR (kW)	Prospective RR (kWh)
C&I SOP Roofing Worksheet	CNP, Xcel	14	115	200	229,389	279,798	175%	122%
CalcSmart Energy Star Roof	AEP TCC, SWEPCO	10	103	204	74,539	359,857	199%	483%
Energy Star Roof Savings Calculator	EPE, TNMP	6	93	164	191,013	228,125	177%	119%
Cool Roof Savings Estimator	Entergy, EPE	2	4	5	8,559	8,795	115%	103%
All	**All**	**32**	**315**	**574**	**503,499**	**876,575**	**182%**	**174%**

*Claimed demand and energy savings include PY2015 EM&V results for roofing projects that had desk reviews and on-site verifications.

4.2.2 General findings

The following are general findings, which pertain to all of the roofing calculators.

- *Reflectance and emissivity*: There are two rating bases for these key parameters - initial and three year - and the TRM clearly states that the three-year values should be used for savings calculations. However, not all of the existing calculators specifically state which value is to be used, and as a result some of the calculators used the initial values.
- *HVAC system parameters*: The approach used for the HVAC system parameters varies significantly across both the existing and the proposed method.
- *Building types*: The new HPR calculator and one of the previous calculators use building type as a way to map HVAC system parameters such as type, efficiency and hours of operation. None of the algorithms cited in the TRM reference building type as an input. The TRM does reference one stipulated value of 2,000 for hours of operation and stipulated values for HVAC efficiency for El Paso Electric only.
- *New roof specifications*: Installed roofing reflectance and emissivity values should always be looked up from the Energy STAR® roofing list or from the project documentation such as product specification sheets.
- *Existing roof parameters and guidance*: The existing roof assumptions such as insulation or R-value, reflectance, and emittance can have a significant impact on project savings. Very few projects are capturing core samples or using the calculator's build-up of the existing roof materials. When the existing roof materials beneath the surface material are unknown, not all calculators provide adequate guidance or default selections for what assumptions should be used.
- *Energy and demand savings methodology*: Across the Texas utilities, there are several ways of calculating energy and demand savings for roofs. Some of the existing approaches are more simplified and conservative in savings estimates as compared to the calculators that employ the HVAC system effects of weather as a means to quantify savings.
- *Calculator access and version control*: The existing calculators are locked and lack a date. While some unlocked calculators were provided to the EM&V team, it is unknown whether the most current calculator version is being used.
- *Industry standard roofing savings calculator*: The Department of Energy (DOE) is still developing a commercial based roofing calculator. It's currently in the beta stage, provides limited access to model and algorithm assumptions, and has shown inconsistent savings results. While one industry accepted roofing savings calculator would be ideal, such a calculator is not available at this time.

4.2.3 New High Performance Roof calculator

The following are findings that pertain to the new HPR calculator.

- *Geographic data*: The new HPR calculator requires the county to be determined in addition to the city. County is mapped to the Texas climate zones, and the corresponding solar and weather data used for the calculations.
- *Energy use savings (kWh)*: The local solar and weather data is used to estimate the hourly impacts to the buildings heating and cooling loads and the basis for savings.
- *Energy demand savings (kW)*: The HPR calculator uses an hourly load shape and the peak probability analysis (PPA) tables as the method for deriving peak demand savings that are in alignment with TRM 3.1: Volume 1.
- *Material selections*: The HPR calculator has somewhat limited selections for roof materials compared to some of the other calculators, however, the implementer is open to providing additional selections into the calculator.
- *Building types*: The HPR calculator has limited selections for building types due to the limits of building occupancy schedule and cooling/heating set points available from DOE/NREL.

4.2.4 Existing roofing calculators used in Texas

The following are findings from the four predominantly used roofing calculators in Texas in PY2015. These calculators include the C&I Standard Offer Program Roofing Worksheet, the CalcSmart Energy Smart Roof Savings Calculator, the Energy Star Roof Savings Calculator, and the Cool Roof Savings Estimator.

A. C&I Standard Offer Program roofing worksheet:

- Most projects were found not using many of the entry fields such as site address in the calculator.
- The calculator only tracks and integrates high level HVAC information such as efficiency. More specific HVAC information such as equipment type and average tons per unit is not captured. This detail is used in other calculators.
- The calculator does not provide the existing roof surface layer type beyond a surface color.
- The calculator does not specify whether to use the initial reflectance or three-year reflectance, although the TRM specifies that the three year reflectance value should be used.

B. CalcSmart Energy Smart Roof savings calculator:

- The calculator's inputs are very similar to those of the HPR calculator. However, there were large differences in savings with the HPR calculator. This is likely due to a difference in how the building cooling load and hours of operation are determined between the two calculators.
- A selection for building type is available, however they do not match up with the HPR calculator building types. For example, the CalcSmart tool has selections for College/University and Education K-12, whereas the HPR calculator only has a single School option.

- The calculator requests and incorporates the age of the existing HVAC system as part of the assumptions and equipment basis.
- Emissivity values assumed for the existing roof are not provided in this calculator, but is a key parameter for the savings calculation.

C. Energy Star Roof savings calculator

- A field for the existing roof surface layer is provided and selectable, however the selections vary to that of the HPR. For example, this calculator has selections for Unpainted Metal, Mineral Surface Cap Sheet, Aluminum Coating and Aluminum Cap Sheet which are not options in the HPR calculator.
- Emissivity values assumed for the existing roof are not provided in this calculator, but is a key parameter for the savings calculation.

D. Cool Roof savings estimator

- The building type is not used by this calculator. Impacts to the building load is stipulated by one value for each weather zone regardless of building type. Changes to these default assumptions are not available.
- The pre-existing surface layer is stipulated at a solar reflectance of 30 percent and an R-value of 15. Changes to these default assumptions are not available.
- The post-roof surface layer is stipulated at a solar reflectance of greater than 70 percent. Changes to these default assumptions are not available.
- The post-roof R-value is not provided, but is assumed to stay the same as the pre-existing roof R-value of 15. Changes to these default assumptions are not available.
- A limited number of HVAC selections are available which include DX, air-cooled or water-cooled HVAC types.
- The calculator’s inputs are very different to those of the HPR calculator. However, there were small differences in savings with the HPR calculator. What primarily led to the similar results were that the default selections for R-value and solar reflectance were similar to the actual sites conditions. Also, even though each calculator assumed different heating/cooling load impacts and HVAC system efficiencies, their combined calculations resulted in similar values between calculators. It is unknown how the stipulated heating and cooling loads for each weather zone were derived within the Cool Roof calculator.

4.2.5 TRM updates

The following are key findings that pertain to clarifications and updates needed in the current measure description and requirements within the TRM.

- Applicable building type: Clarity is needed as to the building types covered by the measure and options for when a building contemplated for the measure is not listed.

- Eligibility criteria: Improved clarity of the referenced standards and a further description of the criteria for eligibility is needed. Some criteria are currently located in other sub-sections of the measure write-up.
- Baseline condition: Many projects are using readily available site specific conditions for key inputs as opposed to deemed values in the TRM. Clarity is needed as to such use.
- High-efficiency condition: New construction projects were found using the roofing calculator for which the TRM indicates use in a retrofit condition. Further clarity is needed as to the roofing measure scopes covered and not covered by the savings methodology.
- Energy and demand savings methodology: The TRM currently describes several ways for calculating energy and demand savings for roofs. One approach is needed.

4.2.6 Summary and next steps

Based on the results and findings of the analysis of roofing calculators used in Texas, the EM&V team recommends the following:

- Update the roofing measure in the TRM to provide improvements and guidance as to the eligibility, baseline condition and high-efficiency conditions of the measure
- Include a description in the TRM for use of the current roofing calculators in addition to the HPR calculator until deemed energy and demand savings values based on one standard methodology such as modelling results can be determined. The deemed savings for different building types and locations in Texas would best represent the variation of customers, weather, and solar resources throughout the state
- Installed roofing reflectance and emissivity values should always be looked up from the ENERGY STAR® roofing list or from the project documentation
- Projects should capture documentation of key assumptions for roofing projects such as the new roof product specifications that clearly show initial and three-year reflectance and emissivity values. Confirmation of the existing roofs build-up and surface material would be ideal such as from photos and certified assessment reports. If roof materials below the surface material are unknown, then the appropriate defaults as specified in the TRM should be used. Again, calculators should be updated to follow these clarified guidelines
- The existing calculators should be updated to resolve the issues identified above and match the improvements that will be forthcoming in the latest TRM Version 4.0. Calculators should also be modified to include a version number and date
- Two different calculators were used for projects across the same utility. A single calculator should be used for all projects by a utility.

4.3 COMMERCIAL LOAD MANAGEMENT PROGRAM

This section summarizes the key findings and recommendations from the PY2015 evaluation of the Commercial Load Management program.

4.3.1 Background

Nine of the Texas utilities operated residential demand response programs in PY2015. The EM&V team applied the method prescribed in TRM 2.1 on a census of records to calculate energy savings and demand reduction.

4.3.2 Findings

Statewide PY2015 evaluated savings from commercial sector load management programs were 218,025 kW and 996,348 kWh. These are lower kW reduction compared to prior years. For kWh, the savings are a rebound from PY2014 and similar to prior years. While kW usage has fallen, it is possible to have higher kWh if more load management events are called. These results are shown in the following two figures.

Figure 4-1. Total Statewide Evaluated Gross Demand Reduction by Program Year—Commercial Load Management Programs

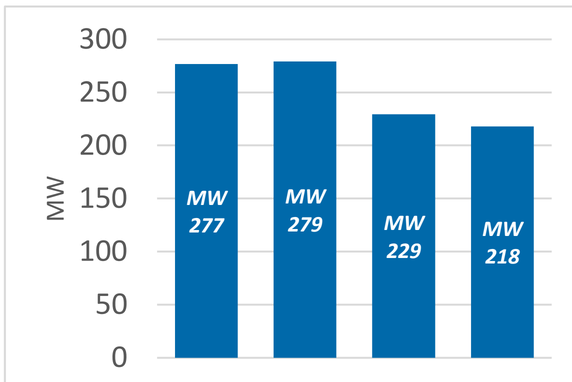
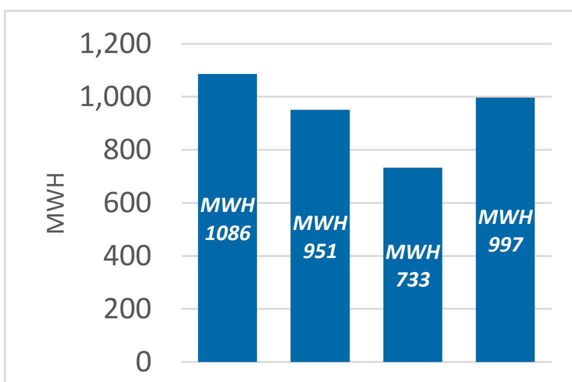


Figure 4-2. Total Statewide Evaluated Gross Energy Savings by Program Year—Load Management Programs



The EM&V team worked with each utility or its data contractor to verify the claimed savings. The EM&V team received meter data load management event information, initial utility savings calculations for each sponsor, and initial program savings, and applied the PY2015 TRM (version 2.1) to calculate initial evaluated savings. The EM&V team found discrepancies across sponsors or portfolio level savings results. In some cases, this was due to calculation errors on the part of a utility, in other cases it was due to calculation approach differences between the EM&V team and the utility. The EM&V team worked with each utility to resolve the differences, which is the primary reason for the 100.0 percent realization rate for both demand and energy savings.

The EM&V team and utilities were closely applying the calculation methods from TRM 2.1. Despite this common calculation framework, details emerged on subtle differences that drove initial discrepancies. Examples include:

- Whether total program savings were calculated from the average of events or the sum of the average sponsor-level savings. While in theory there should be no difference, the points at which rounding occurred can differ, driving minor differences in calculation results.
- Identifying simultaneous interruptible tariff and load management events. The information provided to the EM&V team for one sponsor was not adequate to understand the overlap of an interrupted sponsor also participating in the load management program, nor does TRM 2.1 discuss this situation. The EM&V team worked with the utility to only count load management savings below that of the firm supply identified in the interruptible tariff for that sponsor. The utility had applied the logic reasonably and the EM&V team then applied the same logic, reducing the apparent load management savings for that sponsor.
- One utility chose not to include scheduled events in a sponsor's demand savings unless the sponsor only participated in scheduled events. However, energy savings were calculated for all events, whether scheduled or unscheduled. TRM 2.1 does not address this topic.
- One utility had meter data time stamps that differed from the other utilities' time stamps. In this one case, the time stamp represented the forward-looking interval, whereas all other utilities had time stamps that reflected the preceding interval.

During PY2015, the EM&V team also provided guidance on three topics:

1) Guidance to the utilities on issues related to rounding practices. The EM&V team recommended that rounding occur at the sponsor level for each event.
2) When it was reasonable to substitute utility meter data with sponsor-owned meter data for purposes of calculating event-level savings. If a utility-owned meter failed to record interval data for a baseline or event period, data from a customer-owned meter or sub-meter could be used if the data were substantially similar to utility meter data and the data were used consistently for an entire event's baseline and event-day time periods, thus not mixing utility and sponsor meter data.
3) As part of the PY2015 commercial load management data request, the EM&V team requested data that would support the calculation of PY2015 savings using the TRM 3.1 method, which will be active in PY2016. The TRM 3.1 method for calculating a baseline demand, called High 5 of 10, requires more data and the use of pre-event hours on the event day and baseline days. In most cases, the EM&V team did not receive adequate or specific enough information to make for a direct comparison, but was able to approximate the High 5 of 10 method for each utility. This "dry-run" served two purposes – providing a rough estimate for how the new method may affect program savings, and understanding/preparing for the data request for actual PY2016 evaluation savings. Additionally, the EM&V team provided a spreadsheet illustrating

the calculation method described in text in TRM 3.1 to assist utilities as they develop their own calculation systems.

4.3.3 Recommendations

Based on the experience of PY2015, the EM&V team has several recommendations for utilities operating commercial load management programs:

Recommendation #1: *Utilities should plan to provide comprehensive and complete information about each event.* Although some utilities did provide *sufficient* information about each event from which to develop initial calculations, in many cases, the information was unclear or incomplete. For PY2016, the High 5 of 10 method requires a clear descriptions of each event's start and end time (the full range of the event), as well as when sponsors were given notification that an event was occurring (particularly for unscheduled events). Additionally, it will be important to identify which sponsors or ESIIDs participated in an event and indicate whether meter data or calculations should be used in calculating event or sponsor savings. In some cases, it is possible that a non-participant could show a higher demand during an event – without clarity on this issue, at the sponsor or ESIID level, the evaluated savings could be less than calculated by the utility.

Recommendation #2: *Data Rounding should occur in only two places – sponsor level savings and final program savings summaries*. Absent this standard practice, utilities should document to the EM&V team when round is occurring in their calculations. While rounding differences create only minor discrepancies in calculations, the differences have the potential to sum to a level that creates confusion or doubt. Using a standard practice or documenting differences will reduce the burden on the utilities and EM&V team as discrepancies are investigated after initial calculations are developed.

Recommendation #3: *Document standard practices if sponsors on interruptible tariffs have overlapping interruptions and load management program participation.* While uncommon, the overlap can have significant implications for an individual sponsor's event performance. The EM&V team recommends a standard practice be documented in TRM 4.0 in which an interruptible sponsor's firm delivery sets the ceiling from which further demand reduction is calculated.

Recommendation #4: *Each utility should provide documentation on its entire calculation approach to arrive at program level annual savings*. The EM&V team did not find that any utility was conducting calculations in error, though there were differences that led to differences in initial calculations. By using meter data to perform the evaluation across all sponsors and events, the EM&V team should be able to replicate each utility's results. For PY2016, with a new a more complex method for calculating the baseline, the potential differences caused by undocumented calculation choices may be magnified and are potentially more difficult to identify and resolve. Full documentation will facilitate the process for both the utilities and EM&V team. To the degree possible, the EM&V team will provide guidance in TRM 4.0.

5. PROCESS ASSESSMENTS

This section documents key findings and recommendations from the PY2015 process evaluations, which investigated two areas: 1) market transformation in schools, and 2) pilot programs.

5.1 SCHOOLS MARKET TRANSFORMATION

5.1.1 Background

Standard offer programs (SOPs) and market transformation programs (MTPs) use different program strategies to achieve energy and demand savings. Standard offer programs use a contract between an energy efficiency service provider (EESP) and a participating utility where standard payments are made based upon the amount of energy and peak demand savings achieved. Commercial customers with a peak load equal to or greater than 50 kW can participate directly with the utility. Market transformation programs are strategic efforts, including but not limited to, incentives and education designed to reduce market barriers for energy efficiency technologies and practices. (16 TAC §25.181(k)). In utility interviews, most of the utilities indicated running SOPs internally while having an implementation contractor for the MTPs. In general, MTPs have a highly involved implementation contractor, working on behalf of the sponsoring utility offering technical support to program participants. For the commercial SOP-type programs, there is less technical support provided to participants with the trade-off of higher incentives paid for kW and kWh savings.

As part of the PY2013 EM&V process evaluations, the EM&V team made recommendations regarding the mix of MTPs and SOPs in a utility's portfolio. In summary, the EM&V asserted that because MTPs are strategic efforts that are able to include both incentives and education designed to reduce market barriers for energy efficient technologies and practices, these programs can provide value in delivering services that encompass the comprehensive treatment of harder-to-reach customer segments and support the promotion and adoption of new energy efficiency technologies or services. At the same time, the EM&V team recommended that each utility assess the market barriers each program type is designed to address within their own service territory to determine the right mix of market transformation offerings versus standard offer program offerings, given their customer base and available contractors to deliver the programs to the market.

In keeping with this recommendation, there have been some shifts in the utility SOP/MTP offerings targeting schools. Market transformation programs specifically targeting schools have been part of the Texas utility offerings for over a decade. One utility moved to serving schools through their commercial SOP starting in PY2015. In addition, two utilities—CenterPoint and TNMP— are offering 'lite' versions of their Schools MTP with less assistance and more incentives than the prior MTP version. CenterPoint began the SCORE lite offering in PY2012. Both these approaches are discussed more below.

One reason for transitioning school districts from an MTP to the CSOP is an anticipated decrease in the amount of kW and kWh savings available to school districts energy efficiency projects in upcoming years. A consistent definition of peak demand hours based on the utility system peak that became effective in 2016 could result in new peak demand hours with less overlap with school schedules, lessening the amount of kW and kWh savings that can be achieved through lighting, HVAC, and other energy efficiency projects implemented by school districts that do not operate during the utility system peak. In addition, one utility expressed that they believe more energy efficiency projects for school districts will be focused on retrofit, rather than new construction, also decreasing the kW and kWh savings that can be achieved by school districts and educational facilities. The anticipated lower kW and kWh savings attributable to school district energy efficiency efforts could make it difficult for utilities to demonstrate the cost-effectiveness of the MT program for school districts and educational facilities.

Among Texas utilities, the EM&V team identified two different approaches to transitioning school districts from the MT to CSOP types of programs:

- CenterPoint Energy developed a new program (SCORE LITE) comparable to the Commercial Standard Offer Program (CSOP), to complement the existing MTP for educational facilities and school districts (SCORE) starting in PY2012. Participants in SCORE LITE receive incentives that are comparable to the CSOP, but are not required to pay a deposit, as they would in the CSOP. School districts are expected to transition from SCORE to SCORE LITE over time, however, both programs are operating for the foreseeable future.
- Oncor Energy terminated the MTP for school districts (Education Program) and now requires school districts to participate in the CSOP with other commercial facilities and customers to obtain funding for energy efficiency improvements.

To encourage the transition from SCORE to SCORE LITE over time, CenterPoint plans to identify a small number of school districts participating in the MTP each year that are good candidates to transfer to the SCORE LITE Program. They will meet with the energy manager or representative from these school districts to discuss the requirements and expectations for SCORE LITE, as well as the increased incentives for energy efficiency improvements.

Since the MT Education Program was terminated, Oncor Energy is providing increased outreach to school districts, as well as training and webinars, designed to enable school district energy managers to prepare the application and supporting documentation required for participating in the CSOP. It is also expected that some school districts will opt to hire an ESCO or contractor to work with them on participating in the CSOP.

5.1.2 Process evaluation objectives and methodology

This process evaluation activity was designed to assess how well school districts are transitioning from a MT Schools Program to a CSOP-type of program in the Oncor and CenterPoint service areas.[35] To assess the effectiveness of each transition path, the EM&V team compared the number of participants and the amount of kW and kWh savings achieved for the MT Program and CSOP, for both Oncor and CenterPoint. In addition, the EM&V team recorded the views of school district participants on the strengths and weaknesses of the MT and CSOP types of programs for the Oncor and CenterPoint programs.

[35] Note that Texas New Mexico Power (TNMP) also recently began offering a SCORE Lite, but was not included in the process evaluation research since it already included the two largest electric utilities in Texas in the research and because of the similarities between TNMP's and CenterPoint's program changes.

One hypothesis is that middle-sized and larger school districts (and perhaps urban school districts) will be able to make this transition more effectively than smaller and more rural school districts, since they are more likely to have a larger energy management staff with more professional training (such as a Certified Energy Manager), and the group responsible for energy management is likely to dedicate more of its time toward energy management and less toward maintenance and other related, but non-energy management functions.

5.1.3 Process evaluation objectives and methodology

The experience of CenterPoint and Oncor in developing different paths for transitioning school districts presented an opportunity to compare the effectiveness of these two approaches. The EM&V team conducted the following activities as part of this evaluation:

- Analyzed PY2013–PY2015 participant data to characterize school districts' participation in the Oncor MTP and CSOP, as well as the CenterPoint SCORE and SCORE LITE Programs.
- Conducted interviews with Oncor and CenterPoint staff responsible for energy efficiency programs for school districts.
- Conducted interviews with a mix of large and smaller school districts in Oncor and CenterPoint service territories:
- Persons responsible for energy management for Plano ISD, Wylie ISD, Arlington ISD, and Killeen ISD in the Oncor service area
- Persons responsible for energy management for Cypress-Fairbanks ISD, Royal ISD, Klein ISD, and Sheldon ISD in the CenterPoint service area

5.1.4 Key findings

A. Energy savings – kW and kWh

Table 5-1 shows that the number of school districts participating in the Oncor service area (measured by the number of meters, rather than the number of unique school districts) has steadily decreased from 2010 to 2015, with the largest decrease between 2014 and 2015. The decrease in the kW and kWh savings attributable to school's energy efficiency projects has also decreased substantially. The table also shows that the amount of incentives paid to school districts has been decreasing, approximately in proportion to the decrease in the number of meters participating.

Table 5-1. Oncor Educational Facilities Projects – MT and CSOP

Program Name	Demand Reduction (kW)	Energy Savings (kWh)	Incentives ($)	Number of Meters
2010 MT Edu Facilities	6,409	16,098,534	1,550,339	248
2011 MT Edu Facilities	6,137	14,752,595	2,287,088	222
2012 MT Edu Facilities	4,273	11,704,592	1,894,019	190
2013 MT Edu Facilities	4,837	13,796,079	1,905,428	183

Program Name	Demand Reduction (kW)	Energy Savings (kWh)	Incentives ($)	Number of Meters
2014 CSOP Edu Projects (Solar, BCSOP, CCSOP)	2,280	7,141,672	1,745,446	179
2015 CSOP Edu Projects (BCSOP, CCSOP)	1,511	5,351,950	779,929	107

In contrast, CenterPoint saw the largest participation in terms of meters in 2015 as well as in incentives and kWh savings, though not demand reductions. CenterPoint began offering SCORE LITE in 2014. In 2015, there were 19 school districts participating in the SCORE Program (with 97 projects) and 13 school districts participating in SCORE LITE (with 58 projects). Overall, for educational facilities segment, the two combined programs met the kWh goal, but fell just short of the kW goal in 2015. One reason for missing the kW goal was the 2015 update of the ACE tool used to calculate energy savings for chiller replacements, reducing the kW savings in 2015.

**Table 5-2. CenterPoint Educational Facilities Projects--
SCORE and SCORE LITE Programs**

Program Name	Demand Reduction (kW)	Energy Savings (kWh)	Incentives ($)	Number of Meters
2012 SCORE	3,364	11,206,857	959,930	148
2013 SCORE	3,270	16,101,971	1,411,450	118
2014 SCORE	3,645	13,895,097	1,280,705	137
2015 Commercial MTP	3,635	18,411,505	1,537,351	165

CenterPoint staff also noted that some participants who initially enrolled in SCORE LITE were not fully aware of the requirements (less technical assistance from CenterPoint and Clear Result staff) and had to be transferred back to the SCORE Program. In some cases, staff turnover where an experienced energy manager is replaced by a less experienced energy manager may require some school districts to move from SCORE LITE back to SCORE.

B. Oncor participants' views of the MT Educational Facilities and CSOP Programs

In the Oncor service area, three of the four ISDs interviewed indicated they had previously participated in the MT Educational Facilities Program, before it was terminated, and were continuing or planning to continue participating in the CSOP. All three of these are relatively large with more than 50 facilities and 45,000 students. The fourth ISD interviewed is a medium-sized district, with 25 facilities and about 15,000 students.

All four of the contact persons interviewed were aware the MT Program had been terminated and the CSOP was available to school districts, beginning in 2015. However, there were different levels of awareness of the differences in the MTP and CSOP, as well as different perceptions of the ease of transition from the MTP to the CSOP.

All four of the contact persons indicated they first became aware of the change from the MTP to the CSOP through a presentation. Three reported that the application and documentation required for CSOP were easy, because they relied on contractors who were designing the projects to meet the requirements and deadlines. One ISD reported they attempted to prepare an application for 2015, but were unable to successfully provide the materials required by the deadline. This latter ISD is planning to prepare an application for 2016.

For the three ISD's who successfully participated in the CSOP in 2015, two were aware of the higher incentives paid through the CSOP. One indicated he was not aware of the difference in incentives between the two programs, even though his ISD had participated in both programs. The ISD that was unsuccessful in applying to the CSOP for 2015 indicated the application and documentation required was more difficult and time consuming than they had expected. None of the four ISD's indicated they were aware of or had attended a training workshop or webinar specific to school districts participating in the CSOP, although all indicated they received information about the CSOP through the Texas Energy Managers Association (TEMA).

Two of the ISD's reported asking for and receiving assistance from Oncor for the CSOP. These individuals noted that Oncor is very responsive and helpful, even though the CSOP is designed for school districts to be more self-sufficient for preparing the application and documentation required for participation. They further noted that Oncor local staff are very helpful since they are knowledgeable about the community and the district.

Anecdotal evidence reported by two of the interviewees suggested they were aware of a number of school districts that decided not to participate in the CSOP, because the requirements for completing the application and documentation were more difficult and time consuming then they had been under the former MTP. However, this is anecdotal evidence and was not be confirmed by this evaluation research.

C. CenterPoint participants' views of the SCORE and SCORE LITE Programs

i. SCORE LITE Program

Two respondents from school district currently participating in SCORE LITE reported the transition from SCORE to SCORE LITE was relatively easy for them. One school district is a relatively large district with approximately 55 facilities, while the other ISD is smaller, with about 20 facilities. In both cases, these ISD's have an energy management department with an experienced and professionally qualified Energy Manager and four or more staff. The Energy Manager in each of these ISD's reported spending a majority of his time on energy, rather than maintenance or operations activities. In one case, the ISD Energy Manager had advocated for a CSOP-type of program, so the incentives to the school districts would be higher. The Energy Manager also reported the district works with a CenterPoint Retro Commissioning MTP where they need more technical assistance to take care of three to four facilities per year.

In the case of these two ISD's, both energy managers reported that they do not need the assistance that is offered by the implementation contractor through the SCORE Program. Although it takes some additional time for them to complete the application and documentation internally, the higher incentives paid through the SCORE LITE Program are worth this extra effort. One advantage of offering SCORE LITE, rather than having all school districts participate in the CSOP with other commercial facilities is there is less competition for the available energy efficiency incentives. These energy managers feel that school districts may require more time to obtain all of the approvals and funding required to complete the required application than commercial facilities, so a program like SCORE LITE that is targeted to school districts helps to encourage participation and maximize the energy savings that can be achieved with this sector.

ii. SCORE Program

Two interviewed ISD's are currently participating in SCORE. One is a relatively small ISD with only 4 buildings and 2,200 students, the Supervisor of Operations and Maintenance is responsible for energy management. Energy management is one of many responsibilities for the 2-person staff and no one on the staff is a member of TEMA. The contact person indicated that 2015 was the first year the ISD has participated in SCORE and that participation in SCORE was recommended by a contractor they had hired to install new HVAC equipment. The contractor provided assistance in completing the application forms and documentation for participation in SCORE.

The other interviewed ISD is the third largest ISD in Texas, with approximately 120 facilities. They have a 4-person staff who are dedicated to energy management, with a professionally qualified energy manager directing the department. The current Energy Manager has only been in the position for 6 months, but he is aware that his predecessor participated in SCORE for most years since 2006. The new Energy Manager was not familiar with the SCORE LITE Program, but indicated he will look into it, since completion of the required application and documentation is likely something he is capable of doing internally. This ISD has just allocated funding for construction of two new high schools, three new elementary schools, and one new middle school, as well as a new stadium and a natatorium.

The level of experience and years in the position for the school district energy manager also affects whether a school district selects the SCORE or SCORE LITE Program. At one of the large school districts, the current energy manager is planning to retire within the next year. Even though the ISD successfully participated in SCORE LITE last year and is participating in 2016, he is recommending that his predecessor go back to the SCORE Program for two reasons. The additional technical assistance will be beneficial to a new energy manager and the benchmarking for the ISD (available in SCORE, but not in SCORE LITE) will provide a useful baseline for future planning.

5.1.5 Recommendations

Based on the qualitative feedback obtained as part of this process assessment, the EM&V provides the following recommendations for the utility consider if they are either considering transitioning school participation to the CSOP or a reduced technical assistance MTP offering.

A. Recommendations for school district participation in CSOP

Recommendation #1: Provide clear-cut guidelines and timelines tailored to school districts, including milestones and indicators of where it is appropriate to ask for assistance from utility staff. Be prepared for some increase in staff resources to assist schools participate in CSOP.

Recommendation #2: Provide training and workshops tailored to school districts to facilitate participation in the CSOP. This appears to be particularly important for smaller school districts that do not have an energy manager as well as school districts where staff turnover has occurred.

Recommendation #3: Consider a 'set-aside' of incentive funds for schools**.** The interviews indicated that schools may not have as much flexibility in getting project approval as other commercial customers and could miss out of incentive dollars due to internal bureaucracy for project applications and approvals. Set-aside funds would need to be released at a certain date in the program year if not expended to not impede program participation and reaching goals.

B. Recommendations for school district participation in a MTP 'lite' offering

Recommendation #1: Develop an on-line system or a drop box for submitting and storing project documents, similar to what is used for the CSOP. Having a central repository for all documents related to a project makes it easier for participants.

Recommendation #2: Offer an option for periodic benchmarking for SCORE LITE participants. Benchmarking is viewed as a valuable service that is currently only offered to SCORE participants.

C. Recommendations for either CSOP or MTP 'lite' offerings

Recommendation #1: Continue EESP training and workshops such as those designed to keep mechanical and electrical engineers up-to-date on requirements and specifications for qualifying equipment, such as LED lighting and Energy Star certification. School participants as well as other CSOP participants rely on these trade allies for design assistance and recommendations.

5.2 PILOT PROGRAM DESIGNATION

16 TAC § 25.181 allows utilities to pilot new program concepts without passing cost-effectiveness the first year. This is in keeping with standard industry practice given the first year start-up costs make it difficult to be cost-effective the first year. Recently piloted program concepts have included offerings targeting specific customer segments such as small business, multi-family and data centers; new technologies such as pool pumps and AC tune-ups; and new delivery concepts such as working with Retail Electric Providers (REPs) to deliver energy efficiency offerings to customers.

However, there has been no clear criteria or consistent delineation of when a "pilot" program transitions to a full program in a utility's portfolio. While the transition is clearly articulated in utilities' EEPRs, the drivers of this transition are often not. Documenting and systematizing the "pilot to program" transition is an area for improvement. The Commission does expect pilot programs to pass cost-effectiveness the second year. Therefore, we are recommending that if pilots pass cost-effectiveness the second year of implementation, and if the utility plans to continue to offer it, it then becomes a program.

At the same time, we realize a pilot may not be cost-effective in the second year and a utility will have to consider re-design strategies for the pilot to be cost-effective. In these cases, the offering would continue as a pilot until it demonstrates it is a viable, cost-effective offering or it needs to be discontinued.

Figure 5-3 traces the status and evaluated cost-effectiveness of pilots from 2012 through 2015. Utilities have largely met the second year cost-effectiveness criteria for this recommendation, with some exceptions. AEP TCC and TNC both were below 1.0 for their non-pilot Solar PV programs in 2014, likely due to the avoided costs being the lowest since the EM&V began in 2012, but brought the cost-effectiveness back above 1.0 in 2015. CenterPoint's Residential Retail Electric Provider program was a pilot for three years, the second of which did not pass cost-effectiveness; this program is complicated by the fact that CenterPoint has cycled in additional program components each year, therefore the cost-effectiveness results do not represent the same program operations year to year.

Several utilities have operated small business offerings as pilots for three or more years even though the offering is cost-effective. El Paso Electric has operated its three pilot programs for more than the suggested two years, though the two Solar PV pilots have passed cost-effectiveness in each year of evaluation. Several utilities have dropped below passing programs. SWEPCO's CoolSaver and Solar PV programs were under 1.0 in cost-effectiveness after taking them out of pilot status and opted to cancel the programs.

Table 5-3. Pilot program status, 2012-2015

Utility	Sector	Program	Evaluated Cost-effectiveness[36]				Notes
			2012	2013	2014	2015	
AEP TCC	Com	A/C Distributor Pilot MTP	*0.00*	*0.00*			
	Com	CoolSaver A/C Tune-Up Pilot MTP	*0.83*	1.44	1.43	1.90	
	Com	SMART Source Solar PV Pilot MTP	*0.87*	1.23	4.46	25.44	
	Res	A/C Distributor Pilot MTP	*0.96*	*2.23*	1.59		
	Res	CoolSaver A/C Tune-Up Pilot MTP	*0.73*	1.66	1.18	1.29	
	Res	Efficiency Connection Pilot MTP				*0.42*	
	Res	SMART Source Solar PV Pilot MTP	*0.73*	1.08	0.89	1.06	
AEP TNC	Com	SMART Source Solar PV Pilot MTP	*1.22*	2.51	0.89	2.99	
	Res	A/C Distributor Pilot MTP	*0.70*	*1.77*	1.11		
	Res	Efficiency Connection Pilot MTP				*0.17*	
	Res	SMART Source Solar PV Pilot MTP	*0.87*	1.00	0.87	1.20	

[36] Italics indicate pilot program years.

Utility	Sector	Program	Evaluated Cost-effectiveness[36]				Notes
			2012	2013	2014	2015	
CenterPoint	Com	Data Centers Pilot				*1.90*	
	Com	Pool Pump Pilot				*0.21*	
	Com	Retail Electric Provider Pilot MTP		*1.20*	*2.51*	2.64	
	Com	Sustainable Schools Pilot	*0.00*	*0.96*	*1.15*	1.32	2012 was not a true year of operation, preliminary marketing only.
	Res	Pool Pump Pilot			*1.28*	*1.37*	
	Res	Retail Electric Provider Pilot MTP	*0.13*	*1.09*	*0.97*	1.39	Added pilot program components in 2014 and 2015.
El Paso Electric	Com	Commercial Rebate Pilot Program	*1.65*	*0.78*	*0.79*	*1.18*	
	Com	PV/Solar Pilot MTP		*1.83*	*1.59*	*2.57*	
	Res	PV/Solar Pilot MTP	*1.81*	*2.37*	*1.66*	*6.86*	
Oncor	Res	Residential Demand Response Pilot MTP				*1.51*	

Utility	Sector	Program	Evaluated Cost-effectiveness[36]				Notes
			2012	2013	2014	2015	
Sharyland	Com	SCORE Pilot MTP			*0.00*	*1.71*	2014 was not a true year of operation, preliminary marketing only.
	HTR	Commercial Water Heater Pilot MTP		*0.00*			Budget expended in 2013, no claimed savings and program discontinued.
	Res	Behavioral Pilot Program		*0.00*			Budget expended in 2013, no claimed savings and program discontinued.
	Res	Residential Water Heater Pilot MTP		*0.00*			Budget expended in 2013, no claimed savings and program discontinued.
SWEPCO	Com	LED Lighting Pilot MTP	*2.22*				
	Com	Small Business Direct Install Pilot MTP	*1.72*	*2.45*	1.33	1.17	
	Res	CoolSaver A/C Tune-Up Pilot MTP	*0.53*	*1.06*	0.99		
	Res	ENERGY STAR® Appliance Rebate Program		*0.72*	*0.24*		Program discontinued in 2013; 2014 claimed savings for trailing applications.
	Res	SMART Source Solar PV Pilot MTP	*0.66*	0.94			
TNMP	Com	Open MTP		*2.21*	1.27	1.28	
	Res	Small DRG (Solar PV) Pilot	*0.66*				

Recommendation #1: While pilots are an important part of utility portfolios to introduce new program concepts and/or technologies, utilities should transition pilots to programs after two years if the pilots demonstrate cost-effectiveness.

APPENDIX A: CONSUMPTION ANALYSIS MODEL SPECIFICATIONS

A.1 PRISM MODELS

The team estimated the heating and cooling PRISM model for various heating and cooling bases in both the pre- and post-period for each customer using the following specification:

$$ADC_{it} = \alpha_i + \beta_1 AVGHDD_{it} + \beta_2 AVGCDD_{it} + \varepsilon_{it}$$

Where for each customer '*i*' and day '*t*':

ADC_{it} = Average daily kWh consumption in the pre- or post-program period

α_i = The participant intercept, representing the average daily kWh base load

β_1 = The model space heating slope (used only in the heating only, heating + cooling model) – average change in daily usage resulting from an increase of one daily HDD

$AVGHDD_{it}$ = The base 45-65 average daily heating degree days for the specific location (used only in the heating only, heating + cooling model)

β_2 = The model space cooling slope (used only in the cooling only, heating + cooling model) – average change in daily usage resulting from an increase of one daily CDD

$AVGCDD_{it}$ = The base 65-85 average daily cooling degree days for the specific location (used only in the cooling only, heating + cooling model)

ε_{it} = The error term

Using the above model, we computed weather-normalized annual kWh consumption as:

$$NAC_i = \alpha_i * 365 + \beta_1 LRHDD_{it} + \beta_2 LRCDD_{it}$$

Where, for each customer '*i*' and annual time period '*t*':

NAC_i = Normalized annual kWh consumption

$\alpha_i * 365$ = Annual base load kWh usage (non-weather sensitive)

$LRHDD_{it}$ = Annual, long-term heating degree days of a TMY3 in the 1991–2005 series from NOAA, based on home location

$\beta_1 LRHDD_{it}$ = Weather-normalized, annual weather-sensitive (heating) usage (i.e., HEATNAC)

$LRCDD_{it}$ = Annual, long-term cooling degree days of a TMY3 in the 1991–2005 series from NOAA, based on home location

$\beta_2 LRCDD_{it}$ = Weather-normalized, annual weather-sensitive (cooling) usage (i.e., COOLNAC)

A.2 COMBINED FIXED EFFECTS – WHOLE HOUSE MODELS

To estimate electric energy savings for RSOP and HTR SOP, the EM&V team employed a pre- and post-installation savings analysis fixed-effects modeling method using pooled daily time-series (panel) billing data. The fixed-effects modeling approach corrected for:

- Differences between pre- and post-installation weather conditions; and
- Differences in usage consumption between participants, through the inclusion of a separate intercept for each participant.

This modeling approach ensured that savings estimates were not skewed by unusually high-usage or low-usage participants. The team used the following model specification to determine overall savings:

$$ADC_{it} = \alpha_i + \beta_1 AVGHDD_{it} + \beta_2 AVGCDD_{it} + \beta_3 POST_i + \beta_4 POST_i * AVGHDD_{it} + \beta_5 POST_i * AVGCDD_{it} + \varepsilon_{it}$$

Where, for each participant or comparison customer ‘i' and day ‘t’:

ADC_{it} = The average daily kWh consumption during the pre- or post-installation program period

α_i = The average daily kWh base load intercept for each customer (this is part of the fixed-effects specification)

β_1 = The average daily per-heating degree day usage in the pre-period

$AVGHDD_{it}$ = The average daily base 54 heating degree days,[37] based on home location

β_2 = The average daily per-cooling degree day usage in the pre-period

$AVGCDD_{it}$ = The average daily base 69 cooling degree days, based on home location

β_3 = The average daily whole-house program base load kWh savings

$POST_i$ = An indicator variable that equals 1 in the post-period (after the latest measure installation) and 0 in the pre period

β_4 = The whole-house heating kWh savings per heating degree day

$POST_i * AVGHDD_{it}$ = An interaction between the POST indicator variable and the heating degree days (AVGHDD)

[37] The EM&V team estimated fixed-effects models using the average PRISM reference temperatures of 54°F for heating and 69°F for cooling.

β_5 = The whole-house cooling kWh savings per cooling degree day

$POST_i * AVGCDD_{it}$ = An interaction between the POST indicator variable and the cooling degree days (AVGCDD)

ε_{it} = The modeling estimation error

The following table provides general model output including parameter estimates and standard error.

Table A-1. Combined Fixed Effects Model Outputs, by Program

Group	Variable	Parameter Estimate	Standard Error	Z-Score	p-Value
RSOP	AvgHDD	2.3318	0.0155	150.3	<.0001
	AvgCDD	2.0405	0.0104	196.66	<.0001
	Post	-2.1813	0.0493	-44.25	<.0001
	Post*HDD	-0.3772	0.0067	-56.22	<.0001
	Post*CDD	-0.1676	0.0064	-26.26	<.0001
	R-Square	**0.333**			
	Overall Model Fit: F =	**1,060,972**			
	P-Value	**<.0001**			
HTR SOP	AvgHDD	2.1296	0.0283	75.32	<.0001
	AvgCDD	1.8624	0.0179	103.96	<.0001
	Post	-2.3541	0.0929	-25.33	<.0001
	Post*HDD	-0.3983	0.0123	-32.35	<.0001
	Post*CDD	-0.0954	0.0118	-8.07	<.0001
	R-Square	**0.3123**			
	Overall Model Fit: F =	**289,221**			
	P-Value	**<.0001**			

A.3 COMBINED FIXED EFFECTS – MEASURE-LEVEL MODELS

The measure-level fixed effects models follow a similar form to the whole-house fixed effects models, but are fairly complex and not easily presented due to the extent of parameters used (i.e., up to 10 measures, including indicators for each and interactions with HDDs, CDDs, the post period, and with both post and weather distinctions. For these reasons, we have included an abridged version of the model specification only showing a single measure, along with tables presenting estimates model parameters of all measures.

$$ADC_{it} = \alpha_i + \beta_1 DuctEff * AVGHDD_{it} + \beta_2 DuctEff * AVGCDD_{it} + \beta_3 DuctEff * POST_i + \beta_4 DuctEff * POST_i * AVGHDD_{it} + \beta_5 DuctEff * POST_i * AVGCDD_{it} + \varepsilon_{it}$$

Where, for participant customers '*i*' and day '*t*':

ADC_{it} = The average daily kWh consumption during the pre- or post-installation program period

α_i = The average daily kWh base load intercept for each customer (this is part of the fixed-effects specification)

$DuctEff_i$ = An indicator variable that equals "1" if an account had received a given measure (i.e., duct efficiency) and "0" if not

β_1 = The average daily per-heating degree day usage for homes with a given measure

$DuctEff_i * AVGHDD_{it}$ = An interaction between the DuctEff indicator variable and the heating degree days (AVGHDD)

β_2 = The average daily per-cooling degree day usage in the pre-period for homes with a given measure

$DuctEff_i * AVGCDD_{it}$ = An interaction between the DuctEff indicator variable and the cooling degree days (AVGCDD)

β_3 = The average daily whole-house program base load kWh savings

$DuctEff_i * POST_i$ = An interaction between the DuctEff indicator variable and the POST indicator variable

β_4 = The whole-house heating kWh savings per heating degree day for homes with a given measure

$DuctEff_i * POST_i * AVGHDD_{it}$ = An interaction between the DuctEff indicator variable, the POST indicator variable, and the heating degree days (AVGHDD)

β_5 = The whole-house cooling kWh savings per cooling degree day for homes with a given measure

$DuctEff_i * POST_i * AVGCDD_{it}$ = An interaction between the DuctEff indicator variable, the POST indicator variable, and the cooling degree days (AVGCDD)

Table A-2. RSOP Model Specification by Measure*

Variable	Parameter Estimate	Standard Error	t-statistic	p-Value
Duct Sealing	-447.54	41.13	-10.88	0.0000
Ceiling Insulation	-1,392.34	47.42	-29.36	0.0000
Water Heating	349.46	94.44	3.70	0.0002
Central Air Conditioning	-1,593.88	126.44	-12.61	0.0000
Infiltration	-828.35	37.29	-22.22	0.0000
Wall Insulation	-2,717.63	1,195.03	-2.27	0.0236
Solar Screen	-3,153.10	563.46	-5.60	0.0000
Heat Pump	-3,501.57	510.79	-6.86	0.0000
Ground-Source Heat Pump	-1,377.09	1,396.99	-0.99	0.3227
Windows	-730.47	134.28	-5.44	0.0000

* Values provided here reflect the combination of three parameters that roll up to the total savings for each measure (i.e., POST, POST*HDD, POST*CDD).

Table A-3. HTR SOP Model Specification by Measure*

Variable	Parameter Estimate	Standard Error	t-statistic	p-Value
Duct Sealing	-389.274	75.29	-5.17	0.0000
Ceiling Insulation	-1,371.54	55.78	-24.59	0.0000
Lighting	33.17	131.55	0.25	0.8031
Water Heating	-510.10	195.36	-2.61	0.0093
Infiltration	-597.98	59.83	-9.99	0.0000
Wall Insulation	363.23	541.15	0.67	0.5032
Solar Screen	-351.87	69.31	-5.08	0.0000
Windows	3,300.44	73.64	44.82	0.0000

* Values provided here reflect the combination of three parameters that roll up to the total savings for each measure (i.e., POST, POST*HDD, POST*CDD).

A.4 DEMAND IMPACT MODELS

A.4.1 Full seasonal peak hour model

For the full seasonal peak, the model assumed that the average peak hour of electricity consumption of home '*i*' in hour '*t*' would be determined by the following equation:

$$Hourly\ Usage_{it} = \beta_1\ POST_{it} + \beta_2\ PART_i\ x\ POST_{it} + W'\square\square\square\ \alpha_i + \varepsilon_{it}$$

Where:

β_1	=	Coefficient representing the impact of RSOP or HTR SOP factors affecting the consumption of homes between pre- and post-program periods
POST	=	An indicator variable for whether the hour is pre- or post-treatment; equals "1" in the hours following the last measure installation date and "0" otherwise
β_2	=	Coefficient representing the conditional average treatment effect of the RSOP or HTR SOP on peak hour usage
PART	=	An indicator variable for program participation; equals "1" if the home was in the participant group and "0" otherwise
W	=	A vector of heating degree hours or cooling degree hours
□	=	The vector of coefficients representing the average impact of weather variables on energy use
α_i	=	Average energy use of home 'i' that is not sensitive to weather or time; the analysis controlled for non-weather-sensitive and time-invariant energy use with home fixed effects
ε_{it}	=	The error term for home 'i' in hour 't'

A.4.2 Top twenty peak hour model

For the top twenty peak hour models, the model assumed that the average peak hour of electricity consumption of home '*i*' in hour '*t*' would be determined by the following equation:

$$Hourly\ Usage_{it} = \beta_1\ POST_{it}\ x\ PART_i\ x\ PEAK\ HOUR_t + \beta_2\ POST_{it} + W'\square\square\square\ \alpha_i + \varepsilon_{it}$$

Where:

β_1	=	Coefficient representing the impact of RSOP or HTR SOP factors affecting the consumption of homes between pre- and post-program periods

POST = An indicator variable for whether the hour is pre- or post-treatment; equals 1 in the hours following the last measure installation date and 0 otherwise

β_2 = Coefficient representing the conditional average treatment effect of the RSOP or HTR SOP on peak hour usage

PART = An indicator variable for program participation; equals “1” if the home was in the participant group and “0” otherwise

PEAK HOUR = An indicator variable for each of the top twenty peak hours; equals “1” if the hour is peak hour “t” and “0” otherwise

W = A vector of heating degree hours or cooling degree hours

□ = The vector of coefficients representing the average impact of weather variables on energy use

α_i = Average energy use of home ‘*i*’ that is not sensitive to weather or time; the analysis controlled for non-weather-sensitive and time-invariant energy use with home fixed effects

ε_{it} = The error term for home ‘*i*’ in hour ‘*t*’

A.5 DETAILED METHODOLOGY FOR DEMAND MODELING

The EM&V team estimated peak demand reduction in two ways. First, we estimated the average peak-hour savings across all households within the RSOP and HTR RSOP using a fixed-effects model. We also estimated savings with models using the top 20 peak hours per season.

A.5.1 Full peak period and top 20 hour models

The team defined peak hours for the first model as any hour occurring in the broadly defined peak period by the EE rules:

> “The EE Rule defines the full peak period as the hours from 1 p.m. to 7 p.m. during the months of June, July, August and September, and the hours from 6 a.m. to 10 a.m. and 6 p.m. to 10 p.m. during the months of December, January and February (excluding weekends and Federal holidays). These are also referred to as the ‘summer peak period’ and the ‘winter peak period.’”

In the second method, we estimated the average hourly demand reduction within the top 20 hours during both the winter and summer peak periods. The team based the top 20 hours on the average hourly usage across households in the comparison group during the PY2014 peak periods. We determined peak hours for each of the Weather Bureau Army Navy stations mapped by ZIP code.

The EM&V team then matched the top 20 peak hours to each participant households’ hourly usage data before and after measures were installed by the hour of the year. To do this, some of the pre-period peak hours may be in PY2014 or PY2013, depending on installation dates, while the top 20 post-period hours could be in either PY2014 or PY2015. If, in either the pre- or post-period, the peak hour of the year was during a holiday or weekend, we shifted the peak hour to the preceding day.

The models of the top 20 winter hours only included participant group homes with electric heat. Additionally, to ensure consistency in the analysis population, the team applied the same outlier and other screens to this demand analysis as we had applied to the energy savings analysis.

A.5.2 Savings calculation approach

For both models estimating peak demand reduction, the team used difference-of-differences regression analysis of customer usage with home fixed effects. Difference-of-differences analysis accounts for the effects of naturally occurring efficiency and other non-program impacts on demand during peak hours.

$$Adj.\,Gross\ Savings = (Post\ _{Treatment} - Pre_{Treatment}) - \left(Post_{Comparison} - Pre_{Comparison}\right)$$

The difference-of-differences is an estimate of the effect of the measure on the average home. The home fixed effects account for pre-existing differences in peak energy use between homes in the participant and comparison groups. These pre-existing differences are uncorrelated with participation and should be small.

As an example to demonstrate the similarities between difference-of-differences and the percentage of pre-usage approaches (the latter used for energy savings),

Table 3-17 provided adjusted gross savings for demand impacts using difference-of-differences. Comparing RSOP results to the percentage of pre-usage approach, they are remarkably similar: summer demand is 0.32 kW compared to 0.32 kW and winter is 0.62 kW compared to 0.63 kW.

A.6 RSOP AND HTR SOP PROGRAM BENCHMARKING OF MEASURE DISTRIBUTIONS

To provide a meaningful comparison, the EM&V team benchmarked the impacts from similar energy efficiency programs. It is important to consider the primary electric savings measures that drive the impacts from both programs. The electric savings for the Texas RSOP and HTR SOP primarily came from duct sealing, air infiltration, and ceiling insulation (with smaller percentages coming from other equipment and direct install measures, as shown in the Measure distribution of final analysis sample section of the main memo).

The mix of measures does vary across the benchmarked programs, with many being focused on lighting and few matching the level of duct and air sealing projects as the RSOP and HTR SOP in Texas. The table below presents the measure distributions for several benchmarked programs.

Table A-4. Measure Distributions from Benchmarked HES and LIWx Programs

Type	Program	Distribution
HES	SW Utility HPwES	Lighting (92%), insulation and duct sealing (42%), hot water saving measures (53%)
	SE Utility HES	Attic insulation (95%), HVAC (10%), air sealing (10%), lighting (2%)
	CT HES	Lighting (97%), air infiltration (74%), duct sealing (30%), DWH (14%), insulation (3%), central AC (2%)
	RI EnergyWise HES	Lighting (96%), low frequencies of appliances (e.g., 3% refrigerators)
	MA HES	Lighting (99%), refrigerators (5%), fans (32%) This only includes base load measures, not electric heating participants or shell measures
	WI HPwES	Ceiling insulation (34%), air sealing (83%), lighting (66%), sill-box insulation (44%), wall insulation (40%), hot water saving measures (27%), floor insulation (12%)
	MD HPwES	Ceiling insulation (100%), lighting (45%), base load measures (15%)
TX	TX RSOP	Air infiltration (85%), duct sealing (61%), ceiling insulation (30%), central AC (2%), hot water saving measures (3%)
	TX HTR SOP	Infiltration (65%), duct sealing (40%), ceiling insulation (55%), lighting (6%), DHW (2%)
LIWx	RMP LIWx (ID)	Air infiltration (72%), lighting (61%), windows (58%), doors (57%), ceiling insulation (43%), duct sealing (8%), wall insulation (7%), refrigerator replacement (3%), hot water saving measures (63%)
	PP LIWx (WA)	Attic insulation (99%), lighting (91%), air sealing (94%), duct sealing (46%), hot water saving measures (64%), refrigerators (17%), thermostats (13%)

Type	Program	Distribution
	PWC LIWx (OH)	Lighting (83%), duct sealing (13%), insulation (18%), refrigerators (42%), freezers (17%), hot water saving measures (20%), furnace replacement (11%)
	OH HWAP	Air sealing (83%), insulation (53%), hot water saving measures (61%)
	ORNL LIWx (meta eval)	Comprehensive - measures vary
	CT HES-IE	Lighting (89%), air infiltration (41%), hot water saving measures (32%), ductless heat pumps (15%), refrigerators (15%), attic insulation (6%), duct sealing (2%)
	WI FOE IQ HPwES	Air sealing (87%), ceiling insulation (86%), lighting (85%), wall insulation (45%), hot water saving measures (36%)
	MA LI	Air sealing (100%), ceiling insulation (86%), floor insulation (26%), wall insulation (23%)

Despite variation in the types of electric saving measures installed through these programs, the Texas RSOP and HTR SOP savings of approximately 7.7 percent and 8.2 percent, respectively, of pre-installation period use appeared similar by comparison.

A.7 RSOP AND HTR SOP CONSUMPTION ANALYSIS ADDITIONAL ENERGY IMPACTS

A.7.1 Utility program results

The following tables show additional utility program-level model results.

Table A-5. Utility Program-Level Model Savings—RSOP

Group	Utility	n	PRENAC	Model Savings (kWh)*	Savings as Percentage of Pre-Use	Relative Precisi on at 90%	Savings Lower 90% (kWh)	Savings Upper 90% (kWh)
Participant	AEP TCC	1,566	16,840	871	5%	±11%	777	964
	AEP TNC	335	15,088	1,614	11%	±15%	1,377	1,851
	CNP	409	17,305	1,163	7%	±13%	1,007	1,319
	Oncor	12,036	19,129	1,618	8%	±2%	1,578	1,657
	TNMP	732	12,024	861	7%	±14%	739	983
	Overall	**15,078**	**18,407**	**1,491**	**8%**	**±2%**	**1,456**	**1,525**
Comparison	AEP TCC	1,843	13,795	-202	-1%	±43%	-289	-114
	AEP TNC	266	13,277	-73	-1%	±313%	-301	155
	CNP	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Oncor	7,575	18,425	147	1%	±34%	97	198
	TNMP	107	11,516	-473	-4%	±57%	-743	-202
	Overall	**9,791**	**17,338**	**69**	**0%**	**±62%**	**26**	**112**
Adjusted Gross	AEP TCC	1,566	16,840	1,117	7%	±11%	989	1,245
	AEP TNC	335	15,088	1,697	11%	±19%	1,368	2,026
	CNP	409	17,305	1,094	6%	±15%	932	1,257
	Oncor	12,036	19,129	1,465	8%	±4%	1,401	1,529
	TNMP	732	12,024	1,355	11%	±22%	1,058	1,651
	Overall	**15,078**	**18,407**	**1,418**	**8%**	**±4%**	**1,363**	**1,473**

* During the 2014 analysis period, several changes occurred in Oncor's QA/QC service provider practices to improve savings estimates, resulting in a slight increase in evaluated savings for RSOP when accounting for homes served by terminated service providers.

Table A-6. Utility Program-Level Model Savings—HTR SOP

Group	Utility	n	PRENAC	Model Savings (kWh)	Savings as Percentage of Pre-Use	Relative Precision at 90%	Savings Lower 90% (kWh)	Savings Upper 90% (kWh)
Adjusted Gross*	AEP TCC	389	12,554	688	5%	±21%	541	836
	AEP TNC	106	13,369	872	7%	±36%	555	1,189
	CNP	521	15,634	1,218	8%	±13%	1,057	1,380
	Oncor	3,413	17,617	1,504	9%	±5%	1,435	1,573
	TNMP	64	11,465	1,189	10%	±32%	807	1,571
	Overall	**4,493**	**16,761**	**1,381**	**8%**	**±4%**	**1,322**	**1,439**

* The HTR SOP comparison group adjustment was not significantly different from zero. Therefore, the team applied an adjustment of zero and set adjusted gross savings equal to the participant group impacts.

The following tables provide savings comparisons based on the adjusted gross savings for each utility program, for RSOP and HTR SOP, respectively.

Table A-7. Utility Program-Level Percentage Savings Summary—RSOP

Utility	n	PRENAC	Average Participant Savings (kWh)		Savings as Percentage of Pre-Use	
			Model	*TRM*	Model	*TRM*
AEP TCC	1,566	16,840	1,117	4,149	7%	25%
AEP TNC	335	15,088	1,697	3,650	11%	24%
CNP	409	17,305	1,094	1,793	6%	10%
Oncor	12,036	19,129	1,465	5,168	8%	27%
TNMP	732	12,024	1,355	2,154	11%	18%
Overall	**15,078**	**18,407**	**1,418**	**4,791**	**8%**	**26%**

RSOP savings comparison between model and *TRM* estimates vary quite a bit across utility programs; however, savings percentages are more similar across programs (from 6 percent for CNP to 11 percent for both TNMP and AEP TNC) and within a reasonable range of electric savings for comparable programs (see the Benchmarking section). Instances where model savings are more closely aligned with *TRM* estimates (i.e., CNP and TNMP) may be due to these two utilities having a higher proportion of central AC (27 percent and 13 percent, respectively), for which the measure-level models indicated that savings were much closer to *TRM* estimates (i.e., realization rate of 80 percent). See the Measure distribution of final analysis sample section for more detail.

Table A-8. Utility Program-Level Percentage Savings Summary—HTR SOP

Utility	n	PRENAC	Average Participant Savings (kWh)		Savings as Percentage of Pre-Use	
			Model	*TRM*	Model	*TRM*
AEP TCC	389	12,554	688	3,016	5%	24%
AEP TNC	106	13,369	872	3,215	7%	24%
CNP	521	15,634	1,218	2,085	8%	13%
Oncor	3,413	17,617	1,504	4,350	9%	25%
TNMP	64	11,465	1,189	1,951	10%	17%
Overall	**4,493**	**16,761**	**1,381**	**3,911**	**8%**	**23%**

Similar to RSOP, HTR SOP model savings comparison to *TRM* estimates ranged across utility programs, with percentage savings for most programs between 7 percent and 10 percent. CNP's program is distinct in that nearly all projects received ceiling insulation (99 percent of sample), and few included air infiltration and duct sealing (each less than 1 percent), measures that characterize the other utilities' programs. TNMP's program had the highest percentage of sample projects receiving DHW installation (36 percent); otherwise, it is similar to the other utilities' programs, including high proportions of air infiltration and duct sealing.

Additionally, CNP and the majority of TNMP participants are within climate zone 3, for which the TRM assumes lower air sealing savings (i.e., the kWh impact per cubic feet per minute [CFM] reduction for electric resistance and heat pump heat) and lower ceiling insulation savings than for climate zone 2.

A.7.2 Other diagnostics

The team ran a series of diagnostics and other model summaries to help provide insight into factors that may be causing savings impacts and to characterize trends in model results. The table below provides model savings (i.e., adjusted gross) for each program by pre-installation use levels (binned into quartiles).

Table A-9. Statewide Program-Level Model Savings—RSOP and HTR SOP, by Pre-Period Usage Quartile

Program	Quartile	PRENAC	Average Participant Savings (kWh)		Savings as Percentage of Pre-Use	
			Model	*TRM*	Model	*TRM*
RSOP	Q1	9,497	538	2,670	6%	28%
	Q2	15,206	1,018	4,392	7%	29%
	Q3	19,997	1,531	5,451	8%	27%
	Q4	28,931	2,584	6,649	9%	23%
	Overall	**18,407**	**1,418**	**4,791**	**8%**	**26%**
HTR SOP	Q1	8,541	583	1,993	7%	23%
	Q2	13,812	958	3,397	7%	25%
	Q3	18,365	1,457	4,597	8%	25%
	Q4	26,322	2,526	5,657	10%	21%
	Overall	**16,761**	**1,381**	**3,911**	**8%**	**23%**

There is a clear trend of increased similarity between model and *TRM* estimates as pre-use increases, evident for both programs. Although there can be greater savings potential as use increases for higher energy consuming households, *TRM* savings actually reflect a decrease in percentage savings relative to increasing pre-use levels. This suggests that *TRM* savings may need to be adjusted to better synch with factors that can affect home use, such as household size, conditioned square footage, or even project-specific normalized annual consumption.

The table below provides a summary of statewide program-level model results by heating type (defined by each utility program tracking databases). Results are presented as adjusted gross savings.

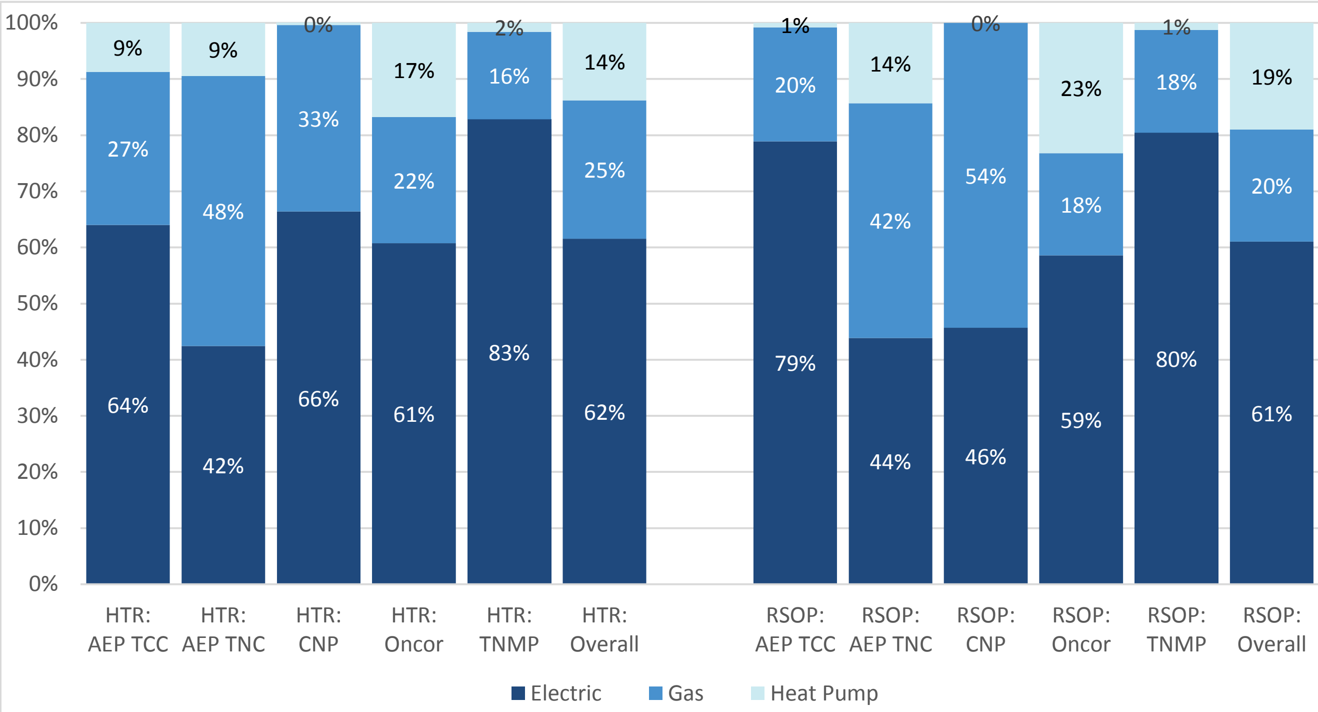
Table A-10. Statewide Program-Level Model Savings—RSOP and HTR SOP, by Heating Type

Program	Heating Type	n	PRENAC	Average Participant Savings (kWh)		Savings as Percentage of Pre-Use	
				Model	*TRM*	Model	*TRM*
RSOP	Electric	9,208	18,051	1,508	5,689	8%	32%
	Gas	3,008	16,753	931	2,250	6%	13%
	Heat Pump	2,862	21,290	1,638	4,569	8%	21%
	Overall	**15,078**	**18,407**	**1,418**	**4,791**	**8%**	**26%**
HTR SOP	Electric	2,766	17,339	1,549	4,791	9%	28%
	Gas	1,107	13,863	837	1,644	6%	12%
	Heat Pump	620	19,353	1,601	4,035	8%	21%
	Overall	**4,493**	**16,761**	**1,381**	**3,911**	**8%**	**23%**

Nearly two-thirds of the participant groups for both programs have electric heating, with the percentage of heat pump users being slighting higher for the RSOP than HTR SOP sample. Although model savings indicate that electric- and gas-heated home savings differ by a few percentages relative to pre use, *TRM* savings percentages assumed that electric homes' experienced more than twice the impact of gas-heated homes. This suggests that savings for those shell measures representing the largest portion of program savings (duct sealing, air infiltration, and ceiling insulation) may be focused around cooling season impacts, possibly overestimating the assumed heating savings.

Additionally, findings at the utility program level suggest that model savings compared to *TRM* estimates may be affected by the sample's distribution of heating types. The greatest similarity between savings estimates for each RSOP and HTR SOP occurred for the CNP and TNMP programs. As Figure A-1 illustrates, neither the CNP nor the TNMP samples had a substantial number of participants with heat pumps. Furthermore, CNP's HTR SOP sample appears to have a higher proportion of gas-heated customers than any other utility sample.

Figure A-1. Participant Sample Distribution of Heating Type by Utility Program



The following table provides a summary of savings by climate zone.

Table A-11. Statewide Program-Level Model Savings—RSOP and HTR SOP, by Climate Zone

Program	Climate Zone	n	PRENAC	Average Participant Savings (kWh)		Savings as Percentage of Pre-Use	
				Model	*TRM*	Model	*TRM*
RSOP	2	12,436	19,026	1,543	5,130	8%	27%
	3	1,217	14,141	872	2,083	6%	15%
	4	1,425	16,650	791	4,141	5%	25%
	Overall	**15,078**	**18,407**	**1,418**	**4,791**	**8%**	**26%**
HTR SOP	2	3,527	17,485	1,484	4,319	8%	25%
	3	607	15,073	1,222	2,094	8%	14%
	4	359	12,503	639	2,980	5%	24%
	Overall	**4,493**	**16,761**	**1,381**	**3,911**	**8%**	**23%**

* Across both programs, the EM&V team associated the following climate zones for the samples by utility: climate zone 2 = Oncor, AEP TNC, TNMP (9%); climate zone 3 = CNP, TNMP (91%), AEP TCC (9%); climate zone 4 = AEP TCC (91%).

As noted, CNP and the majority of TNMP participants live within climate zone 3. While it appears that some TRM savings estimates for climate zone 3 are lower for key measures than the team's actual findings, modeled savings pick up a similar trend, with RSOP savings for climate zone 2 being nearly double those reported for climate zone 3. However, relative to pre usage, modeled savings are more similar between climate zone 2 and climate zone 3, at 8 percent and 6 percent, respectively, compared to *TRM* estimated savings, at 27 percent and 15 percent , respectively.

As noted, a key distinction between the TRM and evaluated model savings is that billing analysis accounts for measure interaction effects while TRM provides savings for measures in isolation. To provide a more direct comparison, the tables below provide a comparison of measure-level fixed effects models for specific measures compared to PRISM models for customers that only received single measures (e.g., measure-only models, such as a home that only received ceiling insulation). As expected, in most cases, the estimated savings for single installs exceed those of installations with other measures, due to the interaction effects. In some cases, the estimated savings of single measures are nearly double those installed with other measures. However, as the table below illustrates, even when considering measures in isolate, they still fall short of the TRM values.

Table A-12. Comparison of Measure-Level Results Using PRISM Measure-Only Models - RSOP

	Measure-Level Fixed Effects Model				PRISM Measure-Only Model			
Measure	n	Model Savings (kWh)	Savings as Percent of Pre-Usage	Relative Precision at 90%	N	Model Savings (kWh)	Savings as Percent of Pre-Usage	Relative Precision at 90%
Ceiling Insulation	4,529	***1,392***	7%	±6%	640	***1,838***	10%	±10%
Duct Sealing	9,131	***443***	2%	±15%	997	***1,008***	5%	±14%
Infiltration	12,753	***821***	5%	±7%	2,471	***1,147***	8%	±7%
CAC	288	***1,579***	9%	±13%	258	***1,522***	9%	±15%
Heat Pump	48	***3,470***	16%	±24%	31	***3,090***	15%	±33%
Windows	189	***724***	4%	±30%	185	***712***	4%	±32%

Table A-13. Comparison of Measure-Level Results Using PRISM Measure-Only Models – HTR

	Measure-Level Fixed Effects Model				PRISM Measure-Only Model			
Measure	n	Model Savings (kWh)	Savings as Percent of Pre-Usage	Relative Precision at 90%	N	Model Savings (kWh)	Savings as Percent of Pre-Usage	Relative Precision at 90%
Ceiling Insulation	2,456	***1,455***	8.%	±7%	1,221	***1,558***	9 %	±9%
Duct Sealing	1,813	***413***	2%	±32%	169	***973***	6%	±27%
Infiltration	2,915	***634***	4%	±16%	773	***941***	7%	±16%

Table A-14. Comparison of Measure Savings by Model Estimates (Combined Fixed Effects and PRISM Measure-Only) to Average TRM Estimates, by Program

Program	Measure	Average Participant Savings (kWh)			Percent Savings Compared to TRM	
		FE Model	PRISM Model	TRM	FE Model	PRISM Model
RSOP	Ceiling Insulation	1,392	1,838	3,831	36%	48%
	Duct Sealing	443	1,008	3,735	12%	27%
	Infiltration	821	1,147	1,546	53%	74%
HTR	Ceiling Insulation	1,455	1,558	3,041	48%	51%
	Duct Sealing	413	973	3,414	12%	28%
	Infiltration	634	941	1,302	49%	72%

A.8 RSOP AND HTR SOP CONSUMPTION ANALYSIS ADDITIONAL DEMAND IMPACTS

A.8.1 Full seasonal peak hour model impacts

Cadmus also calculated the average peak reduction across all hours in the broadly defined peak period for each season.

The following table shows the average reduction per home across all hours in both summer and winter peak periods.

Table A-15. Statewide Peak Period Savings by Season—RSOP and HTR SOP

Program	Group	Summer		Winter	
		Peak Savings (kW)	Relative Precision at 90%	Peak Savings (kW)	Relative Precision at 90%
RSOP	Participant	-0.25	±1%	-0.25	±1%
	Comparison	-0.02	±7%	-0.11	±2%
	Adjusted gross	**-0.22**	**±0.20%**	**-0.14**	**±0.40%**
HTR SOP	Participant	-0.18	±2%	-0.14	±4%
	Comparison	-0.04	±10%	-0.21	±3%
	Adjusted gross	**-0.15**	**±0.50%**	**0.07**	**±2.10%**

Both participant and comparison group homes had lower hourly usage in the post-period peak hours, and both had a greater average reduction in the winter than in the summer.

For the HTR SOP comparison group, the hourly reduction in the winter was greater than for the participant group. For the RSOP and HTR SOP summer season, the participant homes reduced peak-period hourly consumption more than the comparison group homes, resulting in net demand reduction of between 0.15 kW and 0.22 kW during the peak periods.

A.8.2 Top twenty peak hour savings

The table below provides model results for the statewide top 20 summer peak hours and shows a comparison of changes in energy consumption from the pre- to post-program periods for the RSOP participant and comparison groups. The table includes the peak reduction for both groups as well as the combined, adjusted, gross peak demand reduction. It also includes the average peak hour usage in the pre-period by peak hour and the percentage reduction for each hour. The overall reduction is an average across all top 20 peak hours.

Table A-16. Statewide Top 20 Summer Peak Hour Savings—RSOP

Peak Hour	Participant Peak Change (kW)	Comparison Group Peak Change (kW)	Adj. Gross Demand Savings (kW)	Peak Pre Usage (kW)	Savings as Percentage of Pre-Use
1	-0.19	0.17	-0.36	3.99	9%
2	-0.17	0.18	-0.35	4.01	9%
3	-0.23	0.09	-0.32	4.06	8%
4	-0.16	0.21	-0.37	4.04	9%
5	-0.13	0.15	-0.28	3.69	7%
6	0.00	0.34	-0.34	3.95	9%
7	-0.17	0.10	-0.27	4.22	6%
8	-0.02	0.29	-0.31	4.15	7%
9	-0.16	0.15	-0.31	4.19	7%
10	-0.14	0.22	-0.36	3.87	9%
11	-0.04	0.29	-0.34	4.02	8%
12	-0.24	0.12	-0.36	4.25	8%
13	-0.27	0.11	-0.38	4.00	9%
14	0.04	0.37	-0.33	4.26	8%
15	-0.19	0.06	-0.25	4.37	6%
16	-0.12	0.20	-0.32	3.81	8%
17	-0.29	0.03	-0.32	4.24	8%
18	-0.53	-0.18	-0.35	4.46	8%
19	0.02	0.34	-0.32	4.05	8%
20	-0.09	0.18	-0.27	3.96	7%
Overall	**-0.15**	**0.17**	**-0.32**	**4.08**	**8%**

The next table provides model results for the statewide top 20 winter peak hours and shows a comparison of changes in energy consumption from the pre- to post-program periods for the RSOP participant and comparison groups.

Table A-17. Statewide Top 20 Winter Peak Hour Savings—RSOP

Hour	Participant Peak Reduction (kW)	Comparison Group Peak Reduction (kW)	Adj. Gross Demand Savings (kW)	Peak Pre Usage (kW)	Savings as Percentage of Pre-Use
1	-1.11	-0.41	-0.70	5.99	12%
2	-1.28	-0.60	-0.68	5.98	11%
3	-0.98	-0.39	-0.59	5.83	10%
4	-1.88	-1.18	-0.70	5.36	13%
5	-1.42	-0.74	-0.67	5.66	12%
6	-1.85	-1.07	-0.78	5.35	15%
7	-1.11	-0.58	-0.53	5.47	10%
8	-1.01	-0.38	-0.63	5.77	11%
9	-1.17	-0.58	-0.59	5.42	11%
10	-1.01	-0.39	-0.62	5.76	11%
11	-0.95	-0.38	-0.57	5.49	10%
12	-1.58	-0.96	-0.62	5.36	12%
13	-1.09	-0.54	-0.55	5.22	11%
14	-1.59	-0.90	-0.68	5.16	13%
15	-1.36	-0.70	-0.66	5.17	13%
16	-1.60	-0.95	-0.64	5.22	12%
17	-1.62	-1.01	-0.62	5.21	12%
18	-1.69	-1.13	-0.55	5.23	11%
19	-1.34	-0.71	-0.63	5.08	12%
20	-1.96	-1.50	-0.46	5.24	9%
Overall	**-1.38**	**-0.76**	**-0.62**	**5.45**	**11%**

The top 20 hour estimates for HTR SOP participants were very similar to those for the RSOP participants, as shown below, resulting in approximately 0.3 kW reduction (compared to 0.32 kW for RSOP).

Table A-18. Statewide Top 20 Summer Peak Hour Savings—HTR SOP

Peak Hour	Participant Peak Change (kW)	Comparison Group Peak Change (kW)	Adj. Gross Demand Savings (kW)	Peak Pre Usage (kW)	Savings as Percentage of Pre-Use
1	-0.23	0.09	-0.32	3.63	9%
2	-0.11	0.04	-0.15	3.67	4%
3	-0.25	-0.12	-0.13	3.75	4%
4	-0.19	0.10	-0.28	3.68	8%
5	-0.17	0.23	-0.40	3.39	12%
6	-0.07	0.29	-0.36	3.61	10%
7	-0.14	0.23	-0.37	3.87	10%
8	-0.12	0.21	-0.33	3.77	9%
9	-0.25	0.14	-0.39	3.77	10%
10	-0.15	0.02	-0.17	3.58	5%
11	-0.08	0.26	-0.33	3.63	9%
12	-0.26	0.08	-0.35	3.84	9%
13	-0.24	-0.04	-0.20	3.67	5%
14	-0.02	0.20	-0.22	3.85	6%
15	-0.14	0.00	-0.13	3.99	3%
16	-0.20	0.16	-0.36	3.51	10%
17	-0.27	0.03	-0.31	3.88	8%
18	-0.53	-0.23	-0.30	4.00	7%
19	-0.02	0.28	-0.30	3.68	8%
20	-0.14	0.37	-0.51	3.64	14%
Overall	**-0.18**	**0.12**	**-0.29**	**3.72**	**8%**

Similar to RSOP, the table below provides model results for the statewide top 20 winter peak hours and shows a comparison of changes in energy consumption from the pre- to post-program periods for the HTR SOP participant and comparison groups.

Table A-19. Statewide Top 20 Winter Peak Hour Savings—HTR SOP

Hour	Participant Peak Reduction (kW)	Comparison Group Peak Reduction (kW)	Adj. Gross Demand Savings (kW)	Peak Pre Usage (kW)	Savings as Percentage of Pre-Use
1	-1.17	-0.52	-0.65	5.70	11%
2	-1.37	-0.85	-0.52	5.62	9%
3	-1.03	-0.30	-0.73	5.64	13%

Hour	Participant Peak Reduction (kW)	Comparison Group Peak Reduction (kW)	Adj. Gross Demand Savings (kW)	Peak Pre Usage (kW)	Savings as Percentage of Pre-Use
4	-1.86	-1.11	-0.75	5.20	14%
5	-1.50	-0.91	-0.60	5.36	11%
6	-1.89	-0.91	-0.98	5.19	19%
7	-1.15	-0.52	-0.63	5.27	12%
8	-1.09	-0.51	-0.58	5.43	11%
9	-1.24	-0.57	-0.67	5.22	13%
10	-1.11	-0.47	-0.64	5.52	12%
11	-1.02	-0.15	-0.88	5.33	16%
12	-1.45	-1.02	-0.43	5.22	8%
13	-1.13	-0.31	-0.82	5.12	16%
14	-1.56	-0.80	-0.75	5.01	15%
15	-1.35	-0.59	-0.76	5.06	15%
16	-1.60	-0.84	-0.76	5.06	15%
17	-1.57	-0.76	-0.81	5.16	16%
18	-1.77	-1.01	-0.76	5.12	15%
19	-1.35	-0.59	-0.76	4.97	15%
20	-1.78	-1.20	-0.57	5.12	11%
Overall	**-1.40**	**-0.70**	**-0.70**	**5.45**	**13%**

A.9 RSOP AND HTR SOP CONSUMPTION ANALYSIS PROJECT FLOW

Figure A-2. Project Flow