In 2023, the federal standards for ACs and HPs increased, and efficiency ratings were updated from SEER/HSPF to SEER2/HSPF2. For HPs, the federal standards will go into effect in PY2024 to allow for the market sell-down of the older models in 2023. In 2024, the IOUs will be responding to changes to the minimum efficiency standards affecting baselines.

Figure 44. Demand Reductions (MW) from Residential Heat Pumps PY2020–PY2023

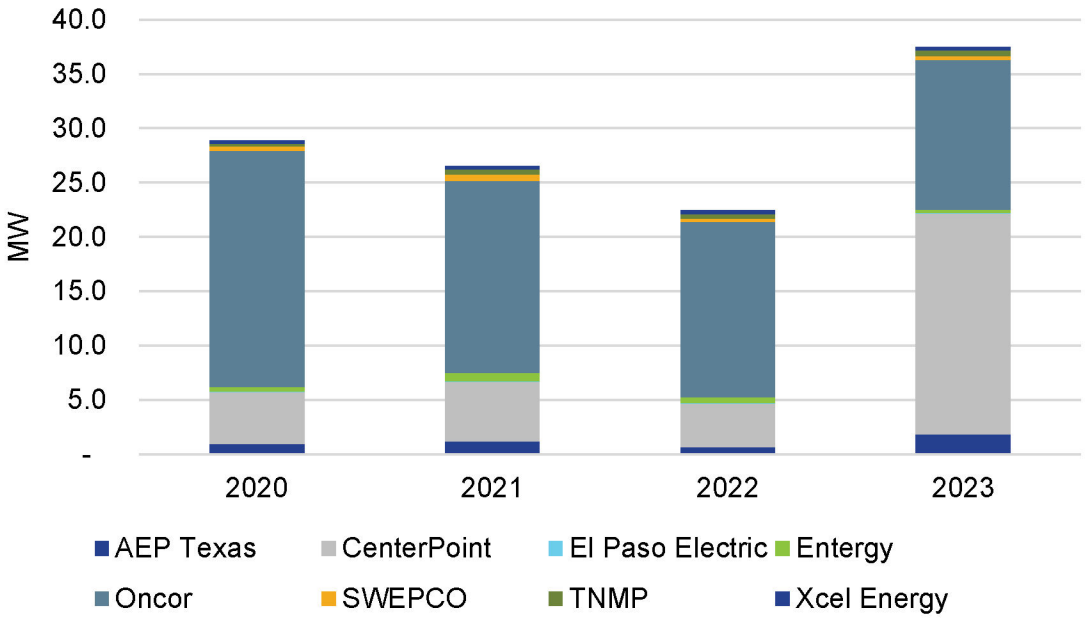
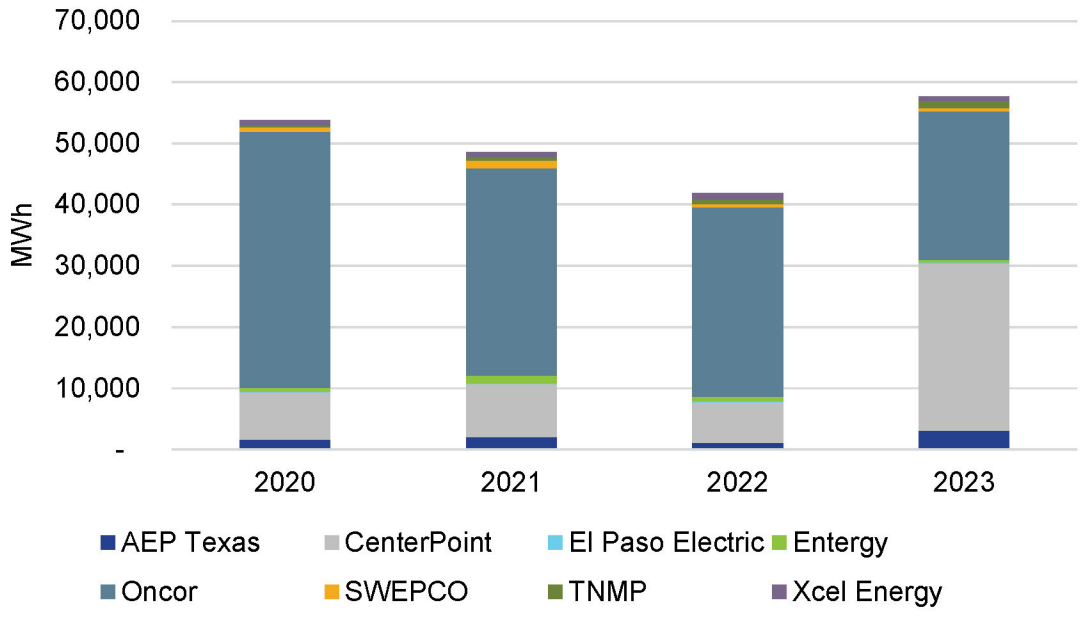


Figure 45. Energy Savings (MWh) from Residential Heat Pumps PY2020–PY2023



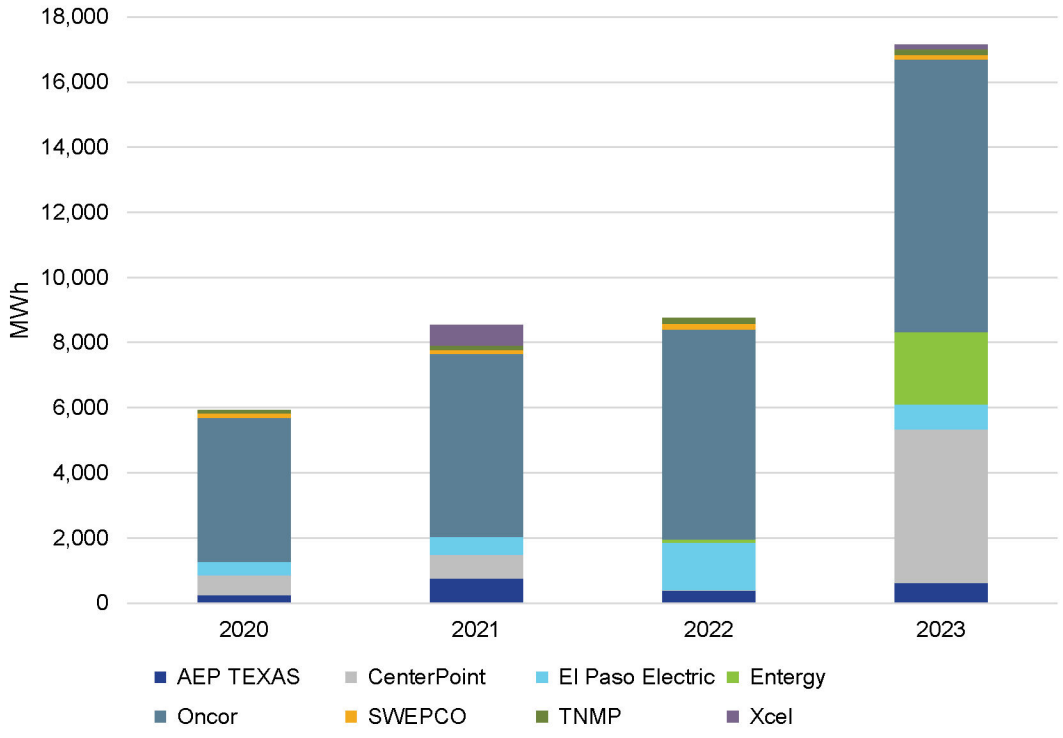
5.4.2 Smart Thermostats

Key Finding: *Smart thermostat* savings more than doubled in PY2023 from PY2022.

In PY2023, *smart thermostats* were installed across all utilities utilizing several different program delivery types such as upstream, midstream, online marketplaces, and direct installations. The IOU programs more than doubled the savings from smart thermostats in PY2023 (Figure 46). The IOU programs installed over 23,000 smart thermostats across eight utilities, saving 17,146 MWh. Some utilities have focused on implementing smart thermostat programs, while others have incorporated them into their existing retail, retrofit, or new construction programs. While in previous years, retail programs have provided the majority of savings, 2023 saw increased smart thermostat participation in direct installation programs. Oncor continues to be the IOU leader in this measure. Oncor piloted three new smart thermostat programs aimed at targeting multifamily, master-meter multifamily[38], and LI multifamily. Both CenterPoint and Entergy, as the second and third largest contributor to smart thermostat savings, also increased their deployment of this measure in PY2023.

The US Energy Information Administration (EIA) conducts the Residential Energy Consumption Survey (RECS) roughly every four years to collect data on residential housing characteristics. In 2020, the RECS data showed that, of the homes in the West-South-Central region, which includes Texas, of respondents indicating *yes* (that they have a thermostat), only 14 percent of those were smart thermostats[39]. Data collection for 2024 RECS will begin in Fall 2024.

Figure 46. Energy Savings (MWh) from Residential Smart Thermostats PY2020–PY2023



[38] Multifamily master meter savings are claimed under the commercial sector.
[39] https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%206.8.pdf

5.4.3 Insulation

Key Finding: *Insulation* measure savings are trending upwards despite the dip in savings from PY2020.

In PY2023, *insulation* measures included *wall insulation*, *ceiling* or *attic insulation*, and *floor insulation*. *Ceiling* and *attic* insulation made up a significant majority of the insulation savings each year. Insulation measures were installed across all utilities. As Figure 47 and Figure 48

show, the IOU programs have increased insulation savings in PY2023 from PY2021 and PY2022 levels. While savings are not back up to PY2020 levels, one driver of this is the previously-mentioned *TRM update based on the consumption analysis*. Hence, the savings after PY2020 are more accurate than the PY2020 savings. Another driver was the *supply chain issues* that insulation contractors faced as a result of the pandemic. As the supply chain has normalized over the years, the insulation measure participation has increased. Entergy had the most insulation savings, followed by TNMP.

There is an opportunity to increase insulation participation, particularly for *wall* and *floor insulation*. Historically, wall and floor insulation participation has been low, likely due to barriers such as difficulty insulating existing homes with walls already in place. However, there are other methods, such as blowing in insulation from the exterior, that are less intrusive to the homeowner. By implementing whole home insulation, the overall HVAC load of the home can be reduced, and replacing HVAC equipment could be a recommended next step. By reducing the load first through whole home insulation, there is greater potential for higher HVAC savings through early retirement and rightsizing.

Figure 47. Demand Reductions (MW) from Residential Insulation PY2020–PY2023

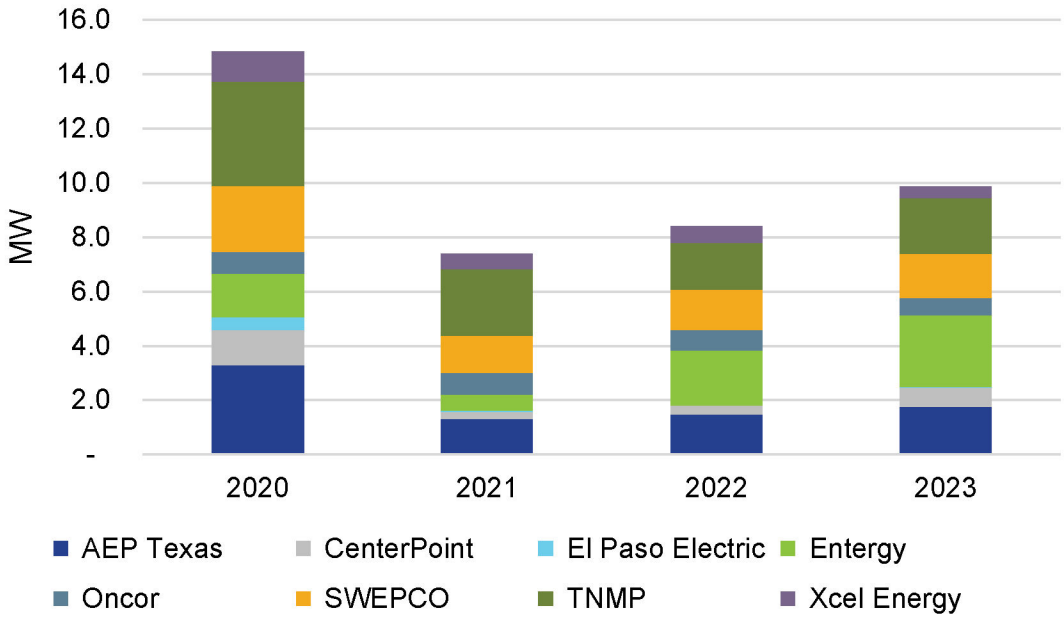
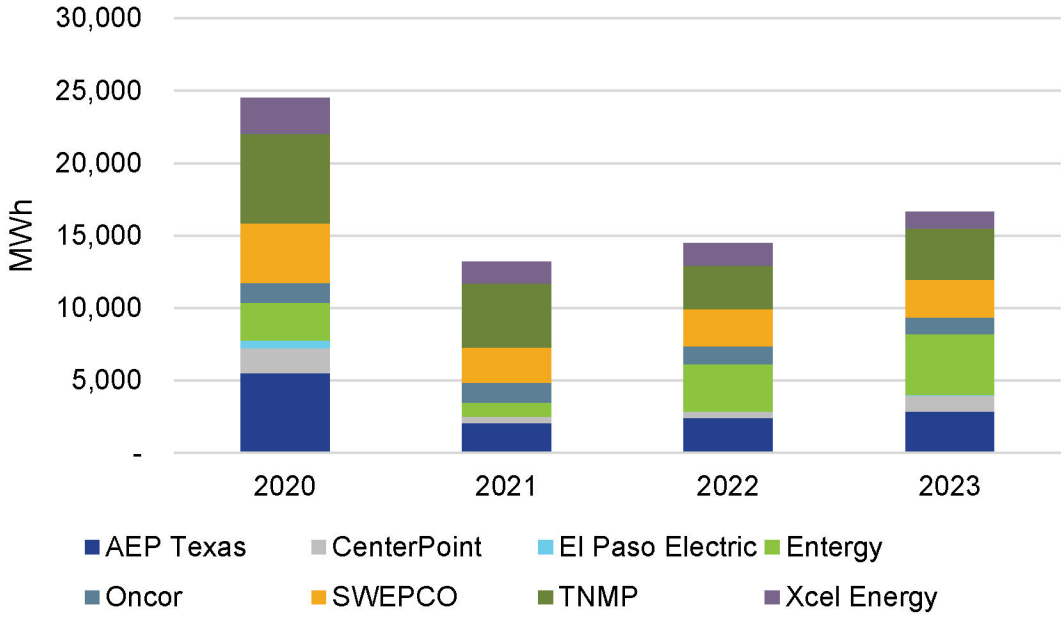


Figure 48. Energy Savings (MWh) from Residential Insulation PY2020–PY2023



5.5 CONSUMPTION ANALYSIS

For PY2023, the EM&V team conducted a consumption analysis on three kinds of residential retrofit programs offered by IOUs—Residential Standard Offer Programs (RSOP), Hard-to-Reach Standard Offer Programs (HTR SOP), and Low-Income Weatherization (LI) programs.

This consumption analysis was performed to assess:

- if the IOU residential retrofit programs are effectively reducing participants' annual energy usage and
- how the IOU residential retrofit programs and measures are performing compared to TRM deemed savings.

The EM&V team collected advanced metering infrastructure (AMI) meter data from IOUs offering RSOPs, HTR SOPs, or LI programs to customers to conduct this analysis. During the consumption analysis study period, only five of the eight IOUs had fully deployed AMI meters and were able to submit program participant data for analysis—AEP Texas, CenterPoint, Entergy, Oncor, and TNMP. Across the five IOUs, over 30,000 households with unique AMI meter data participated in at least one of the three programs between January 1, 2022, and June 30, 2023, and were included in the consumption analysis[40].

[40] The data in this analysis reflects a full year of program participation in PY2022 and program participation for the first half of PY2023. Participant meter data were received for a census of the five IOU programs in this time period, totaling 56,566 participants. More than one-half of the participants' data were retained in the analysis after the data cleaning process; details on the data cleaning process and reasons why meters were excluded from the analysis can be found in *Appendix A: Residential Consumption Analysis*.

Using the data provided by IOUs, the EM&V team conducted an analysis of each household's AMI meter data by:

- measuring the data for the year before they participated in a program,
- measuring the data for the year after program participation,
- normalizing the data for the weather, and
- analyzing the data for energy savings (referred to as *measured savings*) attributable to residential retrofit programs they participated in and any installed measures

The detailed methodology and results of the consumption analysis are discussed in *Appendix A: Residential Consumption Analysis*, which includes summary tables with results by specific program, IOU, measure, and TRM climate zone.

5.5.1 Key Findings and Recommendations

The consumption analysis provided insight into program design and implementation effectiveness at both the program and measure-levels across the IOU programs. The first set of key findings and recommendations focus on program-level performance, while the second set of key findings and recommendations focus on measure-level performance.

5.5.1.1 Program-Level Performance

The key findings, recommendations, and tables below provide measured savings results for each of the three residential retrofit programs (RSOP, HTR SOP, LI programs) offered by the five IOUs included in the PY2023 consumption analysis.

Additionally, the tables below illustrate the program results comparisons of the PY2019 and PY2023 consumption analysis for AEP, CenterPoint, Oncor, and TNMP. In PY2023, Entergy's AMI meters were fully deployed and operational, allowing them to be included in the consumption analysis for the first time.

Key Finding #1: Overall, the residential retrofit programs result in energy savings for participants; however, savings varied across IOUs and program types.

Residential SOP.

In PY2023, RSOP participants saw average savings of 9.6% to their annual energy usage (2,887 kWh)—an increase in average savings as compared to 8.7% for RSOP participants in PY2019.

Table 20 illustrates the change in measured savings for each utility's RSOP from the PY2019 to PY2023 consumption analyses[41].

Table 20. RSOP Results by Utility—PY2023 vs PY2019

Utility	PY2023 measured savings (kWh)	PY2019 measured savings (kWh)	Percentage change
AEP Texas	-41	403	-110.2%

[41] Entergy did not participate in the PY2019 consumption analysis. Therefore, Entergy is not included in Table 20.

Utility	PY2023 measured savings (kWh)	PY2019 measured savings (kWh)	Percentage change
CenterPoint	6,402	1,337	378.8%
Oncor	4,306	1,667	158.3%
TNMP	329	575	-42.8%

- Savings for CenterPoint and Oncor's RSOPs increased from PY2019 to PY2023.
- Savings for AEP and TNMP's RSOPs decreased from PY2019 to PY2023.

Table 21 compares the measured savings and performance of each utility's RSOP against the TRM deemed savings.

Table 21. RSOP Results by Utility—Measured Savings vs TRM Deemed Savings

Utility	N	Measured savings (kWh)	Measured savings as a percentage of annual usage	TRM deemed savings (kWh)	Savings as a percentage of TRM
AEP Texas	5,421	-41	-0.1%	966	-4.3%
CenterPoint	523	6,402	20.0%	131	4884.1%
Entergy	594	5,631	13.7%	2,045	275.4%
Oncor	13,329	4,306	13.5%	3,480	123.7%
TNMP	2,420	329	1.7%	1,705	19.3%

- RSOP savings ranged from 0% for AEP to 20% for CenterPoint.
  - CenterPoint, Entergy, and Oncor's RSOPs achieved above-average savings at 20%, 13.7%, and 13.5%, respectively.
  - AEP and TNMP's RSOPs achieved below-average savings of -0.1% and 1.7%, respectively. (Third from left, Table 21).
- CenterPoint, Entergy, and Oncor's RSOPs outperformed the TRM deemed savings estimates (far right, Table 21), while AEP and TNMP's RSOPs underperformed.

Hard-to-Reach SOP.

While HTR SOP participants saw the lowest average savings across the three retrofit programs participants saw an *increase* in average savings from 5.8 percent in PY2019 to of 8.0 percent (1,454 kWh) in PY2023 (see Table 22).

Table 22 illustrates the change in measured savings for each utility's HTR SOP from the PY2019 to PY2023 consumption analyses[42].

Table 22. HTR SOP Results by Utility—PY2023 vs PY2019

Utility	PY2023 measured savings (kWh)	PY2019 measured savings (kWh)	Percentage change
AEP Texas	-89	788	-111.3%
CenterPoint	437	657	-33.5%
Oncor	1,718	712	141.3%
TNMP	834	581	43.5%

- Savings for Oncor and TNMP's HTR SOPs increased from PY2019 to PY2023.
- Savings for AEP and CenterPoint's HTR SOPs decreased from PY2019 to PY2023.

Table 23 compares the measured savings and performance of each utility's HTR SOP against the TRM deemed savings.

Table 23. HTR SOP Results by Utility—Measured Savings vs TRM Deemed Savings

Utility	n	Measured savings (kWh)	Measured savings as a percentage of annual usage	TRM deemed savings (kWh)	Savings as a percentage of TRM
AEP Texas	3,060	-89	-0.3%	993	-9.0%
CenterPoint	221	437	1.9%	1,659	26.4%
Entergy	377	5,072	14.0%	1,540	329.4%
Oncor	5,310	1,718	10.9%	1,544	111.3%
TNMP	767	834	4.9%	1,624	51.4%

- HTR SOP savings ranged from 0 percent for AEP Texas to 14 percent for Entergy.
  - Entergy and Oncor HTR SOPs were above the average IOU savings at 14.0 percent and 13.5 percent, respectively.
  - AEP Texas, CenterPoint, and TNMP were below the average IOU savings at 0 percent, 1.9 percent, and 4.9 percent, respectively (third column from right, Table 23).
- Entergy's and Oncor's HTR SOP savings outperformed the TRM deemed savings estimates, while AEP Texas', CenterPoint's, and TNMP's HTR SOP savings underperformed (far right, Table 23).

[42] Entergy did not participate in the PY2019 consumption analysis. Therefore, Entergy is not included in Table 22.

Low-Income Weatherization Program.

Of the three residential retrofit programs in PY2023, LI program participants saw the highest average savings at 11.2% of their annual energy usage (2,625 kWh). Additionally, from PY2019 to PY2023, LI program participants saw an increase in kWh savings from 2,079 kWh in PY2019 to 2,625 kWh in PY2023. However, average savings for LI program participants decreased from 18.5% in PY2019 to 11.2% in PY2023.

Table 24 illustrates the change in measured savings for each utility's LI program from the PY2019 to PY2023 consumption analyses.

Table 24. LI Program Results by Utility—PY2023 vs PY2019

Utility	PY2023 measured savings (kWh)	PY2019 measured savings (kWh)	Percentage change
AEP Texas	2,413	1,932	24.9%
CenterPoint	2,694	2,044	31.8%
Oncor	2,533	2,102	20.5%
TNMP	2,946	1,672	76.2%

- Savings for all four ERCOT utilities' LI programs increased from PY2019 to PY2023[43].

Table 25 compares the measured savings and performance of each utility's LI program against the TRM deemed savings.

Table 25. LI Program Results by Utility—Measured Savings vs TRM Deemed Savings

Utility	n	Measured savings (kWh)	Measured savings as a percentage of annual usage	TRM deemed savings (kWh)	Savings as a percentage of TRM
AEP Texas	611	2,413	12.3%	3,437	70.2%
CenterPoint	1,693	2,694	8.7%	3,303	81.6%
Oncor	1,351	2,533	17.4%	5,164	49.1%
TNMP	339	2,946	15.4%	4,225	69.7%

[43] Entergy does not offer a low-income weatherization program; therefore, Entergy is not included in this section.

- LI program savings ranged from 8.7 percent for CenterPoint to 17.4 percent for Oncor.
    - AEP Texas, TNMP, and Oncor LI program savings were above the average IOU savings of 11.2 percent, at 12.3 percent, 15.4 percent, and 17.4 percent, respectively.
    - CenterPoint's LI program achieved below-average savings at 8.7%..
- None of the utilities' LI programs outperformed the TRM deemed savings estimates (far right, Table 25).

Recommendation #1: With the support of the EM&V team, the utilities should:

- Investigate the high-performance drivers and low-performance drivers across residential retrofit programs.
- Develop strategies to address the low-performing programs and maintain effectiveness of the high-performing programs.
- If applicable, develop action plans for under-performing programs before the end of 2024 to discuss with the Energy Efficiency Division and EM&V team prior to the rollout of PY2025 programs[44].
- Additionally, utilities with high-performing programs are encouraged to share best practices at the first Energy Efficiency Implementation Project (EEIP) meeting in 2025[45].

5.5.1.2 Measure-Level Performance

The key findings and recommendations below provide insight into the effectiveness of the primary measures installed through the three residential retrofit programs. This includes both AMI data measured savings for each primary measure (e.g., air infiltration, central AC) and comparisons to the TRM deemed savings estimates for the primary measures.

Key Finding #2: The PY2023 consumption analysis demonstrates a better alignment of savings between the TRM deemed savings estimates and IOU measured savings for residential retrofit measures than the PY2019 consumption analysis[46]. However, measure-level performance still varies by utility and program.

Table 26 compares the measured savings and performance of each residential retrofit measure against the TRM deemed savings.

[44] AEP Texas and TNMP should develop and discuss action plans for improvement in their RSOP and HTR programs for PY2025. CenterPoint should develop and discuss action plans for improvement in their HTR and LI programs for PY2025.

[45] Entergy and Oncor, as having high-performing programs across all three program types, are encouraged to share best practices with other IOUs and present them in the first EEIP meeting of 2025.

[46] The PY2019 consumption analysis was completed in calendar year 2020 and used to inform the TRM update in PY2021.

Table 26. Measure-Level Results—Measured Savings vs TRM Deemed Savings

Measure	N	Measured savings (kWh)	Measured savings as a percentage of annual usage	TRM deemed savings (kWh)	Savings as a percentage of TRM
Air infiltration	14,247	1,516	8.6%	1,131	134.1%
Ceiling insulation	6,862	1,322	5.2%	1,659	79.7%
Central AC	8,302	4,929	14.1%	2,475	199.1%
Central HP	7,389	3,266	13.8%	5,696	57.3%
Duct sealing	4,274	278	0.9%	703	39.6%
ENERGY STAR thermostat	2,831	979	6.9%	658	148.9%
Multifamily heat pump	1,286	2,290	15.5%	4,855	47.2%

Across the five IOU residential retrofit programs included in the PY2023 consumption analysis, the following measures are performing better than the TRM deemed savings estimates (see Table 26):

- air infiltration (134.1 percent),
- central AC (199.1 percent), and
- ENERGY STAR thermostats (148.9 percent).

Other measures have improved performance against the TRM from prior analysis:

- Savings from ceiling insulation measures achieved 79.7% of the TRM deemed savings.
- Savings from duct sealing measures achieved 39.6% of the TRM deemed savings—making duct sealing the lowest performing measure.
- Savings from heat pump measures achieved 57.3% of the TRM deemed savings.

The difference between measured and TRM deemed savings for heat pump measures does not indicate a TRM misalignment, but rather is characteristic of heat pumps replacing another fuel type, such as a natural gas boiler. For example, if the planned retrofits were electric resistance, TRM deemed savings will apply but not be tracked in the AMI measured savings. The PY2024 TRM requires that existing heat pump fuel sources be tracked to utilize deemed savings values; therefore, future analysis will be conducted to characterize the extent to which a change in fuel type drives performance variability.

Table 27 compares each utility's measure-level performance against the TRM deemed savings.

Table 27. Measure-Level Result by Utility—Measured Savings vs TRM Deemed Savings

Measure	N	Measured savings (kWh)	Measured savings as a percentage of annual usage	TRM deemed savings (kWh)	Savings as a percentage of TRM
AEP Texas					
Air infiltration	1,014	131	0.4%	835	15.7%
Ceiling insulation	2,143	953	3.9%	1,742	54.7%
Central AC	399	2,394	7.3%	2,546	94.0%
Central HP	379	3,026	15.3%	5,809	52.1%
Duct sealing	3,556	-731	-2.4%	706	-103.6%
CenterPoint					
Air infiltration	152	3,412	5.8%	215	1586.6%
Ceiling insulation	603	2,612	6.4%	1,153	226.5%
Multifamily heat pump	1,286	2,290	15.5%	4,855	47.2%
Entergy					
Air infiltration	241	4,246	11.3%	446	952.5%
Ceiling insulation	494	5,013	12.2%	2,485	201.8%
Duct sealing	634	5,634	14.3%	657	857.8%
Oncor					
Air infiltration	12,954	1,551	10.0%	1,184	131.0%
Ceiling insulation	1,626	1,638	8.5%	967	169.4%
Central AC	7,949	5,066	14.5%	2,475	204.7%
Central HP	7,046	3,369	13.9%	5,695	59.2%
ENERGY STAR thermostat	2,835	1,333	9.4%	658	202.7%

Measure	N	Measured savings (kWh)	Measured savings as a percentage of annual usage	TRM deemed savings (kWh)	Savings as a percentage of TRM
TNMP					
Air infiltration	48	236	0.9%	793	29.7%
Ceiling insulation	2,213	281	1.4%	2,136	13.1%
Central AC	91	4,345	12.2%	2,214	196.3%
Central HP	274	3,004	15.9%	5,566	54.0%
Duct sealing	332	1,002	3.7%	722	138.8%

- Ceiling insulation:
  - CenterPoint, Entergy and Oncor's measures are outperforming the TRM deemed savings.
  - AEP and TNMP's measures are underperforming in relation to the TRM deemed savings, thereby decreasing the overall measure-level percentage.
- Duct sealing:
  - Entergy and TNMP's measures are outperforming the TRM deemed savings value.
  - AEP's RSOP and HTR SOP both demonstrated no savings for the duct sealing measure, thereby decreasing the overall measure-level average.

Recommendation #2: Given the differing performances in measure-level savings across IOU programs, the EM&V team provides the following recommendations to inform the TRM Working Group and IOU action plans (see Recommendation #1 above):

- Utility programs with demonstrably high performance in the air infiltration measure[47] can expand to residential customers in the PY2025 TRM update.
- IOU programs showing limited savings in the duct sealing measure[48] should limit the measure to low-income programs starting with PY2025. Similar to air infiltration, the measure could expand back to RSOP once improved implementation can be demonstrated in AMI meter data.
- IOU programs underperforming in ceiling insulation[49] should identify QA/QC improvements and begin implementing these improvements in PY2025. In particular, increased QA/QC of baseline insulation documentation requirements may be helpful in improving measure-level performance.
- In a PY2025 consumption analysis, heat pump baseline documentation and savings should be assessed, and any necessary changes to the heat pump algorithm should be identified.

[47] CenterPoint, Entergy and Oncor are eligible to expand air infiltration to RSOP.
[48] AEP's RSOP and HTR programs both need to improve implementation of duct sealing as measured in the AMI meter data.
[49] AEP and TNMP should include QA/QC improvements for ceiling insulation in their action plans in response to Recommendation #1 above.

6.0 LOAD MANAGEMENT PROGRAMS

6.1 SUMMARY RESULTS

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

6.1.1 Savings

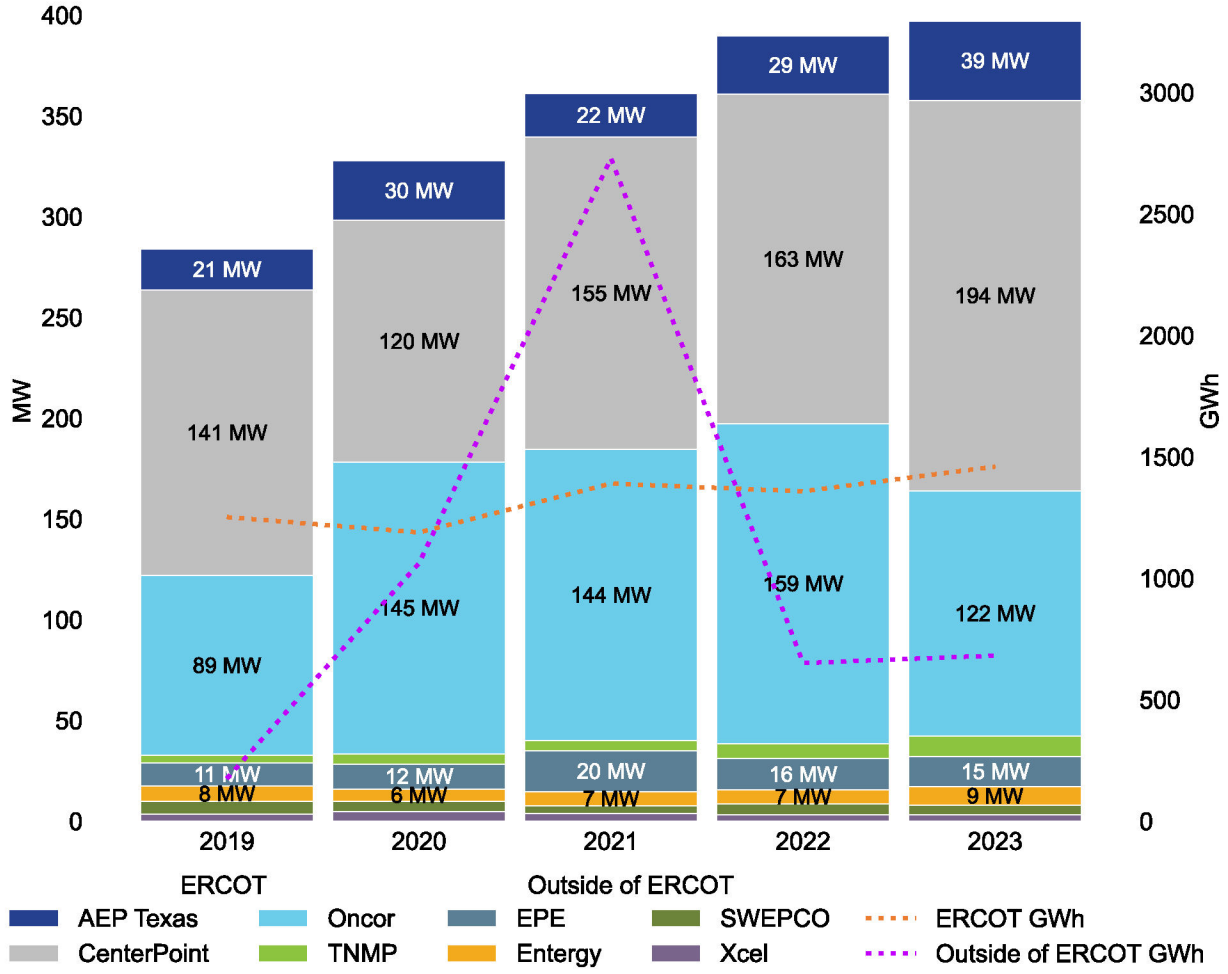
The total savings of the programs were:

- 397,135 kilowatts (kW) (demand reduction) and
- 2,141,731 kilowatt-hours (kWh) (energy savings).

The load management programs' demand reductions increased from program year (PY) 2019 (PY2019) through PY2023. While we see a similar increase again in PY2023, this is primarily due to winter load management programs as opposed to growth in the existing programs as in years prior to PY2022. In response to Senate Bill (SB) 3 passed in the 2021 legislative session (87 R), the ERCOT IOU utilities developed winter load management programs. Oncor included its winter load management program in its energy efficiency portfolio in PY2022. In PY2023, the other three ERCOT utilities also included winter load management programs in their energy efficiency portfolios.

Figure 49 summarizes the megawatt and megawatt-hour savings of all load management programs from PY2019 to PY2023, with fairly consistent growth in megawatts from year to year. PY2021 saw a peak in energy savings due to incentivized smart thermostat savings being claimed in the program that year by El Paso Electric in their load management programs. In response to SB 1699, passed in the 2023 legislative session (88 R), residential load management programs are expected to grow in utilities' energy efficiency portfolios, but this was not seen yet in PY2023.

Figure 49. Total IOU Demand Reduction and Energy Savings by Program Year—Load Management Programs PY2019–PY2023[50]

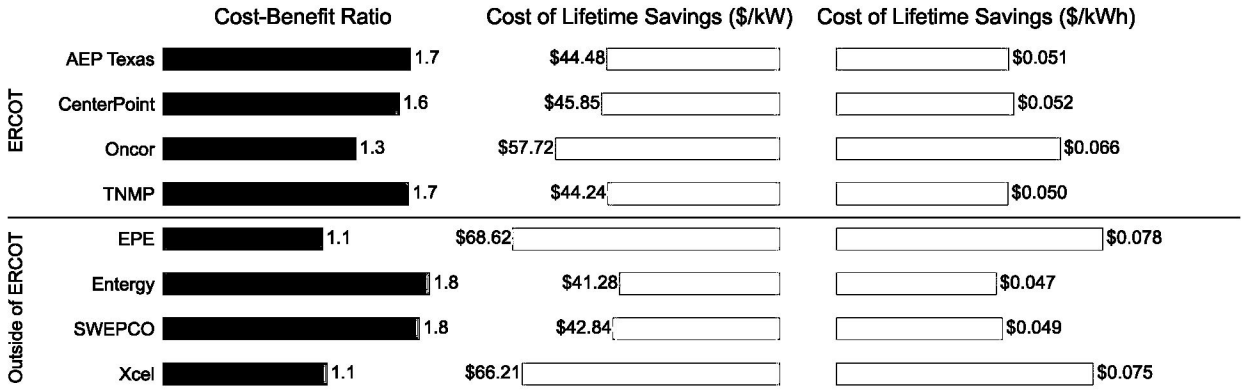


6.1.2 Cost-Effectiveness

Figure 50 summarizes the cost-effectiveness of each utility's energy efficiency portfolio based on savings of all load management programs in PY2022. Most portfolios were cost-effective, ranging from 1.1 to 1.8. The cost per kilowatt ranged from $41.28 to $68.62, and the cost per kilowatt-hour ranged from $0.047 to $0.078. 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.

[50] The following data points consist of the megawatt savings values that were unable to make it on the graph due to limited space: TNMP: PY2019, 3.667 MW; PY2020, 5.004 MW; PY2021, 5.078 MW; PY2022, 7.306 MW; PY2023, 10.278 MW. SWEPCO: PY2019, 6.319 MW; PY2020, 4.889 MW; PY2021, 3.837 MW; PY2022, 5.261 MW; PY2023, 4.555 MW. Xcel: PY2019, 3.417 MW; PY2020, 4.922 MW; PY2021, 3.771 MW; PY2022, 3.282 MW; PY2023, 3.275 MW.

Figure 50. Cost-Benefit Ratio and Cost of Lifetime Savings—Load Management Programs PY2023 ERCOT utilities followed by Outside-of-ERCOT utilities



6.2 COMMERCIAL LOAD MANAGEMENT

This section summarizes the key findings and recommendations from the PY2023 evaluation of the commercial load management programs offered by the eight Texas utilities.

The EM&V team applied the savings calculation methodology prescribed in PY2023 Technical Reference Manual (TRM) 10.0 on a census of records to calculate energy savings and demand reductions from interval meter data.

6.2.1 Programs Overview

Commercial summer load management programs are designed to manage kilowatt usage during summer peak demand periods. These periods are defined in most utility programs as 1:00 p.m. to 7:00 p.m., weekdays, June 1 through September 30. These programs are based on performance and offer incentive payments to participating customers for voluntarily curtailing electrical load on notice.

While each utility operates a unique load management program, there are many similarities among them. In general, a dispatch event may be called at the utility's discretion 30 to 60 minutes in advance of a curtailment event, which generally lasts one to four hours. In most cases, the utility reserves the right to call a certain number of curtailment events per season, ranging from 5 to 12, based on the utility. Customers must meet several eligibility requirements, including but not limited to (1) taking service at the distribution level, (2) meeting minimum demand requirements, and (3) being equipped with interval data recorder metering. Customers cannot simultaneously participate in other load management programs using the same curtailable loads (i.e., *double-dipping*).

Similarly, commercial winter programs offered by ERCOT IOU programs are designed to manage kilowatt usage during winter peak demand periods. These periods are defined as 6:00 a.m. to 10:00 a.m. and 6:00 p.m. to 10:00 p.m., 24/7, December 1 through the end of February.

Participants in both types of programs can either curtail their contracted load during a load control event or opt out if they wish not to participate. Participants receive an incentive based on the kilowatts they curtail during the event. Savings for kilowatts and kilowatt-hours are calculated by following the methodology described in PY2023 TRM 10.0, and an incentive is given to a participant based on the amount of kilowatts saved. This incentive amount is specified in an agreement with the utility when enrolling in the program. Participating customers

can receive up to $50 per kilowatt saved. Commercial customers who meet eligibility criteria for the utility can participate directly in the load management program or through an aggregator or other third party. PY2023 participation is summarized in Table 28 for summer and winter programs. For summer programs, the portion of commercial customers participating through an aggregator or a third party varies by utility. The majority of commercial load management participants in Oncor's programs are through an aggregator, in contrast to Entergy and SWEPCO, where all customers participate directly.

Table 28. PY2023 Commercial Customer Participation Summary by Utility

Utility		Number of sites Summer	Number of sites Winter
ERCOT	AEP Texas	385	9
	CenterPoint	334	105
	Oncor	882	26
	TNMP	69	35
Non-ERCOT	El Paso Electric	18	-
	Entergy	175	-
	SWEPCO	8	-
	Xcel	13	-
Overall		**1,884**	**175**

6.2.2 Key Findings and Recommendations

Key Finding #1: Commercial summer load management programs continue to increase in terms of number of participants (1,884 participants in PY2023 compared to 1,348 in PY2022; 40 percent increase). While the average level of cooperation with curtailment events remains relatively high, it did drop (74 percent in PY2023 from 81 percent in PY2022). For the winter load management programs, the cooperation rate was 82 percent.

As measured by the number of customers, participation in summer load management programs has been steadily increasing since PY2018. Of these participants, three-quarters (74 percent) curtailed load when requested for a curtailment event. The level of cooperation (ratio of enrolled participants compared to participants that were able to curtail) in PY2023 dropped for a few utilities, resulting in an average level of cooperation lower than PY2022. The EM&V team determines this percentage based on sites with zero or negative savings. In some cases, this may be due to a meter or technical issue as opposed to non-performance. Oncor, in particular, accounted for much of the decrease. Participants (through an aggregator) accounted for many of the nonparticipating sites. AEP Texas had the highest cooperation rate of 94 percent, followed by CenterPoint (93 percent), Entergy (86 percent), and Xcel (85 percent).

PY2023 was the first year that all ERCOT IOU utilities offered a winter load management program. The programs were successfully implemented with a high level of cooperation of 82 percent, given the programs are in their early stages.

Recommendation #1: Continue to follow up with participants who underperform during curtailment events, including aggregators, to determine if future program participation or program-contract estimates of available demand reduction need to be revised.

Key Finding #2: Utilities continue to demonstrate strong capabilities to apply the TRM calculation method to savings.

PY2023 is the eighth year in which utilities and the EM&V team have applied the demand savings algorithm for commercial summer load management programs described in TRM 10.0, the second year for Oncor's commercial winter load management programs, and the first year for the other three commercial winter load management programs. There is a mutual understanding of the *high 5 of 10* (summer) and *high 8 of 10* (winter) approaches. The utility companies, implementers, and EM&V team were largely in agreement on final demand savings calculations.

Recommendation #2: Continue implementing the demand savings algorithm described in the TRM and keep active communications with the EM&V team to resolve minor discrepancies in savings calculations. These recommendations will ensure consistency across utilities and enhance overall accuracy and transparency.

6.2.3 Impact Results

The PY2023 savings of summer and winter commercial load management programs are outlined in Table 29.

Table 29. PY2023 Commercial Demand Reduction and Energy Savings

Utility type	Summer		Winter		Overall	
	kW (demand reduction)	kWh (energy savings)	kW (demand reduction)	kWh (energy savings)	kW (demand reduction)	kWh (energy savings)
ERCOT total	261,711	1,128,484	42,068	147,531	303,779	1,276,015
Outside-of-ERCOT total	21,867	171,074	N/A	N/A	21,867	171,074
Overall	**283,578**	**1,299,558**	**42,068**	**147,531**	**325,646**	**1,447,089**

The overall PY2023 savings show a continued increase from PY2022 by roughly 7.7 MW (from 317.9 MW in PY2022 to 325.6 in PY2023). CenterPoint has significant savings among the utilities' commercial load management programs; however, the addition of the winter load management program is a main driver of the growth in the statewide demand reductions from PY2022 to PY2023. When only considering summer load management programs, demand reduction decreased from PY2022 by roughly 9.5 MW (from 293.0 MW in PY2022 to 283.5 in PY2023). Figure 51 and Figure 52 show overall kilowatt savings from ERCOT and outside-of-ERCOT IOUs' commercial load management programs by program year, respectively.

Figure 51. Demand Savings of ERCOT IOU Commercial Load Management Programs PY2019–2023

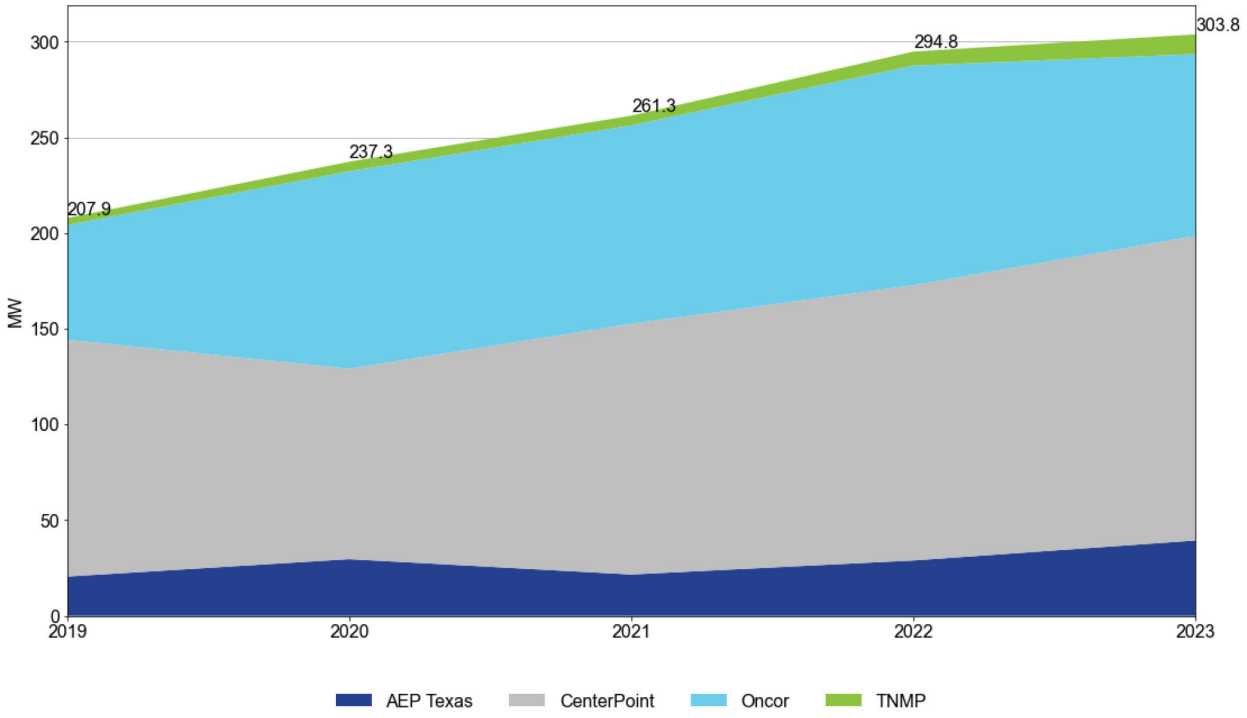
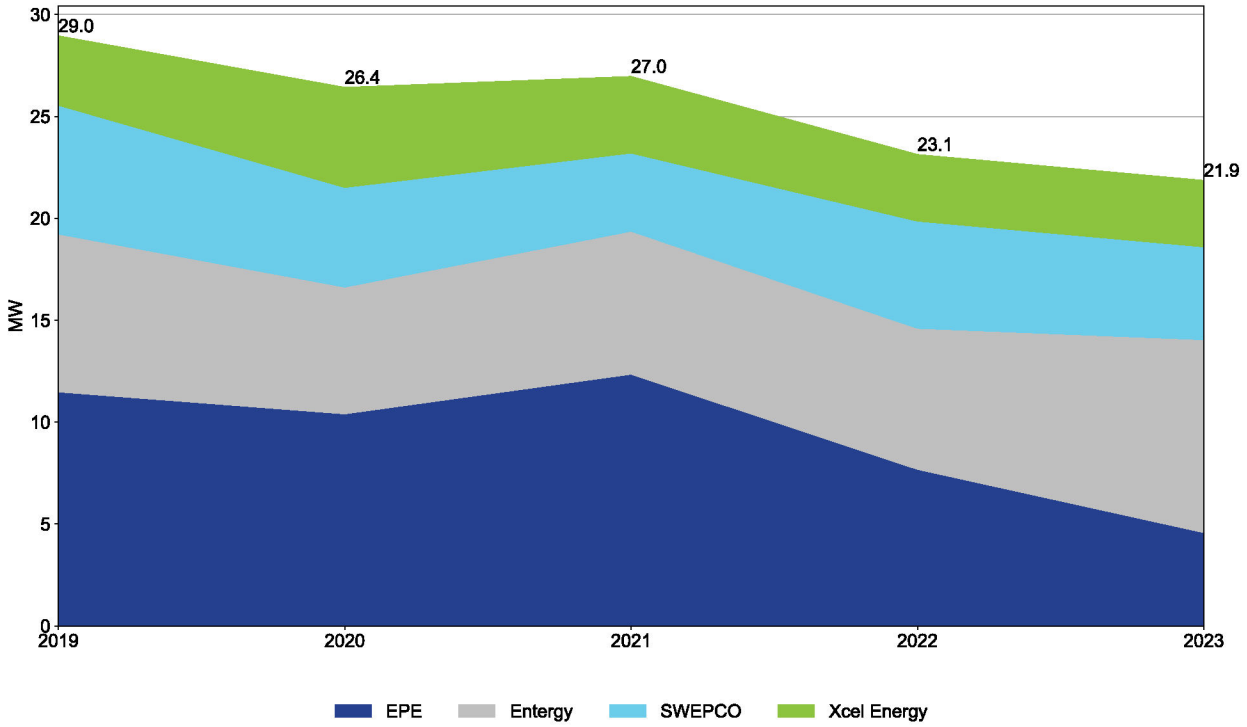


Figure 52. Demand Savings of Outside-of ERCOT IOU Commercial Load Management Programs PY2019–2023



Demand savings calculations for most utilities were calculated the same as the evaluation calculations, indicating that the EM&V team, the implementer, and the utilities follow the TRM algorithm for savings calculation similarly. Four commercial load management programs (offered by three utilities) adjusted their savings to match the evaluated savings. The reason for three of the adjustments is that, when comparing individual meter savings for one of the commercial load management programs, it was found that the utility was following a conservative approach by not setting savings to zero in cases where the calculation methodology produced negative savings. Per PY2023 TRM 10.0, in cases where the savings algorithm produces negative savings, the negative savings can be set to zero. The other adjustment was due to missing data for one site. The site had partial meter data for one of the events; therefore, savings for that meter were not considered since limited data were available during the event period. The three utilities accepted the evaluated results and matched the claimed savings to those of the evaluated savings. As a result, commercial load management programs received a realization rate of 100.0 percent for kilowatts and 100.0 percent for kilowatt-hours.

6.3 RESIDENTIAL LOAD MANAGEMENT

This section summarizes the key findings and recommendations from the PY2023 evaluation of three Texas utilities' residential load management programs (Oncor, CenterPoint, and EPE). Entergy piloted a residential load management program in 2023, and TNMP, AEP Texas, and SWEPCO are considering pilot programs. Xcel offers a residential demand response program but not as part of its energy efficiency portfolio.

Two utilities calculated savings using interval meter data following the *high 3 of 5* method; the third utility used the *deemed savings* method from PY2023 TRM 10.0.

6.3.1 Program Overviews

Residential load management programs are designed to manage kilowatt usage during summer peak demand periods. In PY2022, three of the eight Texas utilities offered their customers a residential load management program (CenterPoint, Oncor, and EPE). Of the three, CenterPoint and Oncor programs utilize a smart thermostat control strategy, and the EPE program utilizes direct load control devices. Incentives for these programs differ by whether or not the utility's service territory is part of the ERCOT) market. Utilities in the ERCOT market receive an incentive based on the kilowatt demand reductions achieved during the load control season; in contrast, EPE pays a flat enrollment incentive and a flat incentive per program year. All participants may opt out of a load control event.

Participants in CenterPoint and Oncor's residential load management programs are evaluated individually using the *High 3 of 5 Baseline with Day-of Adjustment* method described in PY2022 TRM Volume 11.0. In contrast, EPE is evaluated using the deemed savings value measured specifically for the utility (see TRM, Volume 2, Smart Thermostat Load Management). In the past years, the availability of advanced metering infrastructure (AMI) meters has dictated a utility's methodology to calculate savings.

The PUCT's substantive rule § 25.181, relating to the energy efficiency goal, defines the summer control period as June 1 to September 30, within the window of 1:00 p.m. to 7:00 p.m. on non-holiday weekdays for ERCOT utilities and 2:00 p.m. to 8:00 p.m. on non-holiday weekdays for outside-of-ERCOT utilities. Although a utility can call events outside of these defined periods for grid or system reliability needs, the rule currently only counts demand savings occurring during the defined peak periods towards a utility's demand reduction goal.

Table 30. PY2023 Residential Customer Participation Summary by Utility

Utility		Number of participants (targeted devices)
ERCOT	CenterPoint	25,623
	Oncor	28,173
Outside-of-ERCOT[51]	EPE	9,373
Overall		**63,169**

6.3.2 Key Findings and Recommendations

Key Finding #1: The three residential load management programs had seen significant increases in participation until PY2022. Due to budget and participation limits, savings and participation decreased in PY2023. The average level of cooperation remained about the same; it slightly increased to 77 percent in PY2023 from 75 percent in PY2022.

As measured by the number of customers, participation in residential load management programs has been steadily increasing since PY2018, reaching 71,680 participants (targeted devices) in PY2022. The number decreased by 12 percent in PY2023 (63,169 participants). This decrease is driven by one ERCOT IOU that experienced a 30 percent decrease in participation in PY2023.

Savings, on the other hand, reached a peak in PY2021 (72.8 MW in PY2021 compared to 71.8 in PY2022 and 71.5 in PY2023). Of the PY2023 participants, three-quarters (77 percent) curtailed load during the curtailment event. The level of cooperation (ratio of enrolled participants compared to participants that were able to curtail) in PY2023 increased for two utilities and slightly dropped for one utility, resulting in an average level of cooperation slightly higher than PY2022. The EM&V team determines this percentage based on sites with zero or negative savings.

Recommendation #1: Continue to explore cost-effective ways to increase participation and savings for the residential load management programs if needed in the portfolios, including expanding into underserved segments such as multifamily homes, additional devices beyond smart thermostats such as water heaters, and expanded control periods beyond summer as needed for grid or system reliability.

[51] Note that Entergy also piloted a residential load management component in its Residential Solutions program in PY2023, which was not evaluated this year.

Key Finding #2: Due to the unique aspect of the *deemed savings* method (using runtime data and a deemed savings value instead of interval meter data), the approach used to identify participating thermostat devices is critical. TRM language related to the *deemed savings* method has been improved in the past few years, and there is now a mutual understanding of the approach. The utility, implementer, and EM&V team agreed on a final demand savings calculation. In PY2023, documentation for participating thermostat devices has been improved, resulting in minor savings adjustments.

Given the increased interest in residential load management programs, the substantial amount of prior program year data available for the ERCOT IOUs (CenterPoint and Oncor), and the deemed value experience for EPE, the EM&V team conducted a study to determine if a statewide deemed value could be developed to streamline residential participation for use in pilot programs and areas where deployment of AMI meters is ongoing; employing the same participation documentation requirements established for El Paso Electric.

Recommendation #2a: For those interested in a streamlined participation option to offer or participate in a residential summer smart thermostat pilot in PY2024—who do not yet have AMI meters fully deployed—the EM&V team recommends the average statewide demand reduction deemed value per smart thermostat of 1.40 following the Program Tracking Data and Evaluation Requirements outlined in the TRM.

Recommendation #2b: Given that EPEc completed deploying AMI meters in its territory, the EM&V team recommends that EPE utilize a smart thermostat control strategy in PY2024 and follow the M&V methodology outlined in the TRM.

6.3.3 Impact Results

The PY2023 savings for the three residential load management programs (CenterPoint, Oncor, and EPE) are outlined in Table 31.

Table 31. PY2023 Residential Demand Reduction and Energy Savings

Utility type	Overall	
	kW (demand reduction)	kWh (energy savings)
ERCOT total	61,371	184,114
Outside-of-ERCOT total	10,118	510,588
Overall	**71,489**	**694,702**

After the continued increase since PY2019, savings slightly decreased in PY2022 to 71.8 MW and in PY2023 to 71.5 MW. Figure 53 and Figure 54 show ERCOT IOU and outside-of-ERCOT IOU total megawatt savings from residential load management programs by program year (note that AEP Texas discontinued its residential load management program after 2017). From PY2018 to PY2022, Oncor had the most significant savings amongst the residential IOU programs, followed by CenterPoint. In PY2023, however, CenterPoint increased from approximately 20 MW to 35 MW, which resulted in the highest demand savings across all residential IOU programs.

Figure 53. Demand Savings of ERCOT IOU Residential Load Management Programs PY2019–2023

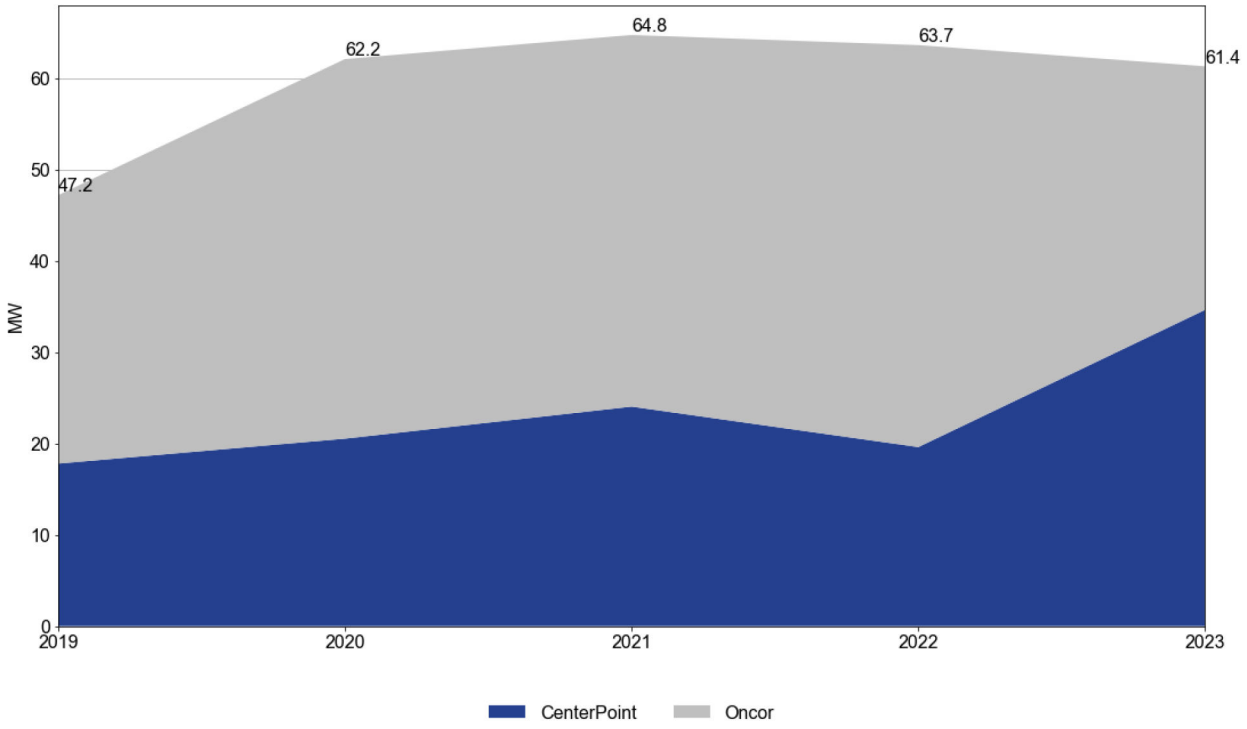
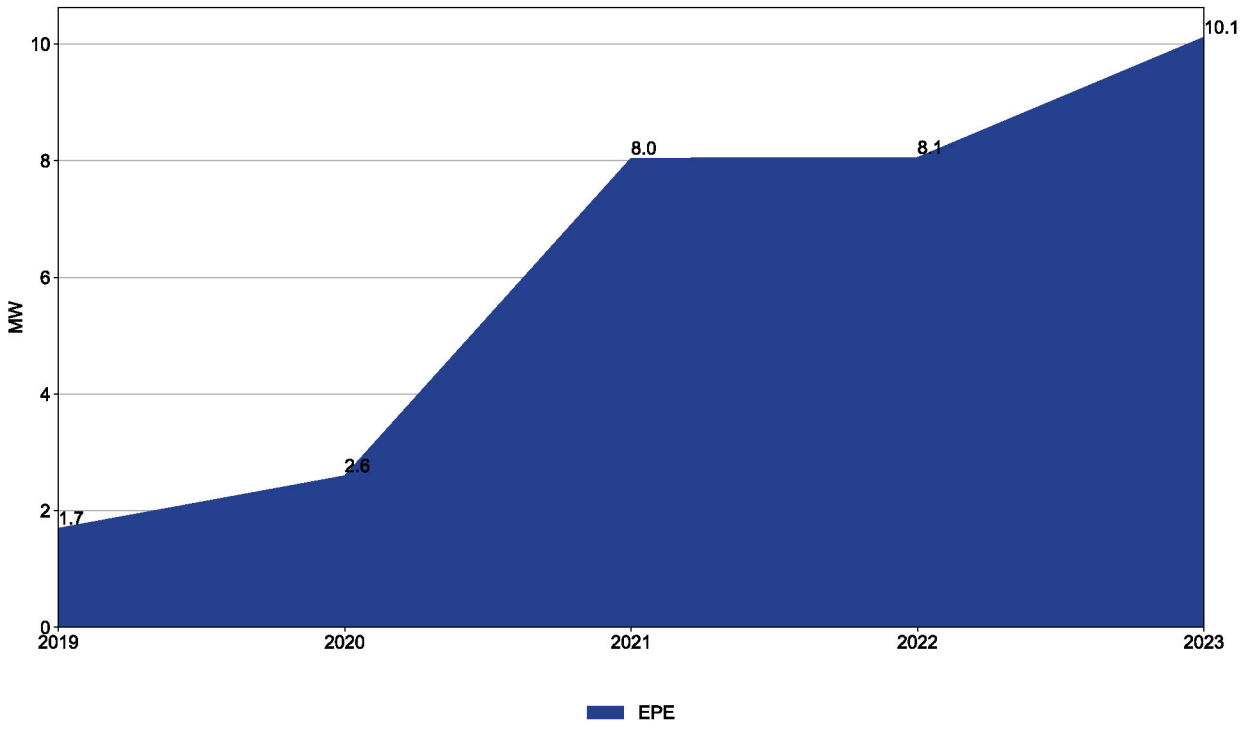


Figure 54. Demand Savings of Outside-of-ERCOT IOU Residential Load Management Programs PY2019–2023



Demand savings calculations for most utilities were calculated the same as the evaluation calculations, indicating that the EM&V team, the implementer, and the utilities follow the TRM algorithm for savings calculation similarly. Two residential load management programs adjusted their savings to match the evaluated savings. The reason for one of the adjustments is minor differences resulting from calculating the kilowatt savings for meters with partial data (per the TRM, savings may still be calculated for less than two percent of meters that fail to record data sufficient to apply the *High 3 of 5* calculation method). The other adjustment was related to the deemed savings approach. The number of participating devices was adjusted for a few events, resulting in a small decrease in savings.

APPENDIX A: RESIDENTIAL CONSUMPTION ANALYSIS

This appendix outlines the methodology and results associated with the residential consumption analysis conducted as part of the PY2023 evaluation, measurement, and verification (EM&V) analysis, expanding on the key findings and recommendations outlined in Section 5.5 of this report. The analysis's goal is to estimate the impact of the Residential Standard Offer Program (RSOP), the Hard-to-Reach Standard Offer Program (HTR), and the Low-Income Weatherization (LI) program at both the program and measure levels. We analyzed customers who participated in these three programs between January 1, 2022, and June 30, 2023, representing a full year of participants in PY2022 and the first half-year of participants in PY2023.

A.1 DATA SOURCES

Data for the consumption analysis came from four sources:

- **Program tracking data:** We received program tracking data that contained account numbers, the program in which the account participated, measure details, installation dates, the address, and reported technical reference manual (TRM) savings.

- **Meter/consumption data:** We received 15-minute interval data from American Electric Power Texas, Inc. (AEP Texas), CenterPoint Energy Houston Electric, LLC (CenterPoint), Oncor Electric Delivery, LLC (Oncor), and Texas-New Mexico Power Company (TNMP). For customers who participated in 2022, we received meter data spanning January 1, 2021, through December 31, 2023. For customers who participated in 2023, the meter data spanned January 1, 2022, through May 30, 2024. This data contained an account number, a timestamp, and kilowatt-hour consumption for each period.

- **Temperature data:** We collected one-hour temperature data from the Automated Surface Observing System (ASOS) network[52]. The temperature data spanned the period from January 1, 2021, through June 30, 2024, and was retrieved from 192 stations covering the state of Texas.

- **Participant survey data:** We conducted a survey of participants in the RSOP, HTR, and LI programs that was aimed at collecting information about factors that could impact a household's consumption, such as whether the household installed solar panels or a major appliance.

[52] The Texas weather stations in the ASOS network can be found at https://mesonet.agron.iastate.edu/request/download.phtml?network=TX_ASOS

A.2 METER FILTERING AND EXCLUSIONS

Fifteen-minute advanced metering infrastructure (AMI) meter data is quite reliable, but due to the sheer quantity of data, some accounts have meter data that could potentially bias results. This could occur for multiple reasons, including connection issues between the utility and the meter, the residence being vacant for an extended period of time, power outages, and software issues. Due to these reasons, accounts were identified that could bias results, which were excluded from the analysis.

An account was excluded from the consumption analysis if it met one of the following criteria:

- the account could not be matched to the tracking data,
- the account had more than 20 percent of its overall meter readings at 0 kWh.
- the account was missing at least one week (10,080 minutes) of continuous meter readings,
- the account had connectivity problems due to the AT&T issues in TNMP's territory,
- the account's annual consumption was higher than 1.5 inter-quartile ranges above the 99th percentile of average consumption and has not been verified by the utility as a high consumer,
- the account lacked sufficient data to construct a fully robust pre- or post-installation period for use in weather normalization, or
- after weather normalization, the account had an annual consumption of less than 500 kWh or larger than the top 0.1 percent of all weather-normalized annual consumption, which was larger than 146,254 kWh.

These criteria were developed in conjunction with the utilities. In particular, we met with the utilities to explain and refine the criteria, and each utility was provided with the accounts identified with potentially high consumption and the accounts with too many zero or missing readings. Oncor verified that the high consumers identified were valid accounts, and so these accounts were retained in the analysis.

In response to our initial data request, each utility provided us with 15-minute AMI meter data for their accounts. The number of meters represented by these data is outlined in Table 32.

Table 32. Meter-Level Data Received

Utility	AEP Texas	CenterPoint	Entergy	Oncor	TNMP
2022 meters received	5,383	1,976	1,892	21,700	2,164
2023 meters received	4,593	560	1,884	14,521	1,893
Total	**9,976**	**2,536**	**3,776**	**36,221**	**4,057**

The number of accounts that fit each of the above criteria is outlined in Table 33.

Table 33. Accounts Matching Filtering Criteria

Utility	AEP Texas	CenterPoint	Entergy	Oncor	TNMP
2022 participants					
Total number of accounts	**5,383**	**1,976**	**1,892**	**21,700**	**2,164**
Reasons for exclusion					
No tracking data	0	0	146	17	0
>20% zero kilowatt-hour readings	360	44	21	234	18
Missing data	806	14	10	59	1,063
Unvalidated high consumption	12	10	4	0 (79*)	0
AT&T issues	0	0	0	0	709
Normalized extreme consumption	35	24	0	101	12
2023 participants					
Total number of accounts	**4,593**	**560**	**1,884**	**14,521**	**1,893**
Reasons for exclusion					
No tracking data	453	0	1,384	6	0
>20% zero kilowatt-hour readings	288	6	64	252	8
Missing data	725	0	9	19	942
Unvalidated high consumption	13	0	4	0 (48*)	8
AT&T issues	0	0	0	0	762
Normalized extreme consumption	31	2	11	17	21

*The 79 and 48 high-consumption accounts from Oncor in 2022 and 2023, respectively, were verified by the utility and were retained in the analysis.

After removing these meters, the total number of accounts that were used in the analysis is outlined by utility in Table 34 and by measure and program in Table 35.

Table 34. Analysis of Meter Counts by Utility

Utility	AEP Texas	CenterPoint	Entergy	Oncor	TNMP
2022	**4,256**	**1,916**	**1,716**	**21,215**	**1,090**
% retained	79.1%	97.0%	90.7%	97.8%	50.4%
2023	**3,250**	**493**	**480**	**9,033**	**931**
% retained	70.8%	88.0%	25.5%[53]	62.2%[54]	49.2%

Table 35. Analysis Meter of Counts by Program and Measure

Measure	RSOP	Hard-to-Reach	LI
Air infiltration	0	14,245	164
Ceiling insulation	3,183	3,150	752
Central AC	8,339	105	0
Central HP	4,847	1,113	1,739
Duct sealing	2,745	1,686	95
ENERGY STAR® thermostat	1,169	1,258	408
Multifamily heat pump	0	0	1,286
Total	**22,287**	**19,735**	**3,994**

Note: The total number of meters in each program is not the sum of the measures due to accounts having installed multiple measures.

[53] A low percentage of Entergy PY2023 participants were retained in the analysis due to the EM&V team's inability to match meters with program tracking data. This was not an issue for the ERCOT utilities due to the ESIID serving as a unique identifier across data sources. To prevent this in future analyses, a PY2023 EM&V recommendation is for utilities outside of ERCOT to have a unique identifier for meters to also be used in program tracking data. We would like to note that Entergy did provide a premise number as a unique identifier in the AMI meter data request; however, we were unable to tie this in many cases to program tracking data for PY2023 participants.

[54] A large number of Oncor's 2023 participants lacked sufficient data to construct a full pre-period for use in weather normalization. Due to the compressed timeline for 2023 participants, we could not obtain the missing data before completing the analysis.

A.3 METHODOLOGY

After the meters were filtered, the data were resampled to one-hour intervals, temperature data from the nearest weather station were attached, and then the consumption data were normalized to remove the effect that weather had on consumption. The differences between the normalized consumption in the period pre-installation and the period post-installation were then analyzed at multiple levels to arrive at the results.

A.3.1 Weather Normalization

For each account, the weather station in the ASOS network that was geographically nearest to the address was identified. The temperature from this weather station was attached to the consumption data after cleaning the weather data to ensure that the temperature data had no gaps.

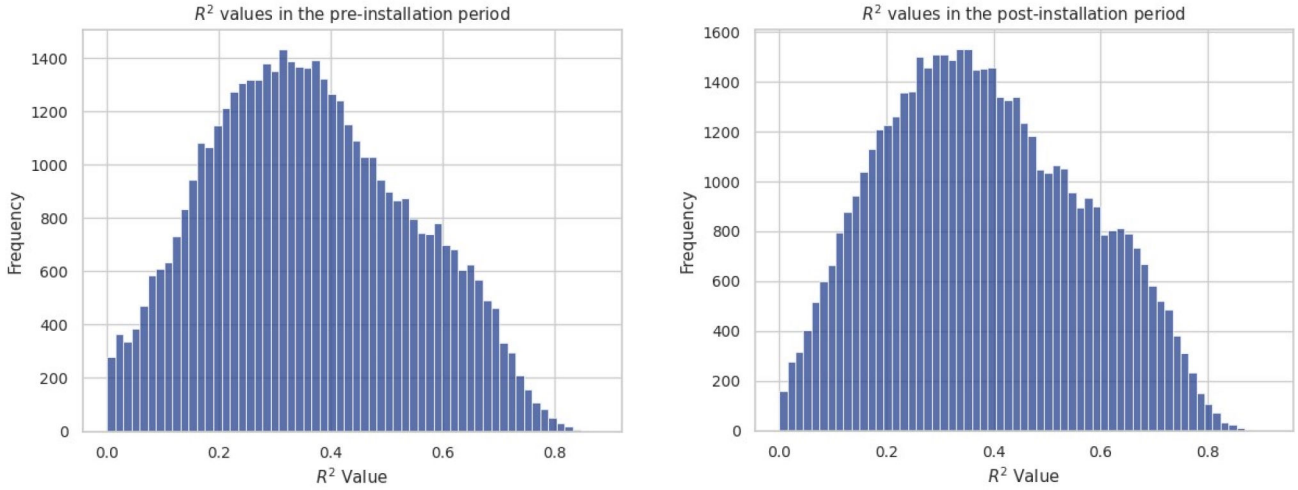
For each meter, the cooling degree hours (CDH) and heating degree hours (HDH) were calculated for multiple setpoints as follows:

- Given a cooling setpoint x, for each hour, the temperature t_h is compared against the setpoint. Then CDH is defined as $CDH_h = t_h - x$ if $t_h - x > 0$, and *0* otherwise. This measures the number of degrees (Fahrenheit) that the outside temperature exceeds the cooling setpoint.
- Given a heating setpoint y, the HDH is defined similarly, with the exception that HDH measures the number of degrees that the outside temperature is below the heating setpoint. So for each hour, $HDH_h = y - t_h$ if $y > t_h$, and *0* otherwise.
- We then set up the following regression for each meter and each combination x and y of potential cooling and heating setpoints:
    - $Consumption_h = \alpha_h + \beta_1 * CDH_{h,x} + \beta_2 * HDH_{h,y} + \sum_i \beta_i * Hour_i + \varepsilon_h$
    - Here, for each hour h, $Consumption_h$ is the hourly consumption of the participant, α_h is the intercept, which corresponds to the average consumption at hour 0. $CDH_{h,x}$ is the CDH assuming a cooling setpoint of x, and $HDH_{h,y}$ is the HDH assuming a heating setpoint of y. Their coefficients, β_1 is the model cooling slope, representing the average change in hourly usage resulting from an increase of one CDH, and β_2 is the model heating slope, representing the average change in hourly usage from an increase of one HDH. Finally, $Hour_i$ is an indicator variable indicating the hour of the day (ranging from 1 to 23), and their coefficients β_i are the average kilowatt-hour baseloads at each hour. The error term, ε_h encapsulates any variance that occurs.
- For each meter, the regression with the best R^2 value was selected and their coefficients and heating and cooling setpoints were recorded.
- Normalization was completed by applying the coefficients and setpoints in the pre- and post-periods to one year of temperature data from the nearest weather station. The year used for all meters was July 1, 2023, through June 30, 2024.

Upon normalization, the average heating setpoint for all individual accounts was 53, and the average cooling setpoint was 71. This compares to the 2020 consumption analysis, where the average setpoints were 56 and 70, respectively. These averages are consistent when the pre-installation period is compared to the post-installation period, and they are also consistent when the accounts that participated in 2022 are compared against the accounts that participated in 2023.

The individual regressions for normalization have an average R^2 value[55] of 37.2 percent. The average R^2 ranges between 36.2 percent and 38.1 percent when the accounts are separated by year or by pre- and post-installation. The distribution of R^2 values for the pre-installation period and the post-installation period are displayed in Figure 55.

Figure 55. R^2 Distributions in the Pre- and Post-Installation Periods



A.3.2 Regression

In the tracking data that was received from the utilities, each account had between one and four measures installed during the analysis period. For each account and each measure, an indicator variable was created, which was *1* if the account had that measure installed and *0* otherwise. Indicator variables were created for each program (RSOP, HTR, LI) as well. The difference between the normalized annual consumption during the pre-installation and post-installation periods was calculated, then regression equations were used to measure the impact that each program and measure had on the difference between the normalized annual consumption.

a. Program-Level Regression

At the program level, the regression equation used to measure impacts is:

$$\mathrm{NACDiff}_i = \alpha_i + \beta_1 * \mathrm{RSOP}_i + \beta_2 * \mathrm{LowIncome}_i + \varepsilon_i$$

Where:

$\mathrm{NACDiff}_i$	Change in weather normalized consumption for account i as calculated from the normalization method outlined above.
α_1	The model intercept represents the average difference for accounts in the HTR SOP program.

[55] The R^2 value for a regression measures the percentage of variation in the modeled variable that the model explains.

β_1	The deviation from α_1 for accounts in the RSOP program.
RSOP_i	An indicator variable for accounts in the RSOP program, which is *1* if the account was in the RSOP and *0* otherwise.
β_2	The deviation from α_1 for accounts in the LI program.
LowIncome_i	An indicator variable for accounts in the LI program, *1* if the account was in the LI program and *0* otherwise.
ε_i	The error/residual term.

The model has an F statistic[56] of 123, signifying that the model explains a significant amount of the variation in the difference in normalized annual consumption.

b. Measure-Level Regression

At the measure level, the accounts were split into the three programs; measure-level regressions were run for all three. The regression equation for each program is:

$$\text{NACDiff}_i = \alpha_1 + \beta_1 * \text{AirInf}_i + \beta_2 * \text{CeilIns}_i + \beta_3 * \text{CentAC}_i + \beta_4 * \text{CentHP}_i + \beta_5 * \text{DuctSeal}_i + \beta_6 * \text{Therm}_i + \beta_7 * \text{MFHP}_i + \varepsilon_i$$

Where:

NACDiff_i	Change in weather normalized consumption for account i as calculated from the normalization method outlined above.
α_1	The model intercept represents the average difference for all accounts in the program.
β_1	The deviation from α_1 for accounts that received an air infiltration measure.
$AirInf_i$	An indicator variable for accounts, which is *1* if the account received an air infiltration measure and *0* otherwise.
ε_i	The error/residual term.

The other coefficients and indicator variables follow a similar pattern. The F statistics for the models for each of the three programs are shown in Table 36.

[56] The F statistic measures the ratio of the variability between the groups (for instance, how different are RSOP participants to HTR SOP participants?) to the variability within each group (for example, how different are the RSOP participants from other RSOP participants?). In other words, it is the ratio of explained variance (in the model) to unexplained variance. The significance level of the F statistic depends heavily on the degrees of freedom in the model, but a good rule of thumb is that an F statistic larger than 2.5 is likely significant.

Table 36. F Statistics for the Measure-Level Regressions

Program	*F* statistic
RSOP	152.6
HTR SOP	34.0
LI	0.6

The F statistics for the RSOP and the HTR SOP indicate that the measure-level models explain a significant amount of the variation in the normalized consumption. For accounts in the LI program, however, the low F statistic and, the subsequent high p-values[57] at the measure level, means that the results for this program, detailed below, are more qualitative and should be taken as informative only. This will also be evident in the confidence intervals around each measure's estimate, shown in the details below.

c. Interaction Between Measures

For some accounts, the participant had more than one measure installed. Table 37 outlines the number of accounts that had another measure installed along with any of the given measures. So, for instance, of the 6,862 accounts that had ceiling installation installed, 1,051 also had the duct sealing measure.

Table 37. Installation of Multiple Measures

Measure	Air infiltration	Ceiling insulation	Central AC	Central HP	Duct sealing	ENERGY STAR thermostat	Multifamily heat pump
Air infiltration	14,247						
Ceiling insulation	968	6,862					
Central AC	3	4	8,302				
Central HP	38	12	16	7,389			
Duct sealing	1,082	1,051	-	8	4,274		
ENERGY STAR thermostat	38	7	-	1,772	-	2,831	
Multifamily heat pump	-	-	-	-	-	-	1,286

[57] The p-value is the probability (between 0 and 1) that chance alone can produce the results, assuming there is no difference between the consumption pre-installation and post-installation. A p-value of larger than 0.1 indicates that we cannot confidently say the difference is not zero.

The interaction between the measures for accounts with more than one measure can lead to issues when using the model to predict individual differences in normalized consumption. However, none of the pairwise interactions between the measures had a significant impact on the model. In Table 38, the p-values for the interaction between each pair of measures are recorded. None of the p-values are smaller than 0.05, and very few are less than 0.1. The only interaction that yielded a significant impact was for accounts that installed air infiltration, ceiling insulation, and duct sealing measures. With these, there were only 124 accounts with all three measures, and the impact did not influence the final results.

Table 38. Interaction Between Pairwise Measure—P-Values

Measure	Air infiltration	Ceiling insulation	Central AC	Central HP	Duct sealing	ENERGY STAR thermostat	Multifamily heat pump
Air infiltration	-						
Ceiling insulation	0.573	-					
Central AC	0.317	0.079	-				
Central HP	0.422	0.282	0.365	-			
Duct sealing	0.652	0.067	0.206	0.301	-		
ENERGY STAR thermostat	0.422	0.334	-	0.459	-	-	
Multifamily heat pump	-	-	-	-	-	-	-

With the large number of accounts that installed measures in isolation and the fact that the interaction between the measures was not significantly impacting the model, we can confidently attribute the modeled savings to the specified measures.

A.3.3 TRM Savings

The program tracking data included information about more than just the measures modeled above. Certain measures are not reported because the number of participants for them is too low (e.g., ENERGY STAR refrigerators) or because their inclusion would detract from the focus of the analysis (e.g., low-flow showerheads).

The TRM savings were calculated for each participant using the ex-ante savings in the tracking data. At the program level, the TRM savings for an account is the sum of the ex-ante savings for the account in that program. At the measure level, the TRM savings for an account are only the ex-ante savings for that particular measure.

A.3.4 Lessons Learned

We identified a few quality assurance and procedure improvements for the next time a similar analysis is run. First, ingesting the data from the utilities was a very slow process and involved multiple uploads and downloads. Ultimately, the data needs to be in Azure, so it would be more efficient to have the data uploaded directly to Azure from the start instead of using SharePoint as a staging point. SharePoint was used as the secure data transfer process, which the utilities are familiar with for other data requests. We will discuss the possibility of utilities uploading to Azure for future analyses, as we also want to balance the burden of the interval meter data request.

Second, the consumption data is processed through many steps with additional data (i.e., tracking data, weather data) being connected to the data at various stages in the process. At each of these stages, there is the potential for accounts to disappear and for data to join incorrectly. We discovered during the weather-joining process that certain temperatures were not being connected correctly, which can have a large impact on the weather normalization process. This was corrected in this year's analysis, and we successfully implemented more quality control checks in our process to catch instances where issues can occur, which should be implemented in future analyses.

Third, care should be taken at the beginning of the process so that the account identifiers received from the utilities are the same as the identifiers in our tracking data. We had some issues with the IDs, particularly with the 2023 participants in Entergy's territory, where the consumption data we received could not be matched with the tracking data.

Finally, working with the utilities from the beginning kept the process transparent and allowed the utilities to have input into how the exclusion criteria were defined.

A.4 RESULTS

This section presents the evaluated savings estimates for the RSOP, HTR SOP, and LI programs. The results are first presented at the program level, followed by the measure level, and finally at the utility level.

Each table below presents the sample size (n), the average normalized annual consumption in the pre-installation period (PRENAC), the modeled savings in kilowatt-hours, 95 percent confidence intervals[58] around the modeled savings, the average TRM savings in kilowatt-hours, and percentages to help put the results into context. Using the RSOP program displayed in Table 39 and Table 40, here is an example of how to read the results: The average participant in the RSOP program saw a reduction of 2,887 kWh, 9.6 percent of the average normalized annual consumption in the pre-installation period. These participants had an average TRM savings of 5,332 kWh, meaning the model savings were 54.2 percent of the TRM savings. The 95 percent confidence interval shown in Table 40 shows that the average reduction in the population is very likely between 2,662 kWh and 3,113 kWh.

[58] Note that the EM&V RFP specified that our confidence intervals only need to be at the 90 percent confidence level. We chose to report at the 95 percent level, as is typical for scientific work, although 90 percent confidence levels are still often used in the energy efficiency industry. The difference in confidence level widens the confidence intervals slightly, but it does not affect any of the conclusions.

It is important to note that there are differences between how savings are calculated in this analysis and how savings are calculated in the TRM. The TRM is designed to estimate savings for a given measure in isolation from any other measures. In this analysis, an account may have installed multiple measures. The discussion on how the measures may have interacted can be found in Section A.3.2, Subsection c. The large number of measures installed in isolation from any others allows us to confidently attribute savings to a particular measure. In addition, these results are aggregate values across the five investor-owned utilities (IOUs); performance both at the program level and compared to the TRM deemed values differed by utility and climate zone.

A.4.1 Results by Program

At the program level, each program showed savings when comparing the normalized annual consumption in the pre-installation period to the post-installation period. In Table 39, the modeled savings are compared to both the average normalized annual consumption in the PRENAC and the TRM savings. When compared to the PRENAC, the programs saved the average participant between 8 and 11.2 percent of their consumption. Additionally, on average, participation in the program realized between 37.9 and 54.2 percent of the claimed TRM savings.

Table 39. Program-Level Results

Measure	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
RSOP	22,287	30,105	2,887	9.6%	5,332	54.2%
HTR	19,735	18,153	1,454	8.0%	3,835	37.9%
LI	3,994	23,403	2,625	11.2%	6,189	42.4%

Table 40. Program-Level Results—Precision and Confidence Intervals

Program	Model savings	Standard error	Lower 95% savings	Upper 95% savings
RSOP	2,887	115	2,662	3,113
HTR	1,454	68	1,322	1,587
LI	2,625	172	2,288	2,963

In the PY2019 consumption analysis, the RSOP savings were 7.6 percent of the PRENAC and 38.6 percent of the TRM savings, which indicates that the savings in PY2023 are higher for both categories. The HTR SOP savings were 4.9 percent of the PRENAC and 30.1 percent of the TRM savings in PY2019, again showing that savings are higher in PY2023. The LI program savings in PY2019 were 15.9 percent of the PRENAC and 38.2 percent of the TRM savings, meaning the comparison to the PRENAC is lower in PY2023, but the comparison to the claimed TRM savings is higher.

A.4.2 Results by Measure

In Table 41 and Table 42, the results are presented at the measure level for all programs combined. In the combined programs, most analyzed measures show significant savings compared to the PRENAC. The exception is duct sealing (or duct efficiency), whose 95 percent confidence interval includes 0, which indicates that the savings demonstrated are not significantly different from 0. Results are separated into their respective programs in the sections that follow.

Table 41. Measure-Level Results—All Programs

Measure	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
Air infiltration	14,247	17,559	1,516	8.6%	1,131	134.1%
Ceiling insulation	6,862	25,310	1,322	5.2%	1,659	79.7%
Central AC	8,302	34,970	4,929	14.1%	2,475	199.1%
Central HP	7,389	23,676	3,266	13.8%	5,696	57.3%
Duct sealing	4,274	30,192	278	0.9%	703	39.6%
ENERGY STAR thermostat	2,831	14,132	979	6.9%	658	148.9%
Multifamily heat pump	1,286	14,745	2,290	15.5%	4,855	47.2%

Table 42. Measure-Level Results—All Programs—Precision and Confidence Intervals

Measure	Model savings	Standard error	Lower 95% savings	Upper 95% savings
Air infiltration	1,516	165	1,192	1,840
Ceiling insulation	1,322	178	972	1,671
Central AC	4,929	184	4,570	5,289
Central HP	3,266	185	2,903	3,629
Duct sealing	278	191	(96)	652
ENERGY STAR thermostats	979	224	540	1,419
Multifamily heat pump	2,290	304	1,695	2,885

a. Measure-Level Results for RSOP

In the RSOP, the central AC and HP measures show more than 10 percent savings relative to the normalized annual consumption in the pre-installation period; duct sealing, on the other hand, is showing less than 40 percent of the claimed TRM savings. Looking at the confidence intervals in Table 44, we cannot say that the modeled savings are significantly different from zero.

Table 43. Measure-Level Results—RSOP

Measure	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
Ceiling insulation	3,183	25,189	1,111	4.4%	2,124	52.3%
Central AC	8,339	35,117	4,924	14.0%	2,457	200.4%
Central HP	4,847	28,703	3,473	12.1%	5,515	63.0%
Duct sealing	2,745	32,606	293	0.9%	738	39.7%
ENERGY STAR thermostat	1,169	13,628	626	4.6%	712	87.9%

Table 44. Measure-Level Results—RSOP—Precision and Confidence Intervals

Measure	Model savings	Standard error	Lower 95% savings	Upper 95% savings
Ceiling insulation	1,111	279	565	1,657
Central AC	4,924	252	4,430	5,417
Central HP	3,473	265	2,953	3,992
Duct sealing	293	286	(267)	853
ENERGY STAR thermostats	626	357	(73)	1,325

b. Measure-Level Results for HTR SOP

In the HTR SOP, most of the measures show good savings relative to the TRM savings. Similar to the RSOP, duct sealing again shows savings that are not significantly different from zero.

Table 45. Measure-Level Results—HTR SOP

Measure	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
Air infiltration	14,245	16,870	1,475	8.7%	1,150	128.3%
Ceiling insulation	3,150	20,992	944	4.5%	1,421	66.5%
Central AC	105	21,405	5,353	25.0%	1,918	279.1%
Central HP	1,113	15,900	2,605	16.4%	5,627	46.3%
Duct sealing	1,686	30,751	(272)	-0.9%	663	-41.0%
ENERGY STAR thermostat	1,258	14,852	1,435	9.7%	642	223.4%

Table 46. Measure-Level Results—HTR SOP—Precision and Confidence Intervals

Measure	Model savings	Standard error	Lower 95% savings	Upper 95% savings
Air infiltration	1,475	236	1,012	1,938
Ceiling insulation	944	249	456	1,432
Central AC	5,353	818	3,750	6,955
Central HP	2,605	392	1,836	3,373
Duct sealing	(272)	265	(790)	247
ENERGY STAR thermostats	1,435	382	687	2,183

c. Measure-Level Results for Low-Income Weatherization

In the LI program, many measures demonstrated savings in the model, particularly when compared against the TRM. Caution should be exercised when applying these results for two reasons: (1) the small sample sizes (in duct sealing and air infiltration in particular) and (2) the large standard errors, which indicate a large variance in the normalized consumption savings for accounts with these measures. In a qualitative sense, the LI program is performing well.

Table 47. Measure Level Results—Low-Income Weatherization

Measure	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
Air infiltration	164	56,749	1,729	3.0%	181	953.7%
Ceiling insulation	752	36,433	3,129	8.6%	900	347.6%
Central HP	1,739	14,982	2,686	17.9%	5,696	47.2%
Duct sealing	95	25,430	2,911	11.4%	387	752.8%
ENERGY STAR thermostat	408	13,428	2,792	20.8%	549	509.0%
Multifamily heat pump	1,286	14,745	2,290	15.5%	4,855	47.2%

Table 48. Measure-Level Results—Low-Income Weatherization—Precision and Confidence Intervals

Measure	Model savings	Standard error	Lower 95% savings	Upper 95% savings
Air infiltration	1,729	1,017	(265)	3,723
Ceiling insulation	3,129	739	1,681	4,577
Central HP	2,686	703	1,309	4,063
Duct sealing	2,911	1,245	472	5,351
ENERGY STAR thermostats	2,792	765	1,293	4,292
Multifamily heat pump	2,290	706	905	3,674

A.4.3 Results by Utility

The modeled savings for each utility are presented below, separated by program and measure. These looks can help the utility isolate which programs and/or measures show savings, and which need further investigation.

a. Program Level Results Separated by Utility

The results for each utility are separated by program in Table 50 with confidence intervals in Table 51. A few programs, including the RSOP in CenterPoint and Entergy, showed large standard errors, which indicate that either the sample size is small, the variance among accounts is large, or potentially both. While the results for these programs should be viewed qualitatively, they still provide insight into how each utility performed in each program and measure.

The utility and program results are compared to the PY2019 results for the ERCOT utilities in Table 49. The RSOP and HTR SOP in Oncor's territory demonstrated over 100 percent increases over the PY2019 results, while the RSOP for CenterPoint increased by over 350 percent. For all four ERCOT utilities, the LI program showed increases between 20.5 percent and 76.2 percent.

Table 49. Program-Level Results—Comparison to PY2019

Program	Model savings (kWh)	PY2019 model savings (kWh)	Percentage change
AEP Texas			
RSOP	(41)	403	-110.2%
HTR SOP	(89)	788	-111.3%
LI	2,413	1,932	24.9%
CenterPoint			
RSOP	6,402	1,337	378.8%
HTR SOP	437	657	-33.5%
LI	2,694	2,044	31.8%
Oncor			
RSOP	4,306	1,667	158.3%
HTR SOP	1,718	712	141.3%
LI	2,533	2,102	20.5%
TNMP			
RSOP	329	575	-42.8%
HTR SOP	834	581	43.5%
LI	2,946	1,672	76.2%

Table 50. Program-Level Results by Utility

Program	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
AEP Texas						
RSOP	5,421	29,446	(41)	-0.1%	966	-4.3%
HTR	3,060	27,771	(89)	-0.3%	993	-9.0%
LI	611	19,595	2,413	12.3%	3,437	70.2%
CenterPoint						
RSOP	523	32,017	6,402	20.0%	131	4884.1%
HTR	221	23,055	437	1.9%	1,659	26.4%
LI	1,693	30,842	2,694	8.7%	3,303	81.6%
Entergy						
RSOP	594	41,041	5,631	13.7%	2,045	275.4%
HTR	377	36,325	5,072	14.0%	1,540	329.4%
Oncor						
RSOP	13,329	31,822	4,306	13.5%	3,480	123.7%
HTR	15,310	15,736	1,718	10.9%	1,544	111.3%
LI	1,351	14,560	2,533	17.4%	5,164	49.1%
TNMP						
RSOP	2,420	19,459	329	1.7%	1,705	19.3%
HTR	767	17,169	834	4.9%	1,624	51.4%
LI	339	19,161	2,946	15.4%	4,225	69.7%

Table 51. Program-Level Results by Utility—Precision and Confidence Intervals

Program	Model savings	Standard error	Lower 95% savings	Upper 95% savings
AEP Texas				
RSOP	(41)	264	(558)	476
HTR SOP	(89)	165	(412)	234
LI	2,413	437	1,556	3,269
CenterPoint				
RSOP	6,402	1,434	3,591	9,213
HTR SOP	437	921	(1,369)	2,243
LI	2,694	1,337	73	5,314
Entergy				
RSOP	5,631	1,100	3,475	7,787
HTR SOP	5,072	865	3,375	6,768
Oncor				
RSOP	4,306	130	4,051	4,562
HTR SOP	1,718	73	1,574	1,861
LI	2,533	268	2,008	3,059
TNMP				
RSOP	329	346	(350)	1,007
HTR SOP	834	228	387	1,281
LI	2,946	471	2,023	3,870

b. Measure-Level Results Separated by Utility

At the measure level, each utility had certain measures that performed better than others. The central AC measure consistently performed well when compared to TRM savings across all utilities, while other measures showed more variability between the different utilities.

Table 52. Measure-Level Results by Utility

Measure	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
AEP Texas						
Air infiltration	1,014	29,862	131	0.4%	835	15.7%
Ceiling insulation	2,143	24,427	953	3.9%	1,742	54.7%
Central AC	399	32,874	2,394	7.3%	2,546	94.0%
Central HP	379	19,798	3,026	15.3%	5,809	52.1%
Duct sealing	3,556	30,820	-731	-2.4%	706	-103.6%
CenterPoint						
Air infiltration	152	59,044	3,412	5.8%	215	1586.6%
Ceiling insulation	603	40,549	2,612	6.4%	1,153	226.5%
Multifamily heat pump	1,286	14,745	2,290	15.5%	4,855	47.2%
Entergy						
Air infiltration	241	37,642	4,246	11.3%	446	952.5%
Ceiling insulation	494	40,933	5,013	12.2%	2,485	201.8%
Duct sealing	634	39,458	5,634	14.3%	657	857.8%
Oncor						
Air infiltration	12,954	15,442	1,551	10.0%	1,184	131.0%
Ceiling insulation	1,626	19,179	1,638	8.5%	967	169.4%
Central AC	7,949	35,042	5,066	14.5%	2,475	204.7%
Central HP	7,046	24,155	3,369	13.9%	5,695	59.2%
ENERGY STAR thermostat	2,835	14,142	1,333	9.4%	658	202.7%

Measure	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
TNMP						
Air infiltration	48	26,241	236	0.9%	793	29.7%
Ceiling insulation	2,213	20,447	281	1.4%	2,136	13.1%
Central AC	91	35,714	4,345	12.2%	2,214	196.3%
Central HP	274	18,878	3,004	15.9%	5,566	54.0%
Duct sealing	332	27,098	1,002	3.7%	722	138.8%

Table 53. Measure Level Results by Utility—Precision and Confidence Intervals

Measure	Model savings	Standard error	Lower 95% savings	Upper 95% savings
AEP Texas				
Air infiltration	131	357	-569	832
Ceiling insulation	953	277	410	1,495
Central AC	2,394	502	1,410	3,379
Central HP	3,026	513	2,020	4,032
Duct sealing	-731	263	-1,246	-217
CenterPoint				
Air infiltration	3,412	1,265	933	5,891
Ceiling insulation	2,612	848	950	4,273
Multifamily heat pump	2,290	746	827	3,753
Entergy				
Air infiltration	4,246	1,681	952	7,541
Ceiling insulation	5,013	1,736	1,612	8,415
Duct sealing	5,634	1,728	2,247	9,020

Measure	Model savings	Standard error	Lower 95% savings	Upper 95% savings
Oncor				
Air infiltration	1,551	376	815	2,287
Ceiling insulation	1,638	380	893	2,383
Central AC	5,066	387	4,308	5,823
Central HP	3,369	371	2,641	4,097
ENERGY STAR thermostat	1,333	342	662	2,004
TNMP				
Air infiltration	236	940	-1,607	2,079
Ceiling insulation	281	306	-318	879
Central AC	4,345	711	2,952	5,738
Central HP	3,004	468	2,088	3,921
Duct sealing	1,002	416	187	1,818

A.5 MEASURE-ATTRIBUTE-LEVEL RESULTS

For each core measure, certain attributes were used to break down the results further and determine whether there were specific drivers for them. For air infiltration and duct sealing, the results were broken into quartiles based on the percentage of cubic-feet-per-minute (CFM) reduction. For ACs and HPs, the results were aggregated by seasonal energy efficiency ratios (SEER). For ceiling insulation, results were separated by starting R-values.

A.5.1 Air Infiltration Attribute Results

The detailed air infiltration results are shown in Table 54. The quartiles are defined by the percentage of CFM improvement. The top three quartiles showed savings in the model, but the accounts in the first quartile did not demonstrate any savings.

Table 54. Detailed Measure Level Results—Air Infiltration

Quartile CFM improvement	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
Q1 (4.7%-26.2%)	276	32,064	-1,072	-3.3%	728	-147.3%
Q2 (26.2%-33.8%)	258	30,905	235	0.8%	744	31.6%

Quartile CFM improvement	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
Q3 (33.8%-47.9%)	257	29,407	1,326	4.5%	675	196.5%
Q4 (47.9%-77.2%)	277	27,187	508	1.9%	621	81.8%

A.5.2 Duct Sealing Attribute Results

The detailed duct sealing results are shown in Table 55. The accounts are separated into four quartiles based on the percentage of CFM improvement, which ranged between 41.7 percent and 98.4 percent. On average, accounts with at least an 83 percent CFM improvement showed savings, while accounts with less than 83 percent improvement did not demonstrate savings.

Table 55. Detailed Measure Level Results—Duct Sealing

Quartile CFM improvement	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
Q1 (41.7%-74.7%)	981	34,704	-611	-1.8%	707	-86.3%
Q2 (74.7%-78.8%)	999	32,419	-937	-2.9%	782	-119.8%
Q3 (78.8%-83.0%)	980	32,721	-260	-0.8%	821	-31.7%
Q4 (83.0%-98.4%)	987	30,231	1,072	3.5%	760	141.0%

A.5.3 Air Conditioner and Heat Pump Attribute Results

Table 56 and Table 57 respectively, show the detailed results for accounts with the central AC and central HP measures, broken down by SEER. There is not any discernable difference between accounts with different SEER values.

Table 56. Detailed Measure Level Results—Central AC

SEER	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
<16	191	35,003	5,523	15.8%	1,655	333.7%
16	3,679	35,578	5,912	16.6%	2,613	226.2%
17	602	37,267	6,075	16.3%	3,345	181.6%
18+	1,439	41,488	6,060	14.6%	4,465	135.7%

Table 57. Detailed Measure Level Results—Central HP

SEER	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
<16	2,965	19,562	3,260	16.7%	5,672	57.5%
16	2,787	25,479	3,627	14.2%	5,678	63.9%
17	244	34,698	2,685	7.7%	5,846	45.9%
18+	707	36,490	4,262	11.7%	7,150	59.6%

A.6 CLIMATE-ZONE-LEVEL RESULTS

The TRM has developed five climate zones to recognize the energy savings differences for HVAC and envelope measures for different weather conditions. Therefore, measures have different savings claimed depending on the location. The climate zones in the TRM are defined by county and are shown in Figure 56. The accounts we analyzed were distributed among Climate Zone 1 through Climate Zone 4, with no accounts in Climate Zone 5. In this section, results are presented separately by climate zone.

Table 58 shows only 112 accounts were analyzed in Climate Zone 1. The relatively large standard error in this climate zone indicates that we cannot say the average savings in this climate zone are significantly different from zero. Climate Zone 2 and Climate Zone 3 show good realization rates relative to the TRM savings in the zones. In Climate Zone 4, however, accounts do not show any savings. In fact, on average, the accounts in Climate Zone 4 show higher normalized annual consumption post-installation than in the pre-installation period.

Figure 56. Map of TRM Climate Zones

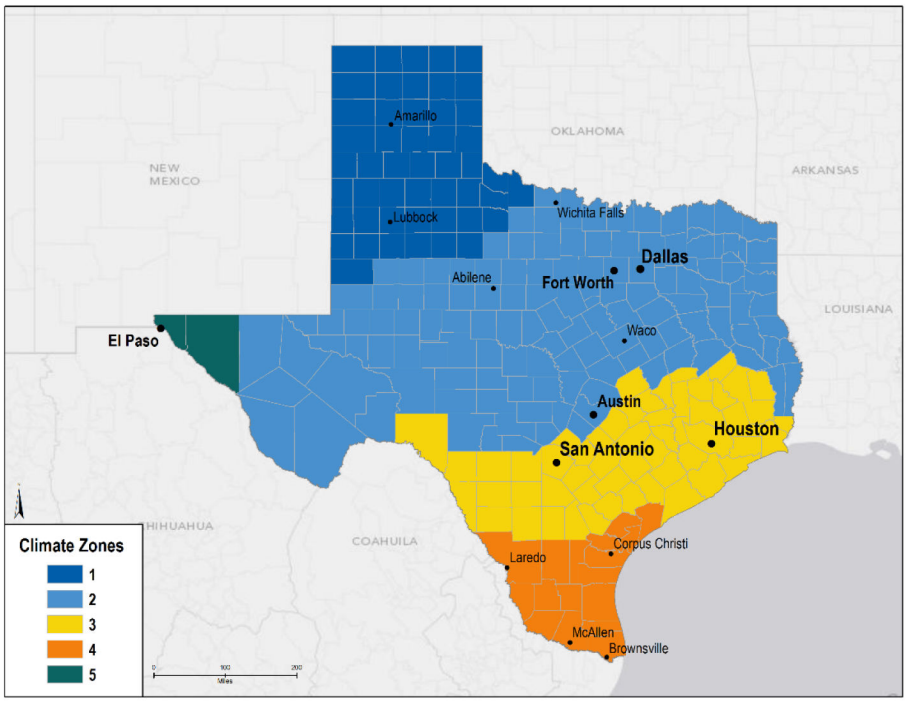


Table 58. Results by Climate Zone

Climate zone	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
1	112	12,534	1,150	9.2%	945	121.7%
2	33,306	22,429	2,686	12.0%	2,517	106.7%
3	5,282	28,812	2,837	9.8%	2,387	118.9%
4	7,181	30,187	-162	-0.5%	799	-20.3%

Table 59. Results by Climate Zone—Precision and Confidence Intervals

Climate zone	Model savings	Standard error	Lower 95% savings	Upper 95% savings
1	1,150	896	-606	2,906
2	2,686	1,268	200	5,172
3	2,837	1,273	341	5,333
4	-162	1,272	-2,655	2,331

A.6.1 Ceiling Insulation Attribute Results

Accounts with a ceiling insulation measure were separated by the starting R-value. The model results are shown in Table 60. Accounts with a starting R-value larger than five demonstrated higher model savings than the TRM savings, while accounts with a starting R-value of four or lower had realization percentages of less than 50 percent.

Table 60. Detailed Measure Level Results—Ceiling Insulation

Starting R-value	n	PRENAC (kWh)	Model savings (kWh)	Savings as a percentage of PRENAC	TRM savings (kWh)	Savings as a percentage of TRM
R0	278	28,275	621	2.2%	1,766	35.2%
R1-R4	3,272	24,744	842	3.4%	2,107	40.0%
R5-R8	1,655	25,378	1,455	5.7%	1,424	102.2%
R9-R14	944	28,903	1,923	6.7%	1,129	170.4%
R15-R22	742	21,360	754	3.5%	558	135.2%

A.7 PARTICIPANT SURVEY RESULTS

Tetra Tech conducted a quantitative survey of residential program participants who received an energy efficiency installation in 2022 or the first half of 2023. The survey focused on the following topics:

- lifestyle changes (i.e., working from home),
- occupancy changes (i.e., number in the household),
- equipment changes (i.e., electric vehicle (EV)),
- behavioral changes (i.e., temperature setpoint),
- a major renovation, and
- perceived comfort level pre- and post-installation.

In addition, the survey concluded with an open-ended question that allowed respondents to share any other energy efficiency concerns.

The goal of conducting the survey was to determine factors that would change an account's consumption that may not be captured solely in the tracking data. Even if these factors do not affect the overall results, having this information can increase confidence that the model savings can be attributed to the specified measures.

Tetra Tech sampled 24,145 participants to garner responses to the survey. The number of responses, separated by utility and by program, are shown in Table 61 and

Table 62, respectively.

Table 61. Survey Responses by Utility

Utility	AEP Texas	CenterPoint	Entergy	Oncor	TNMP
Count	496	131	57	693	67

Table 62. Survey Responses by Program

Program	RSOP	HTR SOP	LI
Count	1,094	243	107

The survey responses were used in two ways to determine their impact on the consumption analysis results. First, the individual responses were analyzed to determine whether they could be used to predict a difference in the account's consumption. Second, the respondents who indicated they installed solar panels or had purchased an EV were removed from the consumption analysis to determine if they were having an adverse impact on the results.

A.7.1 Survey Response Analysis

Responses were used as categorical variables in the following model to determine whether the survey responses could be used to predict savings:

$$\text{NACDiff}_i = \alpha_1 + \beta_1 * \text{RSOP}_i + \beta_2 * \text{LowInc}_i + \beta_3 * \text{Solar}_i + \beta_4 * \text{EV}_i + \beta_5 * \text{Equip}_i + \beta_6 * \text{Renov}_i + \beta_7 * \text{Work}_i + \beta_8 * \text{House}_i + \beta_9 * \text{Comfort}_i + \varepsilon_i$$

Where:

NACDiff_i	Change in weather normalized consumption for account i as calculated from the normalization method outlined above.
α_1	The model intercept represents the average difference for accounts in the HTR SOP program who responded negatively to all major changes, did not have a change in household size, and indicated their comfort did not change upon installing the measure.
β_1	The deviation from α_1 for accounts in the RSOP program.
RSOP_i	An indicator variable for accounts in the RSOP program, which is *1* if the account was in the RSOP and *0* otherwise.
β_2	The deviation from α_1 for accounts in the LI program.
LowIncome_i	An indicator variable for accounts in the LI program, *1* if the account was in the LI program and *0* otherwise.
β_k	The coefficient for each survey indicator variable, which represents the deviation from α_1 for respondents who responded positively to the survey question.
Solar_i	An indicator variable, which is *1* if the respondent said they installed solar panels in the past year and *0* otherwise.
ε_i	The error/residual term.

The other indicator variables are defined similarly, with the exception that multiple indicator variables were created for the questions about household size (with three potential responses), work from home (with four potential responses), and comfort level (with three potential responses). The extra variables were repressed from the model shown above for conciseness.

The regression showed that only one of the survey variables was a significant predictor of the difference in consumption: solar panels. Participants who installed solar panels had an average consumption difference of 4,167 kWh larger than those who did not.

For the remainder of the survey variables, the p-values indicate the variables do not significantly impact the program-level estimates; this gives us confidence that the consumption analysis results are not significantly impacted by some of the major factors that the tracking data does not reveal.

A.7.2 Survey Response Interaction with Consumption Results

To emphasize this last point further, participants who indicated they had installed solar panels or purchased an electric vehicle in the past year were removed; this resulted in 100 accounts being removed from the consumption analysis (58 that had installed solar panels, and 42 with EVs). At both the program and measure levels, the removal of these accounts had very little impact on the modeled estimates, with each estimate within five percent of the original estimates.

APPENDIX B: LIFETIME IOU PROGRAM SAVINGS

The demand reductions and energy savings achieved by programs persist beyond the program year (PY). The duration of savings is based on the type of energy efficiency improvement made and how long it typically lasts. The cumulative savings the utilities have achieved since PY2012—when the PUCT evaluation, measurement, and verification (EM&V) effort began—are shown in Figure 57 (demand reduction) and Figure 58 (energy savings). Demand reductions and energy savings are expected to continue through 2051.

Figure 57. PY2012–PY2051 Lifecycle Demand Reduction by Sector (MW)

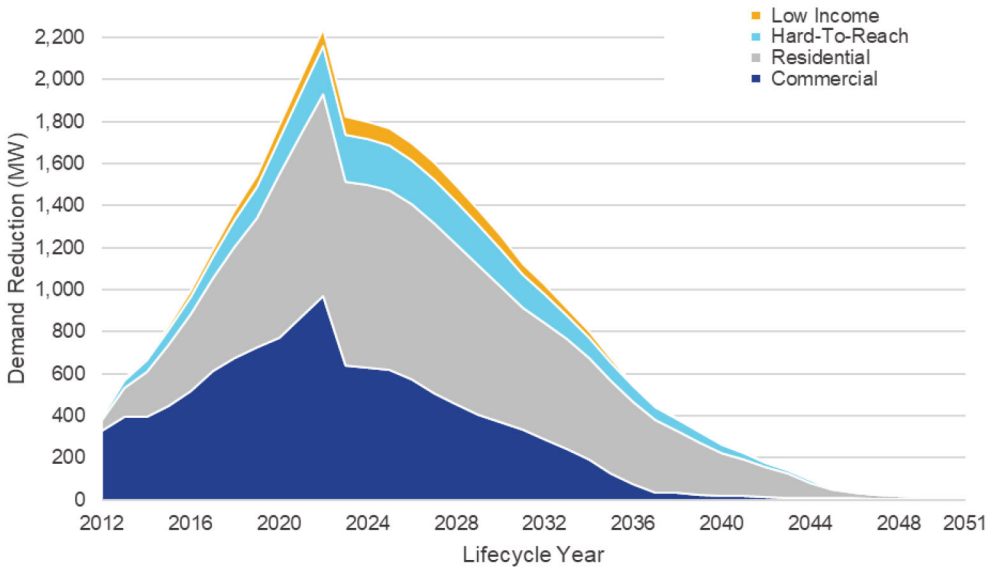


Figure 58. PY2012–PY2051 Lifecycle Energy Savings by Sector (GWh)

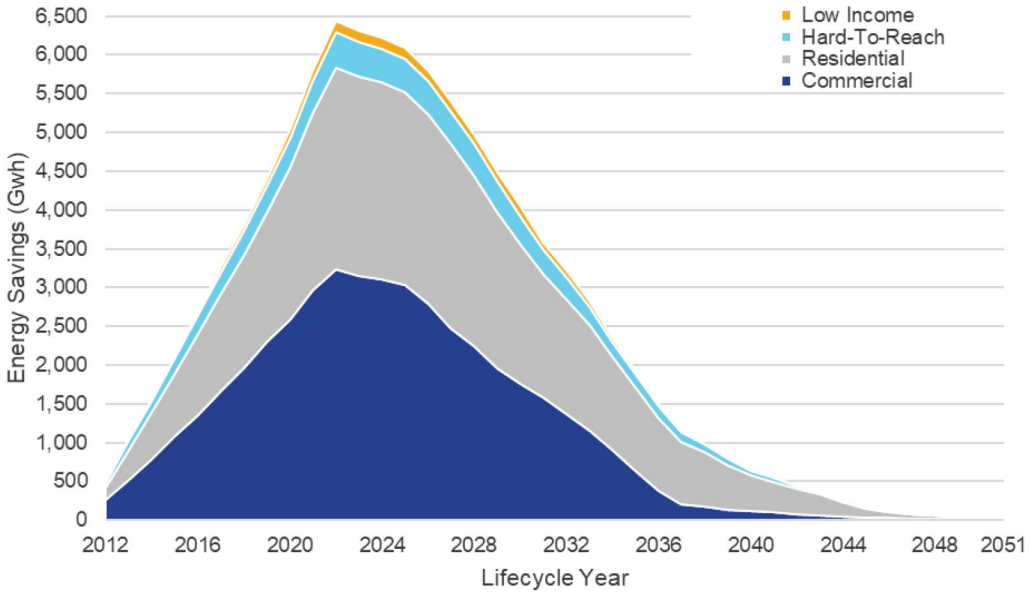


Figure 59 and Figure 60 show the types of measures installed through the programs and how they contribute to lifecycle savings. *Lighting*, *HVAC*, and *building shell* improvements continue to deliver the most savings over time. Load management delivers demand reductions only in the program year and accounts for the spike and drop-off after PY2022.

Figure 59. PY2012–PY2051 Lifecycle Demand Reduction by Measure Category (MW)

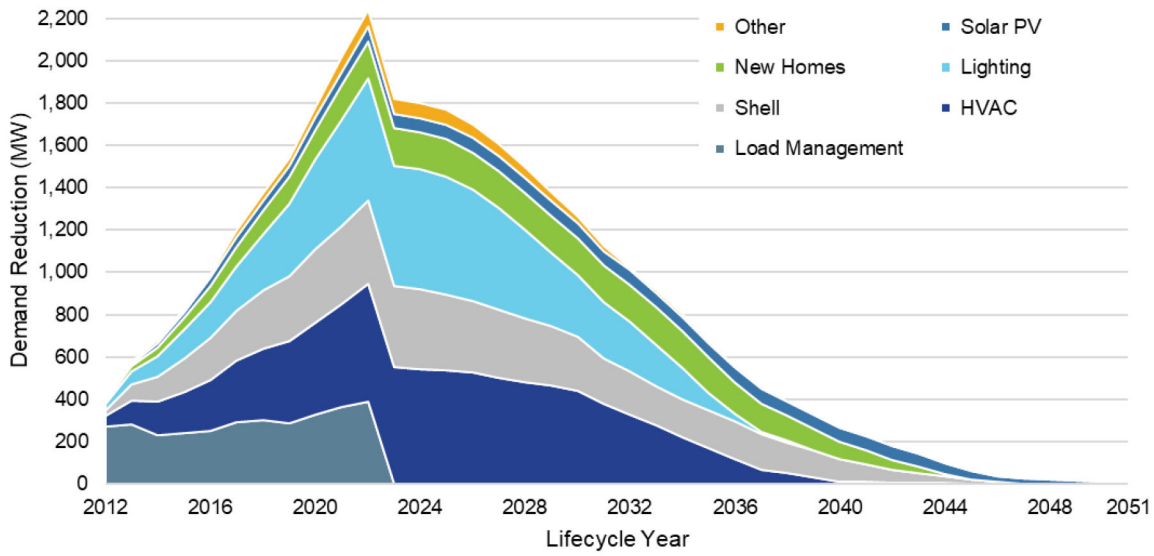
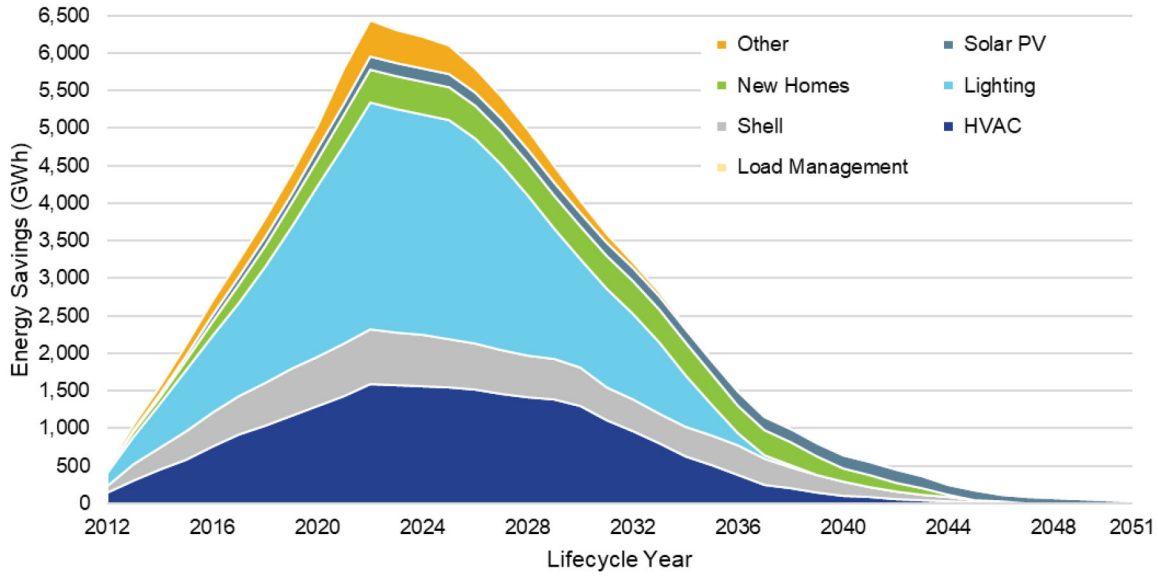


Figure 60. PY2012–PY2051 Lifecycle Energy Savings by Measure Category (GWh)



APPENDIX C: IOU PROGRAM BUDGETS

This appendix shows PY2023 energy efficiency program costs totaled just under $168 million across the eight IOUs. Almost three-quarters of the costs were incentives, with the remainder covering administrative and related costs as well as the performance bonus earned by utilities. See Table 63.

Table 63. PY2023 Utility Program Costs

Utility	Incentive amount	Administrative, R&D, and EM&V costs[59]	PY2023 performance bonus earned	Total PY2023 costs
AEP Texas	$15,133,235	$2,141,566	$6,041,869	$23,224,932
CenterPoint	$36,486,498	$3,577,444	$15,032,510	$55,096,452
Entergy	$6,846,112	$696,417	$3,232,686	$10,775,215*
EPE	$4,570,498	$191,350	$1,731,256	$6,493,104
Oncor	$46,711,169	$6,305,330	$16,592,374	$69,608,873
SWEPCO	$3,471,272	$640,514	$1,233,504	$5,345,290*
TNMP	$4,350,061	$844,261	$1,340,102	$6,534,424
Xcel SPS	$4,399,285	$415,859	$1,651,543	$6,466,687
Total	**$121,968,130**	**$14,812,741**	**$46,855,844**	**$167,424,472**

*Good Cause Exception granted to customer rate caps set in 16 TAC §25.182(d)(7).

[59] EECRF and other case proceeding expenses are not included.

APPENDIX D: STATUS OF PRIOR EM&V RECOMMENDATIONS

The tables in this appendix summarize the status of the 40 PY2021 EM&V recommendations that utilities were to implement in PY2023. Utilities have been responsive to recommendations, with the majority of recommendations (32 of 40) *complete*. Most recommendations were addressed through TRM updates, utility quality assurance/quality control (QA/QC), and reporting practices. The eight *in-progress* recommendations relate to M&V, commercial consumption analysis, and residential recommendations not assessed in the PY2023 EM&V due to the consumption analysis and responding to changing markets and baselines.

Commercial recommendations addressed lighting and new construction projects, M&V, SOPs, Small Business programs, consumption analysis, and program satisfaction and attribution. Twelve recommendations are complete, while 12 of the 14 recommendations are noted as *complete* due to improvement seen in the PY2023 EM&V, a completed TRM update, or EM&V activity, and both M&V and consumption analysis information are noted as *in progress*.

Table 64. Commercial Program Recommendations for PY2023 Implementation

Category	Key finding and recommendation	Implementation	Status
Lighting	Lighting calculation assumptions did not consistently match participant conditions or equipment detailed specifications. Utilities should reduce lighting savings calculation adjustments by completing a detailed review of the claimed savings calculations' individual line-item assumptions and specifications.	Utilities increased QA/QC of the factors that led to adjustments resulting in decreased lighting savings adjustments in the PY2023 EM&V.	Complete
	Lighting savings calculations did not provide consistent results from calculations for lighting equipment that remained in place and lighting equipment that was removed and not replaced.		
New construction	New construction projects can have unpredictable timelines due to market conditions. The energy-efficient calculations did not consistently match the changing construction timelines.	Utilities increased QA/QC to verify new construction projects between the actual constructed components and the submitted calculations and documentation.	Complete
	New construction lighting projects require the participant to determine the baseline code compliance based upon a scale from *undeveloped* to *downtown area*. A conservative assumption to determine energy savings for new construction would be to select *Zone 2*; however, *Zone 3* is typically picked.	The PY2023 TRM was updated to clarify the selection of the new construction exterior lighting zones and detail the default.	Complete

Category	Key finding and recommendation	Implementation	Status
M&V	The claimed peak demand calculation inconsistently uses the peak demand probability factor (PDPF) *top 20 hours* method for custom savings calculations. Last year's evaluation identified that the *top 20 hours* method was not consistently used.	Increased education for implementers and participants regarding the peak demand calculation method in the TRM and engaging the EM&V team as needed to review upfront have helped address these issues. This is *in progress* as improvement was documented with historical implementers, although new implementers need further support to use the calculation method.	 In progress
	The ideal electric consumption billing-data-measurement frequency is at least hourly. Monthly consumption data is not able to capture the relationship between electricity consumption and independent variables necessary to develop robust models to forecast energy savings.	The TRM Working Group updated the PY2023 TRM 10.0 Volume 4 to require hourly consumption data and create an alternative path for data with less frequency.	 Complete
	The M&V savings process requires that the actual weather conditions at the site be used to develop consumption models based on weather conditions. The identification of historical weather data files and the normalized weather data files does not always match the site conditions.	The TRM Working Group updated the PY2023 TRM 10.0 Volume 4 to indicate the preferred historical acquisition process of the weather data file. The clarification also discusses updating the normalized weather data files.	 Complete
SOPs	The EM&V team found calculation assumptions and documentation did not consistently match participant conditions or equipment specifications.	Utilities increased QA/QC of the factors that led to adjustments resulting in decreased savings adjustments in the PY2023 EM&V.	 Complete
Small business	The documentation for small business programs is streamlined to allow for quick processing for smaller projects. However, the EM&V team found documentation discrepancies, including the wrong location, wrong name, and incorrectly identified existing lighting fixtures. The streamlined nature must consistently collect the participant's name, location, and baseline equipment to maintain program integrity.	Utilities consistently delivered small business participant documentation.	 Complete

Category	Key finding and recommendation	Implementation	Status
	The predominant building type is not consistently identified; two-thirds of the evaluated building type adjustments involved the use of the *service* building type.	Building type selection is consistent with other program types.	 Complete
	Entry and exit door seals continue to be implemented below the standards of other measures.	The *entry and exit door seal* measure documentation met the TRM requirements.	 Complete
Consumption analysis	Lighting retrofit projects are providing significant savings in participants' facilities, and the TRM is reliability estimating these savings.	The PY2021 EM&V scope included consumption analysis that concluded the TRM commercial algorithms are estimating savings accurately.	 Complete
	The limited participant group size creates challenges in subdividing various analysis groups. Further complicating the analysis, participants' consumption patterns varied from the comparison group. Data availability is key to understanding the impacts of energy efficiency projects.	Utilities and the EM&V team should analyze opportunities to increase participant group sizes.	 In progress
Program satisfaction and attribution	The programs are generating high satisfaction among participants (average satisfaction is 4.8 on a 5-point scale). In addition, satisfaction increased substantially from the last survey effort (66 percent in the PY2017 survey were *very satisfied* compared with 88 percent in PY2021).	The EM&V team provided the detailed participant survey results so that utilities would be aware of areas of the programs working well and any opportunities for improvement.	 Complete
	Program attribution, the percentage of claimed savings estimated to directly result from the programs, is high (99 percent for CSOP kilowatt and 100 percent for CMTP kilowatt). In other words, the majority of savings are happening because of the program as opposed to other external factors.	Utilities continue to monitor markets and the TRM Working Group updates baselines to continue to maximize net savings.	 Complete

Residential recommendations are categorized by the Energy Independence Security Act (EISA), deemed savings, HTR/LI programs process assessment, and program satisfaction and attribution. Eleven of the twelve recommendations are noted as c*omplete* through TRM updates and the successful implementation of the new low-income eligibility verification; the one *in progress* recommendation is calculating dual baselines correctly, as the PY2023 EM&V did not include desk reviews of this issue due to the residential consumption analysis.

Table 65. Residential Program Recommendations for PY2023 Implementation

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

Category	Key finding and recommendation	Implementation	Status
	The EM&V team found that, in some cases, summer demand savings were claimed for ACs where the full-load efficiency (EER) requirement of 12 was not met.	Demand savings should not be claimed for AC systems where the EER is less than the minimum standard. Only winter demand savings should be claimed for *HP* systems where the EER is less than the minimum standard.[60]	 Complete
HTR/LI programs process assessment	Expanding the list of other qualifying LI programs and services that qualify for the energy efficiency HTR/LI programs could provide more opportunities for streamlined participation.	The list of qualifying programs and services in the PY2023 TRM HTR/LI program eligibility forms was expanded.	 Complete
	Only individually-metered multifamily units have been eligible since master-metered units are in a commercial rate class. The programs can increase their reach to LI customers by including master-metered multifamily units with qualifying residents.	The individual meter requirement in the PY2023 TRM HTR/LI program eligibility forms was removed.	 Complete
	Geographic location information from the Housing and Urban Development (HUD) LI-qualified census tracts provides streamlined participation and improves outreach to HTR/LI customers.	A *geographic location qualifier* category was added to the PY2023 TRM HTR/LI program eligibility forms.	 Complete
	Many community action agencies and social services organizations throughout Texas are already experienced in qualifying LI households for programs and services.	A section for a community action agency or social service organization to verify program eligibility in the PY2023 TRM HTR/LI program eligibility forms was added.	 Complete
	Without verification of self-reported income for those who chose to qualify for the program through this option, there is the potential for program services to go to non-LI customers.	Processes verified income eligibility prior to participation for customers who use self-reported income in PY2023, although there are very few participants.	 Complete

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

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

All load management recommendations are complete. The PY2021 EM&V had three recommendations for calculating impacts and clarifying program eligibility, which were addressed through TRM updates. Two process recommendations were included in the PY2022 EM&V process evaluation of the load management programs.

Table 66. Load Management Program Recommendations for PY2023 Implementation

Category	Key finding and recommendation	Implementation	Status
Commercial	Consider using the results of the annual test event to modify program-contract estimates of available demand reduction and the test and actual events to identify any non-performers who should not be future participants.	The EM&V team conducted a process evaluation of the load management programs as part of the PY2022 evaluation that assessed compliance with events.	 Complete
	There is considerable stakeholder interest in utility load management programs. Utilities should provide online access to program manuals and update these manuals annually to foster a clear understanding of the program operations.	The EM&V team PY2022 process evaluation found manuals updated and available online.	 Complete

Category	Key finding and recommendation	Implementation	Status
Residential	Load management programs continue to effectively increase demand savings and participation. While a relatively low number of meters to date have had missing data, The TRM does not address how to handle missing data for baseline or event days.	The TRM Working Group updated the PY2023 TRM, clarifying how to handle missing data.	Complete
	TRM language related to the *deemed savings* method has been revised over the past few years, and there is now a mutual understanding of the approach; however, the participation documentation could be improved.	The utility using deemed savings provided a file that identified participating smart thermostat devices, including a description of the data fields and the calculation approach.	Complete
	For the *deemed savings* method, there was some confusion on how to claim savings for smart thermostat devices sold through the online marketplace and smart thermostat devices that were not enrolled in the residential load management program at the point of purchase.	The utility is using deemed kilowatt-hour savings for smart thermostat devices that did not enroll during the summer season through the smart thermostat or retail MTPs.	Complete

Portfolio and cross-sector recommendations included market trends, savings opportunities, program tracking data, meter data, and project documentation. Three of the recommendations are *in progress* as the PY2023 EM&V research found opportunities for improvement in responding to changing markets and pursuing new savings opportunities as the programs respond to increased baselines from which to claim savings. For program tracking and project documentation, four recommendations are noted as *complete* due to process improvements put in place, while two are still *in progress.*

Table 67. Portfolio and Cross-Sector Recommendations for PY2023 Implementation

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

Category	Key finding and recommendation	Implementation	Status
	Utilities continued their commitment to diversifying the types of measures delivered through the existing programs as well as new pilots (i.e., installing efficient HVAC in multifamily and new homes and efficient commercial food service equipment). Utilities also continued to expand the types of distribution channels used to reach customers, delivering energy efficiency by working with retailers, distributors, and contractors, as well as adding online offerings.	Adapt programs and measures based on marketplace dynamics and trends, needs of underserved communities, and changes in federal standards and codes.	 In progress
Savings opportunities	The previously referenced EISA changes will decrease demand reductions (kilowatts) available through the programs by about 14 percent, with most of this in the residential sector. Utilities will need to pursue additional savings from other measures to address the impacts of the new regulations on overall savings and continue to meet goals. Identified measures include *smart thermostats*, *lighting controls*, *HP water heaters*, programs utilizing *AMI data*, *mini-splits*, *recommissioning*, and *variable refrigerant flow*.	Expand existing measure offerings and continue to explore potential new measures, engaging the EM&V team as needed. PY2023 saw decreased kilowatt and kilowatt-hour savings as the programs adjusted to the new standards.	 In progress
Program tracking data	The EM&V team loads tracking data received from utilities each quarter by an automated process. Inconsistency in the data format or programs for which data is submitted from quarter to quarter resulted in custom programming for the data to be loaded.	Consider the development of a standard query that is re-run each quarter to capture updated data for the EM&V team; this will guarantee consistency between data request submittals.	 In progress
	Mapping submitted program data to energy efficiency plans and reports (EEPR) can be difficult. The differences in data are also likely to go undiscovered until after the last data submission when reconciliation happens.	Utilities and the EM&V team successfully mapped all potential data names to EEPR names for the program year as part of the first data request, making the final reconciliation of savings numbers more streamlined.	 Complete

Category	Key finding and recommendation	Implementation	Status
	Similar to program mapping, the identification of missing information within the data, such as estimated useful life (EUL) details or too-general roll-ups of measures, may go undiscovered until the end-of-year analysis.	Measure-level documentation and communication have greatly improved, minimizing PY2023 cost-effectiveness calculation issues.	 Complete
Meter data	AMI meter data transfers can be more complicated than program tracking data transfers.	IOUs with AMI meter data and the EM&V team successfully worked through data transfers.	 Complete
Project documentation	The EM&V team found that, in many cases, the documentation verifying residential heating type, particularly electric resistance, was limited; this was an important recommendation from the PY2019 consumption analysis and was to be fully implemented in PY2021.	Educate service providers on TRM documentation requirements and check their compliance with heating type, specifically.	 In progress
	Challenges for utility M&V inspections continued in PY2021. Commercial projects were less likely to have inspection notes documented, and when inspection notes were provided, the findings were not consistently incorporated into the final documentation and tracking system.	Inspection notes were provided and incorporated into final savings.	 Complete

APPENDIX E: PRIORITIZATION TABLES

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

Table 68. Evaluation Prioritization Summary—Commercial Sector

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

Table 69. Evaluation Prioritization Summary—Residential Sector

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

	Program type		
	Residential SOP	HTR/LI	New homes MTP
PY2022 evaluation priority and activity	Medium: desk reviews and on-site M&V	High: desk reviews and on-site M&V, LI/HTR process improvement interviews	Medium: desk reviews
PY2023 evaluation priority and activity	High: consumption analyses[61] of updated measures and participant surveys		High: desk reviews, builder and rater interviews

Table 70. Evaluation Prioritization and Summary—Upstream, Midstream, Pilots, Other

	Program type	
	Upstream or midstream MTPs	Other MTPs, pilots
Percentage of PY2019 savings IOU (kilowatt/kilowatt-hour)	6 percent of IOU demand reductions and 16 percent of IOU energy savings	1 percent of IOU demand reductions and 1 percent of IOU energy savings
PY2020 evaluation priority and activity	Low: tracking system review	Low or medium/TBD
PY2021 evaluation priority and activity	Low: tracking system review	Low or medium/TBD
PY2022 evaluation priority and activity	Low: tracking system review	Low or medium/TBD
PY2023 evaluation priority and activity	High: desk reviews for high-impact measures	Low or medium/TBD—the Oncor Strategic Energy Management pilot will continue as a *medium* priority

Table 71. Evaluation Prioritization and Summary—Load Management and Cross-Sector

	Program type		
	Load management programs (residential and nonresidential)	AC tune-ups (residential and nonresidential)	Photovoltaic (PV)
Percentage of PY2019 savings IOU (kilowatt/kilowatt-hour)	60 percent of IOU demand reductions and <1 percent of IOU energy savings	2 percent of IOU demand reductions and 3 percent of IOU energy savings	<1 percent of IOU demand reductions and 2 percent of IOU energy savings
PY2020 evaluation priority and activity	Medium: census interval meter-data analysis	Low: tracking system review and verification	Medium: review of M&V calculations
PY2021 evaluation priority and activity	Medium: census interval meter-data analysis	Low: tracking system review and verification	Low: tracking system review

[61] The residential consumption analyses included the following utilities with interval meter data given the importance of measuring kilowatt impacts: AEP, CenterPoint, Entergy, Oncor, TNMP.

	Program type		
	Load management programs (residential and nonresidential)	**AC tune-ups (residential and nonresidential)**	**Photovoltaic (PV)**
PY2022 evaluation priority and activity	High: census interval meter-data analysis, aggregator interviews, and participant surveys (70 residential and 70 commercial)	Medium: census review of M&V data and desk reviews	Medium: review of M&V data and desk reviews (PV storage change)
PY2023 evaluation priority and activity	Medium: census interval meter-data analysis	High: tracking system review and verification, desk reviews	Low: tracking system review

Public Utility Commission of Texas

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TETRA TECH

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GLOSSARY: ACRONYMS/ABBREVIATIONS/DEFINITIONS

Acronym	Description
AC	Air conditioner
AEP Texas	American Electric Power Texas
AHRI	Air Conditioning, Heating, and Refrigeration Institute
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
DLC	DesignLights Consortium
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
EM&V	Evaluation, measurement, and verification
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 ID
ESNH	ENERGY STAR® New Homes
EUL	Estimated useful life
EUMMOT	Electric Utility Marketing Managers of Texas
GSHP	Ground-source heat pump
HCIF	Heating/cooling interactive factor
HOU	Hours of use

Acronym	Description
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
Oncor	Oncor Electric Delivery Company LLC
PUCT	Public Utility Commission of Texas
PV	Photovoltaics
PY	Program year
QA/QC	Quality assurance/quality control
QPL	Qualified Products List
RCx	Retro-commissioning
RFP	Request for proposal
RMTP	Residential market transformation program
ROB	Replace-on-burnout
RSOP	Residential standard offer program
SIR	Savings-to-investment ratio
SOP	Standard offer program
SRA	Self-report approach
SWEPCO	Southwestern Electric Power Company
TMY	Typical meteorological year
TEESI	Texas Energy Engineering Services, Inc.
TNMP	Texas-New Mexico Power Company

Acronym	Description
TRM	Technical reference manual
WACC	Weighted average cost of capital
Xcel Energy SPS	Xcel Energy Southwest Public Service, Inc.

1.0 INTRODUCTION

This document presents the third-party evaluation, measurement, and verification (EM&V) for the ERCOT utilities – specifically, the impact evaluation results for energy efficiency portfolios implemented in program year (PY) 2023 (PY2023). Each section begins with a past five-year trend analysis for the utility energy efficiency portfolio in order to provide additional context for PY2023 results. Volume 2 is a companion document to Volume 1 of the Investor-Owned Utilities (IOUs) PY2023 Energy Efficiency Portfolio Report, and Volume 3 presents similar data for the outside-of-ERCOT utilities.

PY2023 marks the twelfth year of Tetra Tech serving as the Public Utility Commission of Texas' (PUCT) EM&V contractor. The PY2023 scope included targeted impact evaluations of projects where savings have the highest uncertainties identified by prior EM&V results or changes in programs or technologies. The targeted impact evaluation focused on certain commercial and residential programs, including different end-use measures (e.g., HVAC, lighting, refrigeration), while a combination of interval meter data analysis and tracking system reviews provided a due diligence of claimed savings on the portfolio of each utility.

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

The EM&V plans[1] for PY2023 were based on the EM&V prioritization. Programs across all utilities with similar program design, delivery, or target markets were identified by the EM&V team, reviewed by type, and prioritized (*high*, *medium,* or *low*) based on the following considerations:

- magnitude of savings—the percentage of contribution to the portfolio of programs' impacts,
- level of relative uncertainty in estimated savings,
- level and value of existing quality assurance/quality control (QA/QC), and verification data from on-site inspections completed by utilities or by their contractors,
- stage of the program or programmatic component (e.g., pilot, early implementation, mature),
- importance to future portfolio performance,
- priorities for PUCT and utilities, prior EM&V results, and upcoming changes in the markets in which the programs operate.

Sections 2.0 through 5.0 detail the EM&V results for each utility's portfolio.

Appendix A describes the PY2023 EM&V methodology. Appendix B contains the visual representation of the EM&V database import, review, and validation process. Appendix C contains the cost-effectiveness calculations methodology used for the program administrator cost test (PACT).[2] Appendix D contains the quality assurance plan for the reported evaluated savings.

[1] See separate Report Appendix: Public Utility Commission of Texas EM&V Plans for Texas Utilities' Energy Efficiency and Load Management Portfolios—Program Year 2023, June 2023.

[2] Also known as the utility cost test.

2.0 AMERICAN ELECTRIC POWER TEXAS IMPACT EVALUATION RESULTS

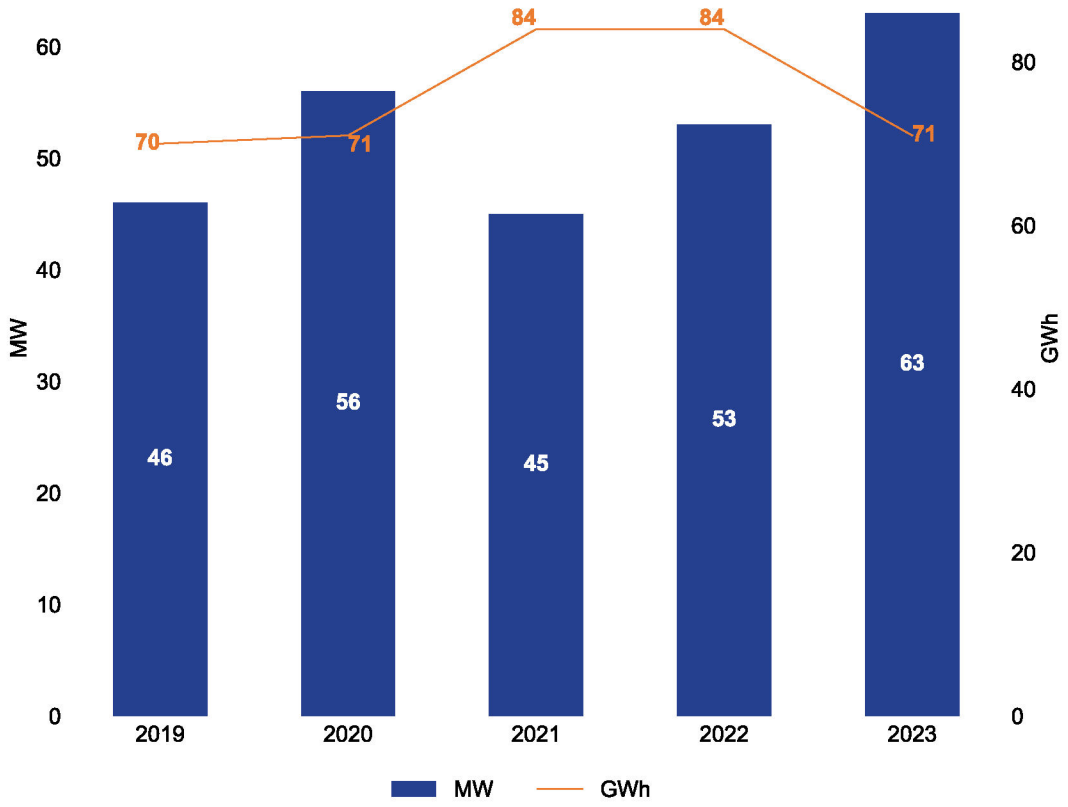
2.1 YEAR-OVER-YEAR COMPARISONS

This section provides a trend analysis for American Electric Power Texas' (AEP Texas) program performances during program year (PY) 2019 (PY2019) through PY2023. This trend analysis provides insight into the PY2023 results included in Sections 2.2 through 2.9.

2.1.1 PY2019–PY2023

PY2023 saw a slight increase in demand reductions and a decrease in energy savings across AEP Texas' portfolio (Figure 1). The addition of a new winter load management program helped AEP Texas achieve an increase in demand reductions. New federal standards in lighting and air conditioners came into effect in PY2023, decreasing energy savings. Overall, savings in PY2023 were consistent with savings in PY2019-PY2020.

Figure 1. AEP Texas Demand Reduction and Energy Savings across Program Year



Load management programs achieved the largest demand reductions for AEP Texas at 62.8 percent of its PY2023 demand reduction goal (Figure 2, left). Compared to the other ERCOT utilities, AEP Texas achieved more of their demand reduction goal through energy efficiency measures and programs—37.2 percent compared to the ERCOT IOU average of 29.8 percent.[3] Commercial market transformation programs' savings (MTP) provided the second largest demand reductions, followed by Residential MTPs.

- **Recommendation:** The PUCT and evaluation, measurement, and verification (EM&V) team should discuss AEP Texas' successful strategies used to achieve over one-third of portfolio savings through energy efficiency and any future plans to increase this percentage.

In PY2023, most of AEP Texas' energy savings (Figure 2 right) were achieved by their commercial MTPs. In contrast, commercial standard offer program (SOP) savings have decreased from prior years, which may be due to the increase in commercial MTPs.

- **Recommendation:** The PUCT and EM&V team should discuss with AEP Texas the reasons for the decrease in commercial SOP savings and future plans for balancing the program design of commercial MTPs and SOPs.

In PY2023, AEP Texas' Residential MTP and SOP delivered more than one-quarter of portfolio savings. In PY2023, low-income (LI) program and hard-to-reach (HTR) program savings have also increased by almost 10 percent from prior years.

- **Recommendation:** While the percentage of residential program savings have been fairly steady in the last two years, the PUCT and EM&V team should understand with AEP Texas what they find to be the right balance of residential SOP and HTR programs across the AEP Texas territory.
- **Recommendation:** The PUCT and EM&V team should discuss with AEP Texas how they have successfully increased savings for LI/HTR customers including differences across the distinct areas within their territory.[4]

[3] PY2023 IOU Energy Efficiency Report Volume 1, Executive Summary, Figure 4.
[4] The consumption analysis indicated strong performance of AEP's LI program (refer to Volume 1 Technical Appendix A).

Figure 2. AEP Texas Demand Reduction and Energy Savings by Program Type[5]

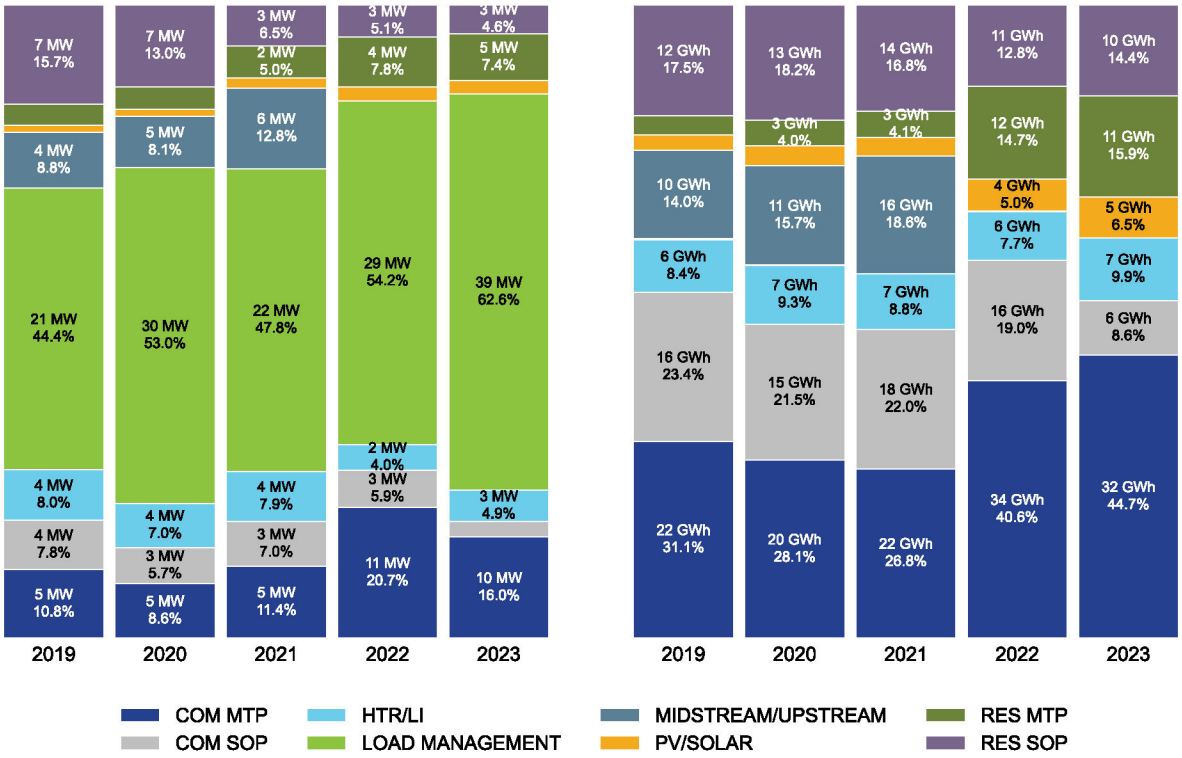
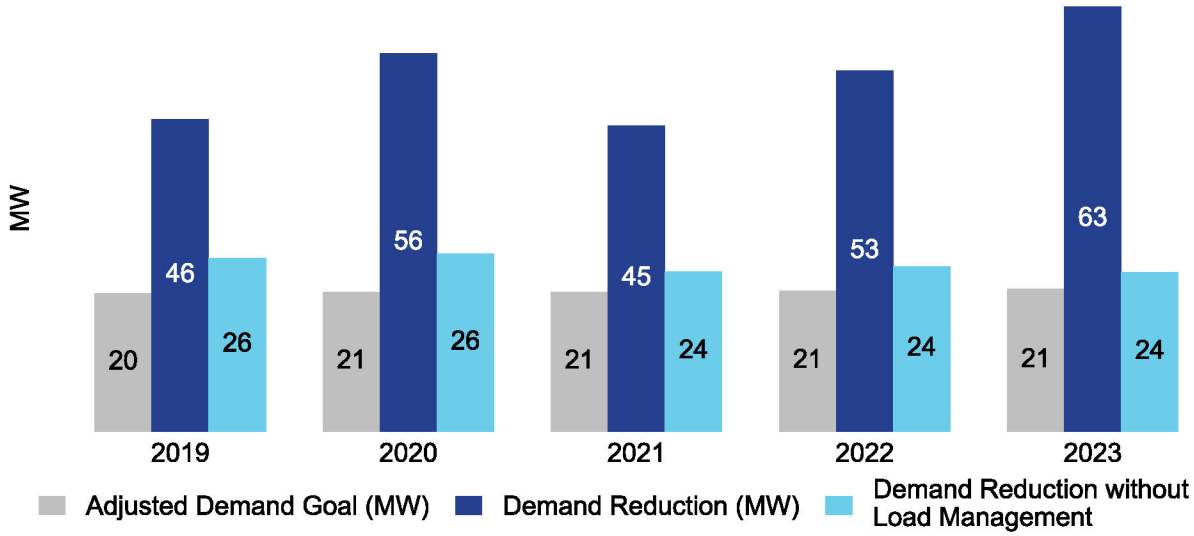


Figure 3 below illustrates how AEP Texas consistently meets their legislated goals through energy efficiency alone unlike the other ERCOT IOUs, AEP has strategically designed its portfolio to achieve the legislated goal for energy efficiency without load management programs.

[5] Demand reductions are reported in megawatts (MW) and energy savings are reported in gigawatt-hours (GWh). EM&V activities and IOU reporting are at the kW and kWh level, larger units are used for visualization purposes.

Figure 3. AEP Texas' PY2019–PY2023 Legislated Goals and Demand Reduction



2.1.1.1 Commercial Savings

In PY2023, the gross savings from AEP Texas' commercial programs (excluding load management) were:

- 11.84 megawatts (MW) of demand reduction and
- 38.62 gigawatt-hours (GWh) of energy savings.

Figure 4 depicts the demand reductions and energy savings from AEP Texas' commercial programs from PY2019 to PY2023, excluding the demand reductions from commercial load management programs. From PY2022 to PY2023, AEP Texas' commercial programs saw a decrease of 2 MWs in demand reductions, bringing the PY2023 demand reductions in-line with PY2019. Additionally, AEP Texas' commercial programs saw a decrease of 11 GWh in energy savings from PY2022 to PY2023.

Figure 4. AEP Texas' Demand Reduction and Energy Savings by Program Year—Commercial Programs, Excluding Load Management, PY2019–PY2023

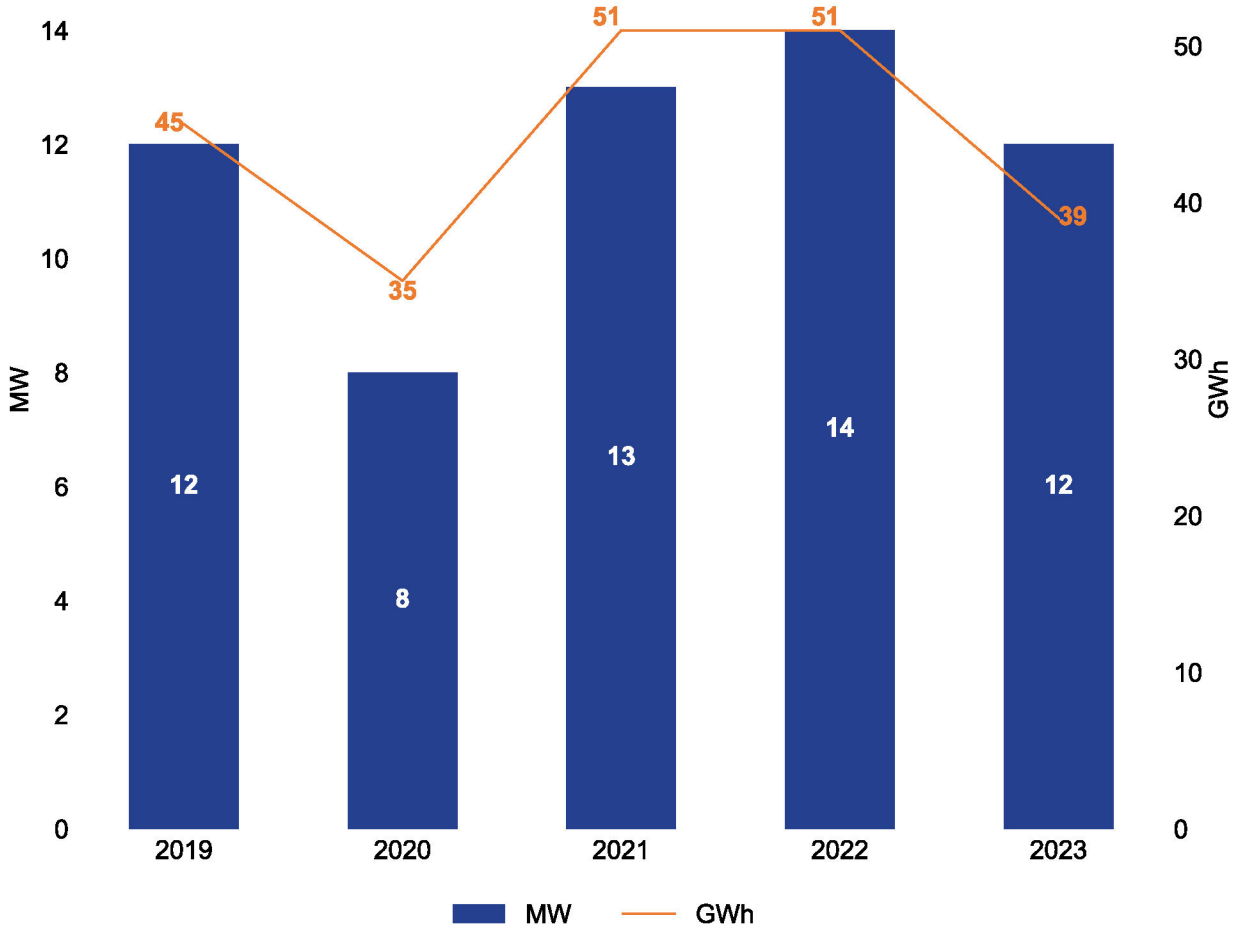
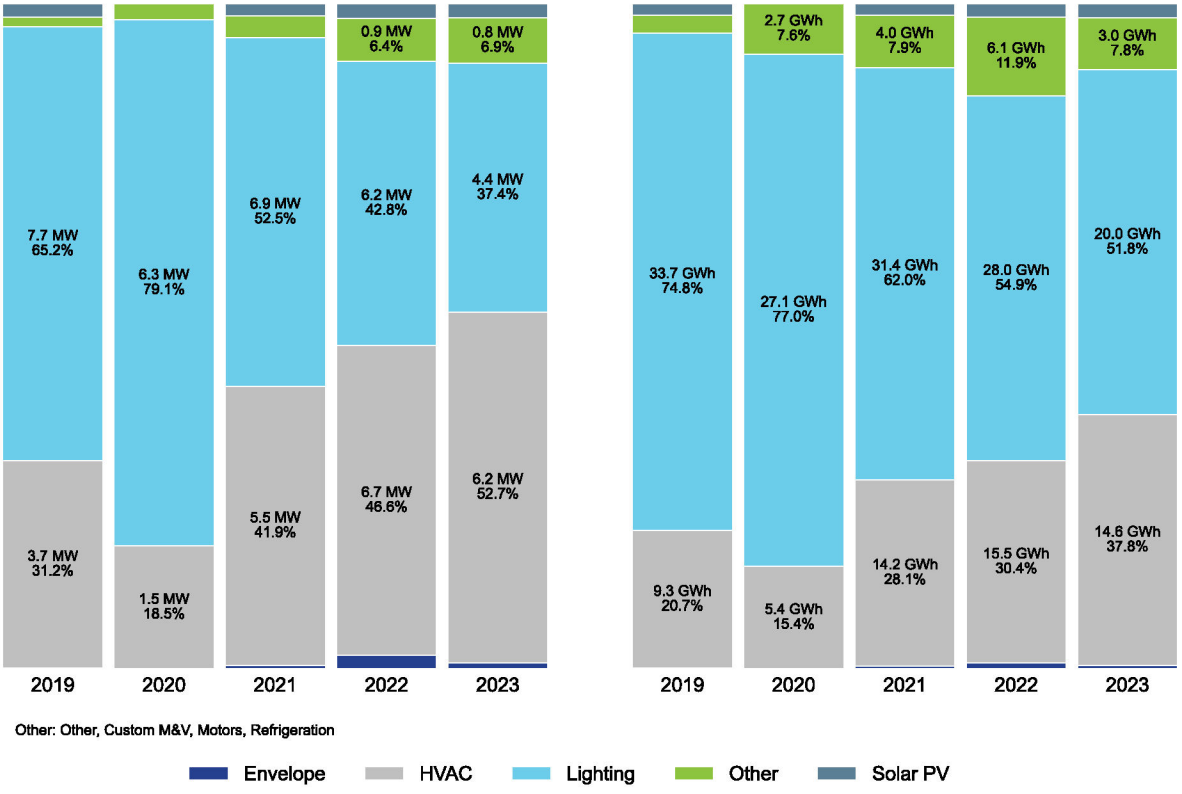


Figure 5 highlights how the proportion of demand reductions and energy savings from *heating, ventilation, and air conditioning* (*HVAC)* measures have continually increased from PY2019 to PY2023, while reductions and savings from *lighting* measures have decreased. *Lighting* measures continue to provide about one-third of demand reductions and one-half of energy savings—37 percent and 52 percent, respectively. Figure 5 also highlights the decrease in *savings from lighting measures* in comparison to *HVAC* measures, indicating that commercial programs are becoming less dependent on *lighting* projects to deliver savings.

- **Recommendation:** The PUCT and EM&V team should discuss with AEP Texas the strategies they have used to successfully increase *HVAC* in their commercial programs, and their future plans to continue diversifying their measures mix beyond *lighting*.

Figure 5. AEP Texas' Demand Reduction and Energy Savings by Measure Category—Commercial Programs, Excluding Load Management, PY2019–PY2023



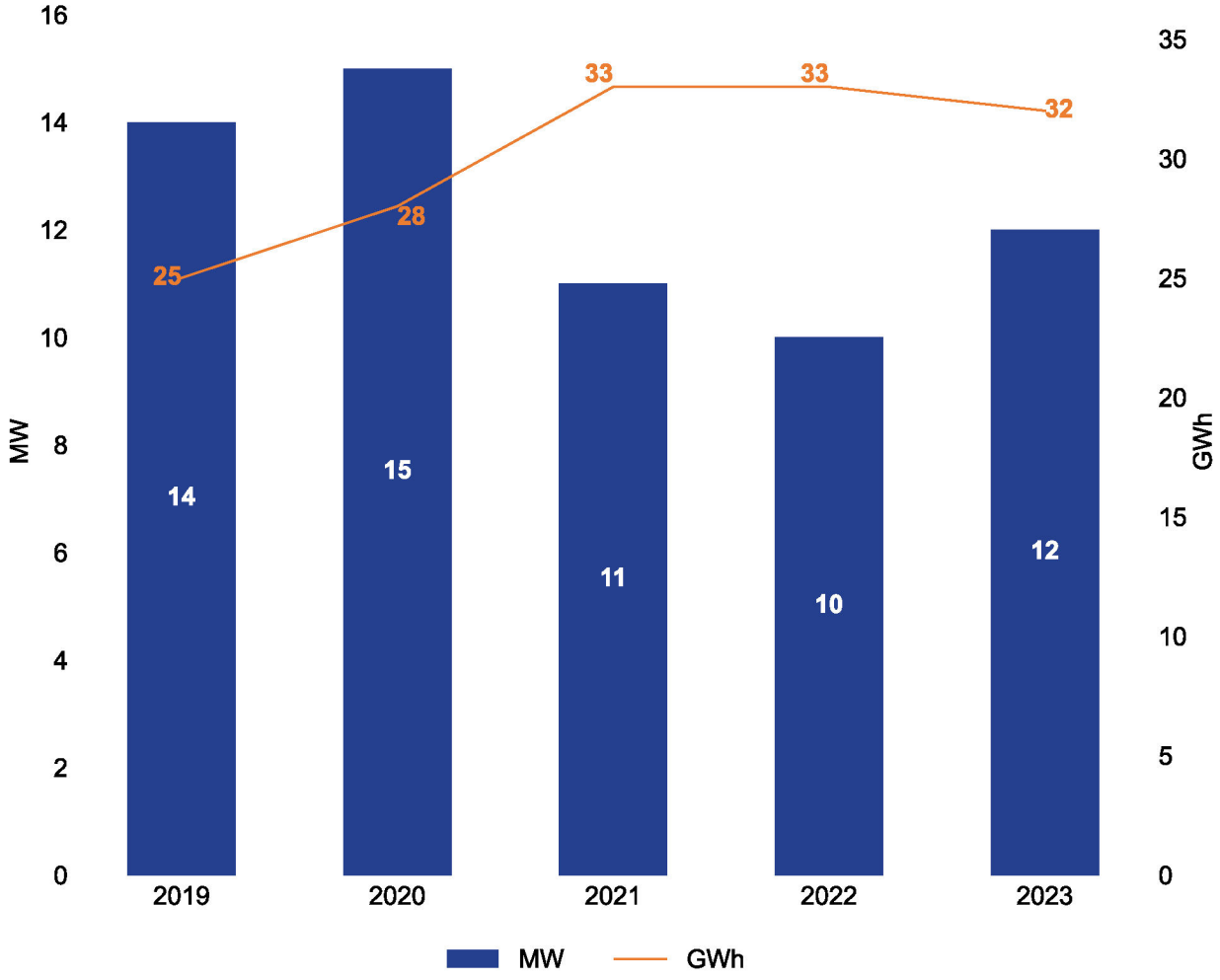
2.1.1.2 Residential Savings

The PY2023 gross savings from AEP Texas' residential sector programs (excluding load management) were:

- 11.688 MW of demand reduction and
- 32.24 GWh of energy savings.

Figure 6 shows an increase in the demand reductions achieved in PY2023 and a decrease in energy savings. Some of the decrease in demand reductions and energy savings for AEP Texas were due to changes in the residential lighting changes to the Energy Independence and Security Act (EISA) backstop in PY2022, new federal standards for HVAC in 2023, and updates to the Texas Technical Reference Manual (TRM) in PY2021 to better align TRM deemed savings with measured savings from the PY2019 consumption analysis .

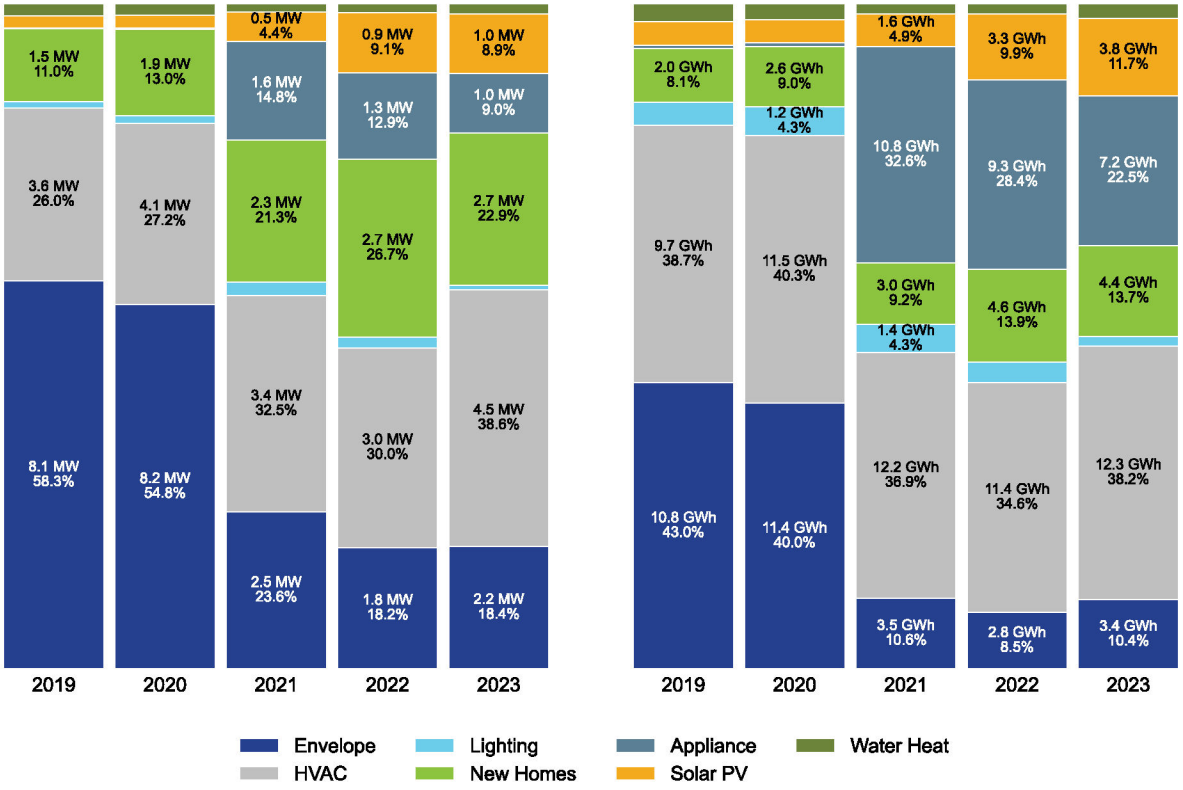
Figure 6. AEP Texas' Demand Reduction and Energy Savings by Program Year—Residential Programs, Excluding Load Management, PY2019–PY2023



For PY2023, AEP Texas' residential demand reductions (excluding load management) and energy savings were primarily derived from *HVAC* measures, at over one-third of both kilowatts (kW) and kilowatt-hours (kWh). Figure 7 shows the breakdown of savings by measure category, establishing *HVAC* measures as the biggest contributor to increased demand reductions and energy savings year over year, followed by *new homes* and *envelope* measures.

- **Recommendation:** The PUCT and EM&V team should discuss with AEP Texas the strategies they have used to successfully increase demand reductions and energy savings from the *HVAC* measure in their residential programs and how they plan to maintain this momentum.

Figure 7. AEP Texas' Demand Reduction and Energy Savings by Measure Category—Residential Programs, Excluding Load Management,PY2019–PY2023



2.1.1.3 Load Management Savings

The PY2023 gross savings from AEP Texas' load management programs were:

- 39.4 MW of demand reduction and
- 0.0394 GWh of energy savings.

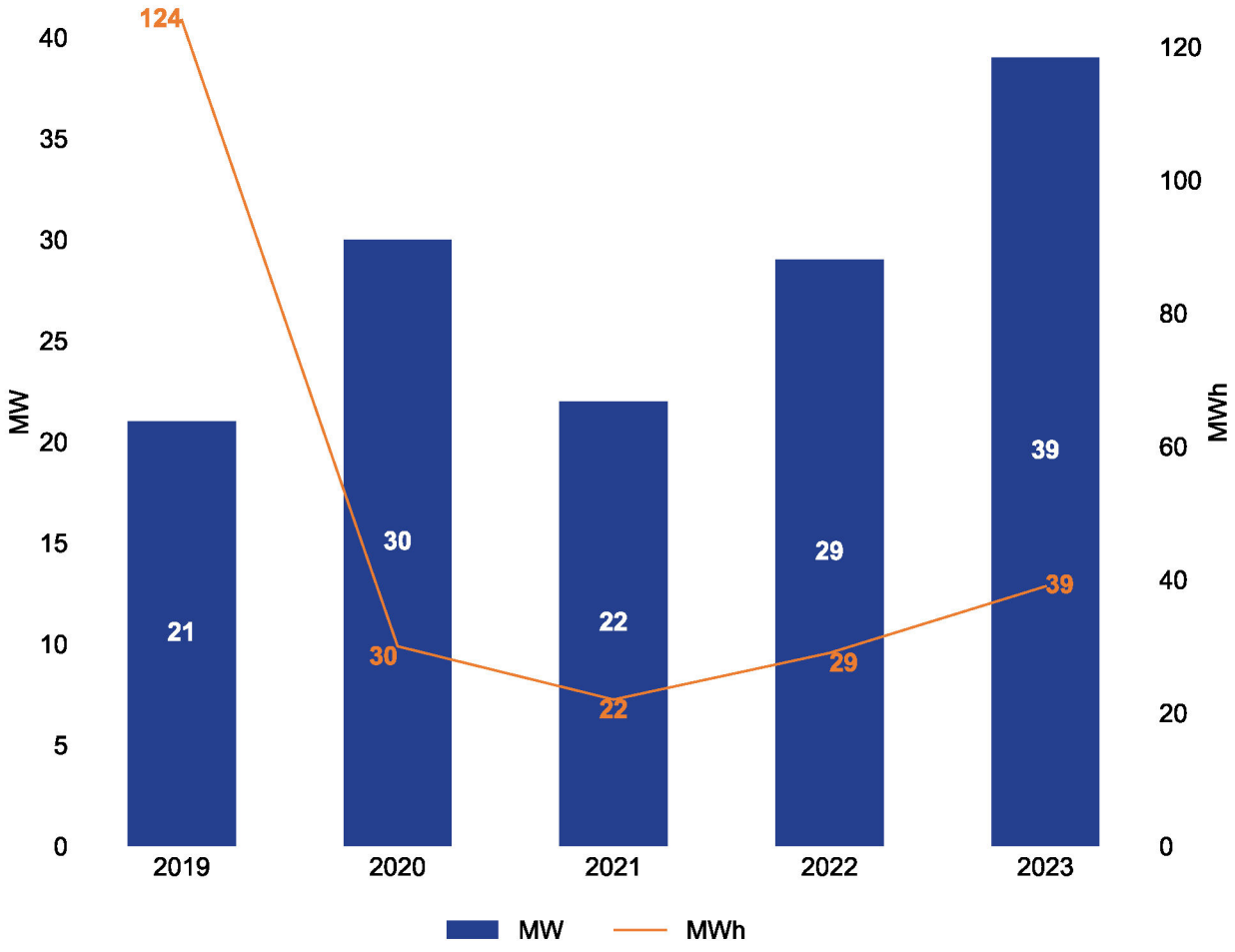
Figure 8 illustrates the demand reductions and energy savings for AEP Texas' load management programs from PY2019-PY2023, showing fairly consistent growth in demand reductions since PY2021. A decrease in program participation contributed to the dip in demand reduction in PY2021. In PY2023, the addition of the winter load management program resulted in a relatively higher increase in demand reductions.

The energy savings derived from load management programs are dependent upon the number of curtailment events called each year and their duration. Except for PY2019, AEP Texas' energy savings from load management programs have followed the pattern of demand reductions over the past few years. In PY2019, there were an increased number of events that resulted in higher energy savings than demand reductions.

Across all eight utilities, AEP achieved the highest cooperation rate—the percent of contracted load relief delivered in response to curtailment events—in its commercial load management program.

- **Recommendation:** The PUCT and EM&V team should discuss with AEP the successful strategies used to achieve a high cooperation rate in their commercial load management program.

Figure 8. AEP Texas' Demand Reduction and Energy Savings by Program Year—Load Management Programs, PY2019–PY2023

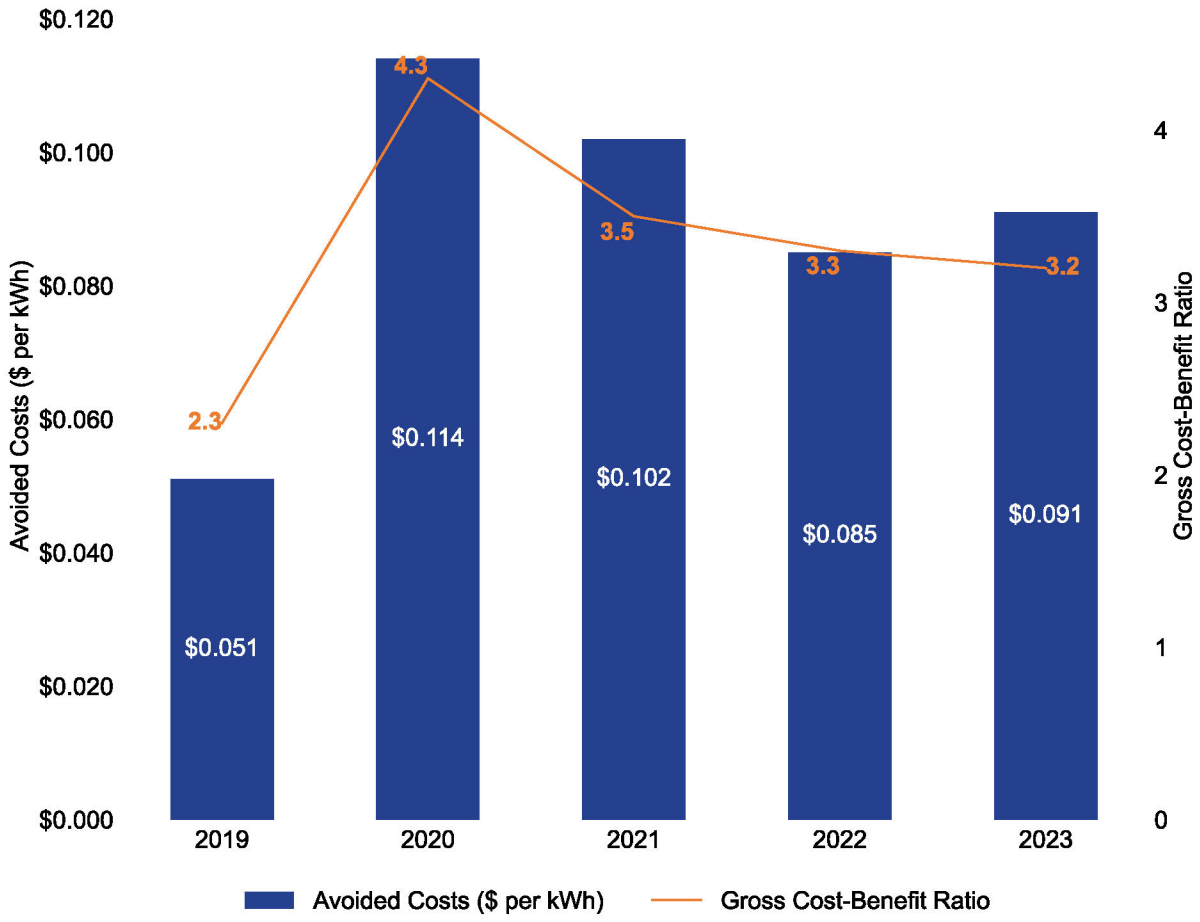


2.1.2 Cost-Effectiveness

Figure 9 overviews the avoided costs and cost-effectiveness ratios for AEP Texas over the last five years.[6]

The overall cost-effectiveness ratio has consistently remained above 2.0 for AEP Texas. While PY2020 saw a high of 4.3, the cumulative cost-effectiveness of AEP Texas' programs remains healthy at 3.2 in PY2023. The cost-effectiveness ratios over the last four years have been high largely due to the higher avoided costs of energy.

Figure 9. AEP Texas' Gross Cost-Benefit Ratio and Avoided Cost by Program Year



2.2 KEY FINDINGS

Section 2.2 presents the evaluated savings and cost-effectiveness results for AEP Texas, both on a portfolio- and program-level. The key findings are summarized first, followed by details for each program with a *high* or *medium* evaluation priority. *Low* evaluation priority programs where claimed savings were only verified through the EM&V database are listed at the end.

[6] IOU program cost-effectiveness tests compare the benefits of the programs to the costs – a ratio over 1.0 representing a cost-effective program. Texas EM&V utilizes the Program Administrator Cost Test to assess cost-effectiveness.

2.2.1 Evaluated Savings

AEP Texas' evaluated savings for PY2023 were 62.9 MW in demand reductions and 70.9 GWh in energy savings. The overall portfolio realization rates are approximately 100 percent. AEP Texas was responsive to all EM&V recommendations to adjust claimed savings based on EM&V results (see Table 4), supporting healthy realization rates.

Table 1 shows the claimed and evaluated demand reductions for AEP Texas' portfolio and broad customer sector and program categories. Load management results are based on census reviews, and therefore precision calculations are not applicable (N/A).

Table 1. AEP Texas PY2023 Claimed and Evaluated Demand Reductions

Level of analysis	Percentage portfolio savings	Claimed demand reductions (kW)	Evaluated demand reductions (kW)	Realization rate (kW)	Precision at 90% confidence
Total portfolio	**100.0%**	**62,923**	**62,930**	**100.0%**	**100.0%**
Commercial	18.8%	11,840	11,840	100.0%	18.8%
Residential	16.0%	10,041	10,048	100.1%	16.0%
Low-income	2.6%	1,646	1,646	100.0%	2.6%
Load management*	62.6%	39,396	39,395	100.0%	62.6%

*The review for the load management program included a census review of equations and interval meter data to estimate the baseline usage and the resulting level of load curtailment achieved for each event for all participants.

Table 2 shows the claimed and evaluated energy savings for AEP Texas' portfolio and broad customer sector and program categories for PY2023.

Table 2. AEP Texas PY2023 Claimed and Evaluated Energy Savings

Level of analysis	Percentage portfolio savings	Claimed energy savings (kWh)	Evaluated energy savings (kWh)	Realization rate (kWh)	Precision at 90% confidence
Total portfolio	**100.0%**	**70,898,720**	**70,898,719**	**100.0%**	**N/A**
Commercial	54.5%	38,621,949	38,621,949	100.0%	N/A
Residential	41.2%	29,206,964	29,206,964	100.0%	N/A
Low-income	4.3%	3,030,412	3,030,412	100.0%	N/A
Load management*	0.1%	39,396	39,395	100.0%	N/A

* The review for the load management program included a census review of equations and interval meter data to estimate the baseline usage and the resulting level of load curtailment achieved for each event for all participants.

Program-level realization rates are discussed in the detailed findings subsections; however, it is important to note that these results should only be viewed qualitatively due to the small sample sizes at the utility program level.

In program-level realization rates, we have also included a qualitative rating of *good*, *fair*, and *limited* associated with the level of program documentation received from the utility. AEP Texas received *good* documentation scores for all evaluated programs.

2.2.2 Program Funding and Cost-Effectiveness Results

AEP Texas' total portfolio funding for PY2023 was $16,666,699 (excluding research and development, EM&V, and their performance bonus), resulting in a cost-effectiveness score of 3.2 (or 3.4, excluding low-income programs[7]).

The more cost-effective programs were the SCORE/CitySmart MTP and the residential SMART Source Solar PV MTP, while the less cost-effective programs were the Winter Load Management SOP and the Commercial Foodservice Pilot MTP.

All of AEP Texas' programs were cost-effective, except for the Commercial Foodservice Pilot MTP. However, the Commercial Foodservice Pilot MTP was first implemented in Q3 of 2023 with no projects completed in PY2023. AEP Texas has reported that there are several completed projects for PY2024 and is expected to pass cost-effectiveness in its second year.

Table 3. AEP Texas Cost-Effectiveness Results

Level of analysis	Claimed savings results	Evaluated savings results	Net savings results
Total portfolio	**3.18**	**3.18**	**2.86**
Total portfolio excluding low-income programs	**3.42**	**3.42**	**3.05**
Commercial	**4.66**	**4.66**	**4.21**
Commercial Solutions MTP	5.31	5.31	4.66
Commercial SOP	4.57	4.57	4.14
CoolSaver A/C Tune-Up MTP	4.02	4.02	3.61
Open MTP	2.90	2.90	2.75
SCORE/CitySmart MTP	6.58	6.58	5.81
SMART Source Solar PV MTP	3.91	3.91	3.95
Residential	**2.88**	**2.88**	**2.50**
CoolSaver A/C Tune-Up MTP	2.57	2.57	2.06
High-Performance New Homes MTP**	5.18	5.18	3.63
Residential SOP	2.13	2.13	1.93
SMART Source Solar PV MTP	5.67	5.67	5.43
Hard-to-Reach SOP	1.95	1.95	1.95

[7] Cost-effectiveness testing for low-income programs uses the Savings-to-Investment ratio as discussed in Appendix C.

Level of analysis	Claimed savings results	Evaluated savings results	Net savings results
Low-income*	**2.99**	**2.99**	**2.99**
Targeted Low-Income Energy Efficiency Program*	2.99	2.99	2.99
Load management	**1.69**	**1.69**	**1.69**
Commercial Load Management SOP	1.74	1.74	1.74
Winter Load Management SOP	1.39	1.39	1.39
Pilot	**0.00**	**0.00**	**0.00**
Commercial Foodservice MTP	0.00	0.00	0.00

* The low-income program is evaluated using the Savings-to-Investment Ratio (SIR).

**Net savings for the High-Performance New Homes MTP will be updated in the final version of this report based on net-to-gross research conducted as part of the PY2023 EM&V scope.

2.3 SAVINGS DIFFERENCES

As discussed above, utilities are provided the opportunity to adjust savings at the project level based on interim EM&V findings.

Table 4 summarizes savings differences identified by the EM&V team, which AEP Texas also used to adjust their claimed savings[8]. AEP Texas adjusted claimed savings for all projects with any differences found by the EM&V team and included these adjustments in their June 1st Energy Efficiency Cost Recovery (EECRF) filing.

Table 4. Claimed Savings Adjustments by Program

Program	EM&V demand claimed savings adjustments (kW)	EM&V energy claimed savings adjustments (kWh)
Commercial Solutions MTP	-2.25	-8,410.00
Commercial SOP	-9.04	-25,875.79
CoolSaver A/C Tune-Up MTP (Residential)	-0.04	-154.00
High-Performance New Homes MTP	-2.49	1,707.30
Open MTP	-21.00	-32,303.00
SCORE/CitySmart MTP	-12.52	-27,152.00
Total	**-47.34**	**-92,187.49**

[8] The EM&V team requests that utilities adjust projects when evaluated and claimed savings differ by more than five percent.

2.4 DETAILED FINDINGS—COMMERCIAL

2.4.1 Commercial Solutions Market Transformation Program (MTP) (Medium Evaluation Priority)

Program contribution to portfolio savings (kW)	Claimed demand reductions (kW)	Evaluated demand reductions (kW)	Realization rate (kW)	Program contribution to portfolio savings (kWh)	Claimed energy savings (kWh)	Evaluated energy savings (kWh)	Realization rate (kWh)	Program documentation score
1.9%	1,192	1,192	100.0%	8.7%	6,164,045	6,164,045	100.0%	Good

Completed desk reviews*	On-site M&V visit
7	3

*Confidence intervals are not reported at the utility program level as these results should only be viewed qualitatively due to the small sample sizes.

The PY2023 Commercial Solutions MTP evaluation efforts focused on desk reviews and on-site M&V visits. The sample of completed desk reviews and on-site M&V visits for this program is listed above.

The EM&V team adjusted the claimed savings for two of the projects as both projects had adjustments greater than five percent. AEP Texas accepted the evaluated results and matched the claimed savings to those of the evaluations for the two projects, resulting in a 100 percent final program realization rate for kilowatt and kilowatt-hour. Further details of the EM&V findings are provided below.

Participant ID 11-1-1-2-61971: A retail and office location installed an exterior lighting retrofit of a shared parking lot. During the desk review and on-site M&V visit, the EM&V team identified one installed fixture type that was not listed on the DesignLights Consortium® (DLC) qualified product list (QPL). This adjustment decreased demand reductions and resulted in a realization rate of 78 percent. The adjustments also decreased energy savings and resulted in a realization rate of 78 percent.

Participant ID 11-1-1-3-134081: A mall installed four new packaged air conditioning (AC) units. During the desk review, the EM&V team adjusted the calculation to use the older rating baseline (energy efficiency rating 1 (EER1)/season energy efficiency rating 1 (SEER1)(EER1/SEER1) for the AC and heat pump equipment under 5.4 tons and adjusted the capacity to match the rated capacities in the calculation. This adjustment decreased demand reductions and resulted in a realization rate of 66 percent. The adjustment also decreased energy savings and resulted in a realization rate of 92 percent.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications) for the seven projects that had desk reviews completed because sufficient documentation was provided for the sites. Most of these were regular lighting projects where documentation included invoices, QPL qualifications, equipment specifications, pre-installation and post-installation inspection notes, project savings calculators, and photographic documentation of existing and new equipment. A couple of projects were missing invoices. Complete documentation enhances the accuracy and transparency of project savings along with ease of evaluation. Overall, the EM&V team was satisfied with the project documentation provided and assigned a program documentation score of *good*.

2.4.2 Commercial Standard Offer Program (SOP) (Medium Evaluation Priority)

Program contribution to portfolio savings (kW)	Claimed demand reductions (kW)	Evaluated demand reductions (kW)	Realization rate (kW)	Program contribution to portfolio savings (kWh)	Claimed energy savings (kWh)	Evaluated energy savings (kWh)	Realization rate (kWh)	Program documentation score
2.5%	1,548	1,548	100.0%	8.6%	6,128,668	6,128,668	100.0%	Good

Completed desk reviews*[9]	On-site M&V visit
8	4

*Confidence intervals are not reported at the utility program level as these results should only be viewed qualitatively due to the small sample sizes.

The PY2023 Commercial SOP evaluation efforts focused on desk reviews and on-site M&V visits. The sample of completed desk reviews and on-site M&V visits for this program is listed above.

The EM&V team adjusted the claimed savings for six projects. Four projects had adjustments of less than five percent compared to the originally claimed savings, while the other two projects had adjustments greater than five percent compared to the originally claimed savings. AEP Texas accepted the evaluated results and matched the claimed savings to those of the evaluations for the six projects; therefore, the final program realization rate is 100 percent for kilowatt and kilowatt-hour. Further details of the EM&V findings are provided below.

Participant ID 11-4-1-2-9039: An office and manufacturing building completed an LED lighting retrofit. During the desk review, the EM&V team adjusted the fixture wattage of one LED fixture based on the DLC QPL. The control device was also removed from the savings calculations for this fixture. These adjustments slightly decreased demand reductions and resulted in a realization rate of 98 percent. The adjustments also slightly decreased energy savings and resulted in a realization rate of 96 percent.

[9] Two projects were located on the same campus and were sampled separately, although they are reported under one EM&V participant.

Participant ID 11-4-1-2-77360: A high school completed an early retirement retrofit for two air-cooled chillers. During the desk review and on-site M&V visit, the EM&V team adjusted the cooling capacity of the new units to match the Air Conditioning, Heating, and Refrigeration Institute (AHRI) tested capacity and the age of the existing units based on the serial number of the existing units. These adjustments decreased demand reductions and resulted in a realization rate of 91 percent. The adjustments also decreased energy savings and resulted in a realization rate of 92 percent.

Participant ID 11-4-1-2-79341: A secondary school installed a new air-cooled chiller in place of an existing unit. During the desk review and on-site M&V visit, the EM&V team adjusted the cooling capacity of the new unit to match the AHRI-tested capacity. This adjustment decreased demand reductions and resulted in a realization rate of 82 percent. The adjustments also slightly decreased energy savings and resulted in a realization rate of 97 percent.

Participant ID 11-4-1-2-79355: An elementary school completed an early retirement retrofit of air-cooled chillers and AC units and installed new motors and variable frequency drives (VFD) on the air handling units. During the desk review and on-site M&V visit, the EM&V team adjusted the baseline efficiencies of the existing AC units to match the prescribed assumptions in the TRM. The EM&V team also adjusted the fan motor hours of operation, load factor, and baseline motor efficiency based on the assumptions in the TRM. Overall, these adjustments slightly increased demand reductions and resulted in a realization rate of 101 percent. The adjustments also slightly increased energy savings and resulted in a realization rate of 101 percent.

Participant ID 11-4-1-2-79881: An elementary school completed an early retirement retrofit of air-cooled chillers and AC units and installed new motors and VFDs on the air handling units. During the desk review and on-site M&V visit, the EM&V team adjusted the baseline efficiencies of the existing AC units to match the prescribed assumptions in the TRM. The EM&V team also adjusted the fan motor hours of operation, load factor, and baseline motor efficiency based on the assumptions in the TRM. Overall, these adjustments slightly increased demand reductions and resulted in a realization rate of 101 percent. The adjustments also slightly increased energy savings and resulted in the realization rate rounding to 100 percent.

Participant ID 11-4-1-3-64925: A retail building installed new lighting and HVAC units for a major renovation of a building. During the desk review, the EM&V team adjusted the building type for both the *lighting* and *HVAC* measures based on the building description. Additionally, the EM&V team adjusted the efficiencies of the HVAC equipment to the newer rating baselines (EER2/SEER2) and adjusted the capacity to match the AHRI-rated value. Lastly, the EM&V team identified one installed fixture that was not listed within the DLC QPL. Overall, these adjustments slightly decreased demand reductions and resulted in a realization rate of 96 percent. The adjustments also decreased energy savings and resulted in a realization rate of 97 percent.

Documentation Score

The EM&V team verified key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications) for the eight projects that had desk reviews completed because sufficient documentation was provided for the sites. Project documentation at these sites included invoices, QPL qualifications, pre-installation and post-installation inspection notes, project savings calculators, and photographic documentation of existing and new equipment. Complete documentation enhances the accuracy and transparency of project savings and ease of evaluation. One project had missing photos, and another project had no post-inspection. Overall, the EM&V team assigned a program documentation score of *good*.

2.4.3 SCORE/CitySmart Market Transformation Program (MTP) (Medium Evaluation Priority)

Program contribution to portfolio savings (kW)	Claimed demand reductions (kW)	Evaluated demand reductions (kW)	Realization rate (kW)	Program contribution to portfolio savings (kWh)	Claimed energy savings (kWh)	Evaluated energy savings (kWh)	Realization rate (kWh)	Program documentation score
4.1%	2,579	2,579	100.0%	14.7%	10,419,334	10,419,334	100.0%	Good

Completed desk reviews*	On-site M&V visit
8	4

*Confidence intervals are not reported at the utility program level as these results should only be viewed qualitatively due to the small sample sizes.

The PY2023 SCORE/CitySmart MTP evaluation efforts focused on desk reviews and on-site M&V visits. The sample of completed desk reviews and on-site M&V visits for this program is listed above.

The EM&V team adjusted the claimed savings for two projects as both projects had an adjustment of greater than five percent. AEP Texas accepted the evaluated results and matched the claimed savings to those of the evaluations for the two projects with significant adjustments. Therefore, the final program realization rate is 100 percent for kilowatt and kilowatt-hour. Further details of the EM&V findings are provided below.

Participant ID 11-1-1-2-63172: A high school replaced air-cooled rooftop HVAC units. During the desk review and on-site M&V visit, the EM&V team calculated the savings using the EER1/SEER1 version of the calculator because the newly installed units did not have EER2/SEER2 AHRI ratings. This adjustment decreased demand reductions and resulted in a realization rate of 93 percent. The adjustment also slightly decreased energy savings and resulted in a realization rate of 99 percent.

Participant ID 11-1-1-3-66758: A new construction high school installed interior and exterior LED lighting. During the desk review, the EM&V team adjusted the exterior lighting zone because the school was located in a primarily residential area. The EM&V team also adjusted three lighting fixture assumptions; two fixtures were identified as non-qualified, and the fixture wattage on the other was adjusted to match the DLC QPL listing. Overall, these adjustments decreased demand reductions and resulted in a realization rate of 78 percent. The adjustments also decreased energy savings and resulted in a realization rate of 83 percent.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications, and AHRI certifications) for the eight projects that had desk reviews because sufficient documentation was provided for the sites. Project documentation included invoices, QPL qualifications, equipment specifications, pre-installation and post-installation inspection notes, project savings calculators, and photographic documentation of existing and new equipment, which are significant efforts by the utility to verify equipment conditions and quantities. A couple of projects were missing specification sheets and invoices. Complete documentation enhances the accuracy and transparency of project savings and ease of evaluation. Overall, the EM&V team assigned a program documentation score of *good*.

2.4.4 Open Market Transformation Program (MTP) (Medium Evaluation Priority)

Program contribution to portfolio savings (kW)	Claimed demand reductions (kW)	Evaluated demand reductions (kW)	Realization rate (kW)	Program contribution to portfolio savings (kWh)	Claimed energy savings (kWh)	Evaluated energy savings (kWh)	Realization rate (kWh)	Program documentation score
2.2%	1,354	1,354	100.0%	6.9%	4,915,529	4,915,529	100.0%	Good

Completed desk reviews*	On-site M&V visit
8	4

*Confidence intervals are not reported at the utility program level as these results should only be viewed qualitatively due to the small sample sizes.

The PY2023 Open MTP evaluation efforts focused on desk reviews and on-site M&V visits. The sample of completed desk reviews and on-site M&V visits for this program is listed above.

The EM&V team adjusted the claimed savings for five projects. Two projects had an adjustment of less than five percent, while the other three projects had an adjustment of greater than five percent compared to the originally claimed savings. AEP Texas accepted the evaluated results and matched the claimed savings to those of the evaluations for the projects with significant adjustments. Therefore, the final program realization rate is 100 percent for kilowatt and kilowatt-hour. Further details of the EM&V findings are provided below.

Participant ID 11-1-1-2-14804: A warehouse completed an interior and exterior LED lighting retrofit. During the desk review, the EM&V team identified that the baseline equipment had daylighting sensors, but the sensors were not replaced. This adjustment decreased demand reductions and resulted in a realization rate of 94 percent. The adjustment also decreased energy savings and resulted in a realization rate of 95 percent.

Participant ID 11-1-1-2-62609: A retail store in a strip mall completed an interior LED lighting retrofit. During the desk review, two fixtures were identified as non-operating in the baseline equipment, and two 8-lamp fixtures were adjusted to four 4-lamp fixtures. These adjustments slightly decreased demand reductions and resulted in a realization rate of 95 percent. The adjustments also slightly decreased energy savings and resulted in a realization rate of 95 percent.

Participant ID 11-1-1-2-78287: A retail building completed an interior LED lighting retrofit. During the desk review, the EM&V team adjusted the baseline ballast factor on fluorescent lighting to a normal ballast factor. This adjustment decreased the demand reductions and resulted in a realization rate of 95 percent. The adjustments also decreased the energy savings and resulted in a realization rate of 95 percent.

Participant ID 11-1-1-2-79643: A warehouse completed an interior and exterior LED lighting retrofit. During the desk review, the EM&V team adjusted an efficient LED fixture wattage from 163 W to 164 W based on the DLC QPL. This adjustment slightly decreased the pe demand reductions and resulted in a realization rate that rounded to 100 percent. The adjustments also decreased the energy savings and resulted in a realization rate that rounded to 100 percent.

Participant ID 11-1-1-3-66050: A motel installed new weatherstripping around all exterior doors. During the desk review and on-site M&V visit, the EM&V team identified doors that had partial, existing, functional weatherstripping. The EM&V team adjusted the calculation so that the gap was measured based on the existing conditions of the weatherstripping. These adjustments decreased the demand reductions and resulted in a realization rate of 60 percent. The adjustments also decreased the energy savings and resulted in a realization rate of 60 percent.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications, and AHRI certifications) for all the projects that had desk reviews because sufficient documentation was provided for the sites. Project documentation included invoices, QPL qualifications, equipment specifications, pre-installation and post-installation inspection notes, project savings calculators, and photographic documentation of existing and new equipment, which are significant efforts by the utility to verify equipment conditions and quantities. Most of the lighting projects were missing specification sheets and certifications of the installed fixtures that were identified through the model numbers. A couple of projects were missing inspection notes and photos, although they were not critical to the evaluation. Complete documentation enhances the accuracy and transparency of project savings and ease of evaluation. Overall, the EM&V team assigned a program documentation score of *good*.

2.5 DETAILED FINDINGS—RESIDENTIAL

The PY2023 evaluation's primary focus was on a retrofit consumption analysis. Therefore, the scope and related findings in the following sections are limited. All residential programs and subprograms included in the consumption analysis received a tracking system review for program impacts, which included verification of claimed savings against the final PY2023 tracking data provided to the EM&V team for the EM&V database.

2.5.1 High-Performance New Homes Market Transformation Program (MTP)

Program contribution to portfolio savings (kW)	Claimed demand reductions (kW)	Evaluated demand reductions (kW)	Realization rate (kW)	Program contribution to portfolio savings (kWh)	Claimed energy savings (kWh)	Evaluated energy savings (kWh)	Realization rate (kWh)	Program documentation score
4.3%	2,695	2,702	100.3%	6.4%	4,551,687	4,551,687	100.0%	Good

Completed desk reviews*
5

*Confidence intervals are not reported at the utility program level as these results should only be viewed qualitatively due to the small sample sizes.

The PY2023 High-Performance New Homes MTP evaluation efforts focused on desk reviews. The number of completed desk reviews for this program is listed above. Five desk reviews were completed to check that the measure data and documentation collected by contractors aligned correctly with that in the tracking system, and savings were calculated in accordance with the TRM.

The EM&V team adjusted the total claimed savings for three projects. The three projects had adjustments of less than five percent compared to the originally claimed savings, and AEP Texas did not adjust to match the evaluated savings. Therefore, the final program realization rate is 100.3 percent and 100.0 percent for kilowatt and kilowatt-hour, respectively. Further details of the EM&V findings are provided below.

During the desk review process, the EM&V team identified substantial differences between the savings reported in the documentation provided and the ex-ante savings reported by the utility for all five of the sampled projects. After discussions with the EM&V team, the implementer identified a program-wide error in their system, causing the tracking system to report different ex-ante savings than calculated in the documentation, affecting all projects reported in the High-Performance New Homes MTP for PY2023. The EM&V team received corrected data from the implementer and evaluated savings using the new data, resulting in a slight adjustment to three projects.

Documentation Score

The EM&V team was able to verify key inputs and assumptions for the five projects that had desk reviews. Project documentation at these sites included a Home Energy Rating System (HERS) certificate, fuel summary reports, and new equipment specifications. Complete documentation enhances the accuracy and transparency of project savings along with ease of evaluation. Overall, the EM&V team assigned a program documentation score of *good*.

2.6 DETAILED FINDINGS—LOAD MANAGEMENT

2.6.1 Commercial Load Management Standard Offer Program (SOP) (Medium Evaluation Priority)

Program contribution to portfolio savings (kW)	Claimed demand reductions (kW)	Evaluated demand reductions (kW)	Realization rate (kW)	Program contribution to portfolio savings (kWh)	Claimed energy savings (kWh)	Evaluated energy savings (kWh)	Realization rate (kWh)	Program documentation score
55.8%	35,115	35,115	100.0%	0.1%	35,115	35,115	100.0%	Good

Completed desk reviews*
N/A

*The review for the load management program included a census review of equations and interval meter data to estimate the baseline usage and the resulting level of load curtailment achieved for each event for all participants.

The EM&V team evaluated the AEP Texas Commercial Load Management SOP by applying the TRM calculation methodology to interval meter data. In PY2023, the meter data were supplied in 15-minute increments. Load management events occurred on the following dates and times shown by AEP Texas' Southern and Northern territories:

- Southern territory:
  - June 6, 2023, from 4:00 p.m. to 5:00 p.m. (scheduled[10]),
  - June 22, 2023, from 4:00 p.m. to 5:00 p.m. (scheduled), and
  - August 15, 2023, from 1:00 p.m. to 2:00 p.m. (scheduled).

- Northern territory:
  - June 6, 2023, from 4:00 p.m. to 5:00 p.m. (scheduled), and
  - June 22, 2023, from 4:00 p.m. to 5:00 p.m. (scheduled).

There were no unscheduled events in PY2023. The EM&V team received the interval meter data and a spreadsheet that summarized the event-level savings for the nineteen sponsors across 385 sites. Twenty-four sites did not participate in any of the scheduled events. All sponsors had at least one site that curtailed during each event[11].

After the EM&V team applied the *High 5 of 10* baseline calculation method, it was found that the evaluated savings matched the savings provided for all sites. The kilowatt savings for each participating site corresponded to the kilowatt reductions that occurred at the scheduled event (no averaging was necessary because each participating site participated in only one event). The kilowatt-hour savings for each participating site were calculated by multiplying the kilowatt reductions by the total number of event hours. Program-level savings were calculated by adding all site-level savings.

[10] Scheduled events are IOU program test events to ensure equipment is working and customers know how to respond whereas unscheduled events are for ERCOT Energy Emergency Alert Level 2 (EEA2) or system reliability.

[11] See the Report Volume 1 recommendation to monitor load management cooperation rates.

The table above shows the EM&V team (evaluated) and AEP Texas' (claimed) calculated kilowatt and kilowatt-hour savings. No adjustments were made to the program savings; however, a negligible difference in kilowatt and kilowatt-hour was a result of different rounding practices during calculations. The realization rate for kilowatt and kilowatt-hour is 100 percent, with a documentation score of *good*.

2.6.2 Winter Load Management Standard Offer Program (SOP) (Medium Evaluation Priority)

Program contribution to portfolio savings (kW)	Claimed demand reductions (kW)	Evaluated demand reductions (kW)	Realization rate (kW)	Program contribution to portfolio savings (kWh)	Claimed energy savings (kWh)	Evaluated energy savings (kWh)	Realization rate (kWh)	Program documentation score
6.8%	4,281	4,281	100.0%	0.0%	4,281	4,281	100.0%	Good

Completed desk reviews*
N/A

*The review for the load management program included a census review of equations and interval meter data to estimate the baseline usage and the resulting level of load curtailment achieved for each event for all participants.

The EM&V team evaluated the AEP Texas Winter Load Management SOP by applying the TRM calculation methodology to interval meter data. In PY2023, the meter data were supplied in 15-minute increments. Load management events occurred on the following date and time:

- December 16, 2022, from 9:00 a.m. to 10:00 a.m. (scheduled)

There were no unscheduled events in PY2023. The EM&V team received the interval meter data and a spreadsheet that summarized the event-level savings for the four sponsors across nine sites. One site did not participate in the scheduled event. All sponsors had at least one site that curtailed during each event.

After the EM&V team applied the *High 5 of 10* baseline calculation method, it was found that the evaluated savings matched the savings provided for all sites. The kilowatt savings for each participating site corresponded to the kilowatt reductions that occurred at the scheduled event (no averaging was necessary because each participating site participated in only one event). The kilowatt-hour savings for each participating site were calculated by multiplying the kilowatt reductions by the total number of event hours. Program-level savings were calculated by adding all site-level savings.

The table above shows the EM&V team (evaluated) and AEP Texas' (claimed) calculated kilowatt and kilowatt-hour savings. No adjustments were made to the program savings. The realization rate for kilowatt and kilowatt-hour is 100 percent, with a documentation score of *good*.

2.7 DETAILED FINDINGS—CROSS-SECTOR

2.7.1 Residential CoolSaver A/C Tune-Up Market Transformation Program (MTP) (Medium Evaluation Priority)

Sector	Program contribution to portfolio savings (kW)	Claimed demand reductions (kW)	Evaluated demand reductions (kW)	Realization rate (kW)	Program contribution to portfolio savings (kWh)	Claimed energy savings (kWh)	Evaluated energy savings (kWh)	Realization rate (kWh)	Program documentation score
Residential	3.2%	1,984	1,984	100.0%	9.5%	6,726,137	6,726,137	100.0%	Good

Completed desk reviews*
5

*Confidence intervals are not reported at the utility program level as these results should only be viewed qualitatively due to the small sample sizes.

The PY2023 CoolSaver A/C Tune-Up MTP evaluation efforts focused on desk reviews and on-site M&V for the residential sector. The number of sampled and completed desk reviews and site visits for this program are listed above.

The EM&V team adjusted the claimed savings for four commercial projects. Three projects had adjustments of less than five percent, while one project had adjustments of greater than five percent compared to the originally claimed savings. AEP Texas accepted the evaluated results and matched the claimed savings to those of the evaluations for all three projects. Therefore, the final program realization rate is 100 percent for kilowatt and kilowatt-hour. Further details of the EM&V findings are provided below.

Participant ID 11-1-1-2-59135: The project included a tune-up of a 1.5-ton AC unit for an apartment unit. During the desk review, the EM&V team identified a slight deviation between the claimed and evaluated kilowatt-hour savings due to rounding in the calculation process. Overall, the adjustment resulted in project-level realization rates that rounded to 100 percent for energy savings. However, demand reductions were not impacted by the adjustments, so the demand reductions remained at 100 percent.

Participant ID 11-1-1-2-60610: The project included a tune-up of a 4-ton AC unit for a single-family home. During the desk review, the EM&V team identified a slight deviation between the claimed and evaluated kilowatt-hour savings due to rounding in the calculation process. Overall, the adjustment resulted in a project-level realization rate that rounded to 100 percent for energy savings. However, demand reductions were not impacted by the adjustments, so the demand reductions remained at 100 percent.

Participant ID 11-1-1-2-72805: The project included a tune-up of a 2-ton AC unit for an apartment unit. During the desk review, the EM&V team adjusted the cooling capacity of the unit to match the documentation and identified a slight deviation between the reported and evaluated return and supply enthalpies. Overall, the adjustment resulted in a project-level realization rate that rounded to 100 percent for energy savings. However, demand reductions were not impacted by the adjustments, so the demand reductions remained at 100 percent.