

From here, utilities employing direct control units “ping” enrolled devices to begin load control. For utilities employing curtailment incentives and critical peak pricing, management of energy use is left to the customer once the demand response event begins.

Table 5-6. Program Delivery

Program Administrator	Delivery Method
TX Utilities	Internal.
	<p>Unscheduled events may be called based on if ERCOT issues an EEA2 emergency alert, for ERCOT utilities.</p> <p>Unscheduled events may be called at the utility’s discretion for non-ERCOT utilities.</p>
NV Energy	Internal, Third-party (Pelican, Encycle, BuildingIQ)
Alliant Energy	Internal
CPS Energy	Internal
Duke Energy	Internal
Florida Power & Light	Internal
Pacific Gas & Electric	Internal
San Diego Gas & Electric	Internal
Southern California Edison	Internal
ERCOT	Internal

Notification Strategies

It is industry-standard for utilities to use notifications to keep enrolled C&I customers informed of scheduled demand response events. Notifications among sampled utilities are transmitted via phone, email, text, or fax, and can be sent to multiple contacts simultaneously. Five of the eight researched utilities schedule demand response events and notify enrolled customers within 24 hours of the event’s scheduled start. Three of the eight researched utilities are not clear as to when notifications are sent out.

Table 5-7 highlights availability of notifications prior to or during an event.

Table 5-7. Notifications

Program Administrator	Program Name	Notifications
Texas Utilities	Commercial Load Management SOP	<p>Phone call to project sponsor.</p> <p>ERCOT: 30 minutes prior to event (AEP – 1 hour)</p> <p>Non-ERCOT: One hour prior to event</p>
NV Energy	PowerShift	Phone, email, or text, all to multiple contacts 24 hours before event
Alliant Energy	INTSERV Electric Interruptible Program	Phone, email, or text, all to multiple contacts Minimum 2 hours’ notice

Program Administrator	Program Name	Notifications
CPS Energy	Commercial Demand Response	Phone, email, or text Within 2 hours in advance
Duke Energy	PowerShare	Phone, email, fax 15 minutes to 24 hours before event
Florida Power & Light	Business OnCall	Unknown
Pacific Gas & Electric	Peak Day Pricing	Phone, email, or text, all to multiple contacts By 2:00 p.m. the day prior to a SmartDay
San Diego Gas & Electric	No official name	Phone, email, or text, all to multiple contacts By 3:00 p.m. the day prior to event
Southern California Edison	Summer Discount Plan + CPP	Phone, email, or text, all to multiple contacts By 3:00 p.m. the day prior to event
ERCOT	ERS	Phone call 10-30 minutes prior to event

Demand Response Event Dynamics

Timing and limitations of load control seasons on demand response events are illustrated in Table 5-8. Demand response event limits are set by utilities engaging in direct control of participating C&I buildings. These depend on the state the demand response program is operating in and unique climate and demand conditions that are foreseen by the utility.

Table 5-8. Load Control of Researched Utilities

Program Administrator	Load Control Season	Load Control Times	Load Control Limitations
Texas Utilities	June 1–September 30, excluding holidays and weekends	1:00 p.m.–7:00 p.m.	1 hour minimum 4 hours maximum 1-2 events minimum (scheduled events) 5-14 events maximum (scheduled and unscheduled events)
NV Energy	June 1–September 30 ¹ , not including holidays and weekends (Southern NV) July 1–September 30, not including holidays and weekends (Northern NV)	1:00 p.m.–7:00 p.m.	2 hours per event <= 2 events per week
Alliant Energy	Entire year	Unknown	4 hours per event 50 hours per year
CPS Energy	Smart thermostats + Direct Control Units: May 1–September 30, non-holiday weekdays.	3:00 p.m.–7:00 p.m.	Unknown

Program Administrator	Load Control Season	Load Control Times	Load Control Limitations
Duke Energy	Curtailment incentives: June 1–September 30, any day.	11:00 a.m.–7:00 p.m.	
	Summer Only Option: June 1–September 30, non-holiday weekdays.	Summer Only: 12:00 p.m.–8:00 p.m.	10 hours per event 10 events per year (Summer Only option)
	Extended Summer Option: May 1–October 31, any day.	Extended Summer: 10:00 a.m.–10:00 p.m.	No restriction on number of events (Extended Summer and Annual options)
	Annual Option: Entire year.	Annual: 10:00 a.m.–10:00 p.m. (May 1–October 31); 6:00 a.m.–9:00 p.m. (November 1–April 30).	
Florida Power & Light	April 1–October 31	Unknown	6 hours per event
Pacific Gas & Electric	May 1–October 31	2:00 p.m.–6:00 p.m.	4 hours per event 15 events per year
San Diego Gas & Electric	May 1–September 30, any day of week	11:00 a.m.–6:00 p.m.	7 hours per event 18 events per year
Southern California Edison	June 1–September 30, non-holiday weekdays (direct control unit)	2:00 p.m.–6:00 p.m.	6 hours per event 9 events per year (minimum)
	Year-round, non-holiday weekdays (critical peak pricing)		15 events per year (maximum)
ERCOT	February 1– May 31, June 1–September 30, October 1 – January 31	1:00 p.m.–7:00 p.m.	12-hour maximum event duration.
	Not including holidays and weekends		Unlimited maximum per season.

Due to the uniqueness of employed demand response tactics and the differences in program composition across researched utilities, we highlight demand response event dynamics for utilities employing (1) direct control units, (2) curtailment incentives, and (3) critical peak pricing in their demand response portfolios separately.

Direct Control Units

To curtail peak loads in their service territories, Florida Power & Light and Southern California Edison included direct control units in their demand response portfolios. This enables the utility to trigger an event to immediately curtail loads from enrolled HVAC equipment, removing a component of customer error that may be present in other demand response programs. Load control seasons, restrictions, and overall dynamics are discussed below for Florida Power & Light and Southern California Edison.

Florida Power & Light has a load control season for its C&I customers spanning April 1 to October 31. When an event is called, C&I customers can only have their load curtailed for enrolled HVAC units over a period of six hours. Florida Power & Light will determine appropriate cycling that occurs during this 6-hour period for enrolled HVAC units, shutting off compressors for enrolled units for 15 to 17.5 minutes

at a time for every 30 minutes that a demand response event is in effect. Documentation does not explicitly state whether there are limitations on the number of events that can be called per year.

Southern California Edison has a load control season that spans non-holiday weekdays from June 1 through September 30. Southern California Edison is limited to a period of 90 hours per enrolled customer per load control season under its direct load control program. Enrolled customers receive a notification at least 24 hours prior to the start of an event to modify energy use accordingly. On days when load control is utilized, enrolled equipment can be controlled for up to six hours per day. The extent to which loads on enrolled equipment are controlled depends on the cycling option chosen by the customer. For customers enrolled in the 30 percent cycling option, the direct control unit will shut off the HVAC compressor for 9 minutes out of every half-hour period. The compressor will then shut off for longer periods in higher cycling options, with those enrolled in the 50 percent option having their HVAC compressor shut off for 15 minutes out of every half-hour period, and those enrolled in the 100 percent option having their HVAC compressor shut off for the entirety of the demand response event.

For Southern California Edison customers who are enrolled in critical peak pricing, the load control season spans the entire year, with each episode limited to a length of 6 hours. Customers are notified at least 24 hours prior to the start of an event to modify energy use accordingly. Southern California Edison is also limited to a period of 90 hours per enrolled customer per load control season under its critical peak pricing program.

For Southern California Edison customers simultaneously enrolled in both direct load control and critical peak pricing, load control season comes in two waves. Between June 1 and September 30, these customers are subject to both critical peak pricing and direct load control. Otherwise, for the period spanning October 1 through May 31, these customers are subject only to critical peak pricing schedules. Since load control restrictions are limited to each program, customers enrolled in both programs are subject to up to 180 hours of load control per year, with 180 hours reached if direct load control event days are different from critical peak pricing event days.

Curtailment Incentives

Alliant Energy, Duke Energy, ERCOT, and Texas utilities employ curtailment incentive strategies to curtail peak load on event days. Duke Energy rewards customers for meeting their curtailed load agreement. Alliant Energy caps use at the amount contained in the curtailment agreement. Details pertaining to the program offerings by each of the utilities are highlighted further below.

Alliant Energy employed curtailment incentives in its INTSERV interruptible service program. Event days can be called at any time during the year but are limited to 4 hours per event and 50 hours per year. Under the program, Alliant signs curtailment contracts with individual large C&I customers with at least 200 kW of curtailable load, binding large C&I customers to a reduced load during event days. Large C&I participants submit a new contract on January 1 of each year to maintain enrollment in the INTSERV program and to allow these customers to correct their curtailment commitments for event days. Once an agreement is reached between Alliant and the enrolled large C&I customer, Alliant will cap energy use during event hours at the contracted curtailment level. Opt-out potential is discussed further in the next section.

Duke Energy also employed curtailment incentives for its large C&I customers, and enrolled C&I customers would have to meet curtailment agreements via reductions of energy use during events, no matter the duration of these events. This contrasts with the experience for C&I customers under the INTSERV program offered by Alliant Energy, as those customers would have their usage automatically interrupted to remain in compliance with their curtailment contract.

Demand response events can be called at any time of the year for those enrolled in the Annual option contained in the PowerShare program. Under this Annual option, events can be called at any time

between 10:00 a.m. and 10:00 p.m. from May 1 through October 31, and at any time between 6:00 a.m. and 9:00 p.m. from November 1 through April 30. For PowerShare participants enrolled in the Extended summer option, load control season includes all days between May 1 through October 31, 10:00 a.m. until 10:00 p.m., with no restriction on the duration or number of episodes called. Those customers enrolled in the Summer Only option face the shortest load control season, spanning non-holiday weekdays from June 1 through September 30, 12:00 p.m. until 8:00 p.m. with a maximum 10 hours per event and 10 events per year.

Once an event is called, PowerShare customers enrolled in the CallOption subset of the program receive a notification to reduce their load to a point at or below the level agreed upon in their curtailment agreement the morning of the event. QuoteOption customers instead elect a certain amount of curtailable load on the day of the event after receiving a notification 30 minutes prior to the event. Penalties applied for not meeting curtailment agreement are not clear based on available documentation. If the event is successfully completed at or below the curtailment agreement amount, then bill credits are received. (These are described in more detail in the Incentive Structure section).

Critical Peak Pricing

The main goal of critical peak pricing is to shift consumption from peak period to off-peak during an event day. This is done via imposition of an adder per kWh of consumption to penalize heavy consumption during event hours. When combined with non-event incentives, this adder is expected to be an effective means of discouraging consumption during the event period.

Pacific Gas & Electric will call an event—or SmartDay—any day between May 1 and October 31, including weekends and holidays. Events are called between 2:00 p.m. and 6:00 p.m. during the load control season. A maximum of 15 events may be called during the load control season, and these events may be no longer than 4 hours. During these events, electric rates for Peak Day Pricing customers will go up by the \$1.20 per kWh adder.

San Diego Gas & Electric will call an event any day from May 1 through September 30 between 11:00 a.m. and 7:00 p.m. Events are limited to 7 hours in duration and there cannot be more than 18 events during any load control season. During events, electric rates for enrolled customers are raised, revised upward by a \$1.35 per kWh adder, slightly higher than that imposed by Pacific Gas & Electric.

Direct Control Units, Curtailment Incentives, and Smart Thermostats

Of the programs covered in this benchmarking analysis, CPS Energy was the only utility to offer direct control units, curtailment incentives, and smart thermostats in its commercial demand response program. CPS Energy offered its C&I demand response customers the option of curtailment incentives, smart thermostats, or direct control units in order to curtail loads during demand response events. Only small commercial customers are able to participate in demand response with smart thermostats and direct control units, and only large commercial customers are able to participate in demand response with curtailment incentives.

Large commercial customers face curtailment incentive-based demand response events that can be called from June 1 through September 30 for both sets of measures, with an event being called at any point between 1:00 p.m. and 7:00 p.m. during this time span. Following notification receipt, the customer is required to curtail its use according to its curtailment contract. Customers can track their energy use through free access to 15-minute meter data to ensure compliance.

For small business customers with smart thermostats and direct control units, an event can only be called on weekdays between May 1 and September 30 between 3:00 p.m. and 7:00 p.m. Smart thermostat customers will then have their thermostat set-points changed to be within three degrees Fahrenheit of their pre-event set-point to maintain comfort. Customers with direct control units will have their HVAC compressors shut off for 10 minutes during every half-hour period that the event is in effect.

Direct control units will kick into effect at random times for 10 minutes at a time to ensure stress on the grid is distributed evenly during event hours.

Opt-out Potential

Potential for a customer to opt out of specific demand response events is relatively limited among the set of researched C&I demand response programs. Alliant Energy and CPS Energy were the only utilities that posted opt-out potential for specific events. Otherwise, the three California utilities provided information for how to move off the program. Duke Energy and Florida Power & Light provided no information for how to leave the program or opt out of specific events.

Through its INTSERV interruptible service demand response program, Alliant caps energy use to the amount detailed in the curtailment contract during events between the participant and Alliant. Alliant will contact the customer at least two hours prior to an event to allow customers to determine whether they would like to participate in an upcoming event. Should the customer decide not to participate in the event, they must contact Alliant to request to buy through. Under this option, the customer faces sharply increased prices per kWh of energy consumption applied to the difference between the agreed curtailment load and actual consumption during the event day. The customer must contact Alliant with intention to buy through at least one hour prior to the start of the event. It does not appear that there are any limits on the number of times a customer can do this during a load control season.

CPS Energy C&I customers enrolled in its demand response program with either curtailment incentives, a smart thermostat, or a direct control unit can opt out of specific events by calling CPS Energy. Customers with smart thermostats that have the Total Connect Comfort app on their smartphones may choose to opt-out of specific events instead. Customers with smart thermostats are encouraged to stay in the program for a minimum of three years. Opting out of the program before then will cause the customer to lose the smart thermostat. Otherwise, waiting until three years have passed will allow the customer to take ownership of the smart thermostat.

Participants in the Texas Utilities CLM programs can opt out of an event at any time or not take part in an event if desired. If a participant does opt out of an event, they will receive no incentive for the event as they will not have curtailed any demand during the event. Additionally, it is stated in the program manuals for these programs that if a participant does opt out, the participant will be looked at unfavorably by its utility during the next application to the program in the following program year.

Pacific Gas & Electric, San Diego Gas & Electric, and Southern California Edison provided detailed information of how to move out of their critical pricing programs but did not enable customers to opt out of specific events. Customers in Southern California Edison's Summer Discount Plan with direct control units were also unable to opt out of specific events. Instead, demand response customers had to exit the demand response program completely in order to opt out of future events after a one-year refractory period. Due to California regulations, all C&I customers that choose to opt out must choose a similarly-structured TOU rate plan available.

Demand Response Outcomes

Participation Numbers and Total Energy Savings

Table 5-9 provides, where available, total commercial and industrial base of utilities, customers enrolled in demand response under the respective utilities, and demand response outcomes.

Table 5-9. Program Goals and Outcomes

Program Administrator	Customers Enrolled	Program Outcomes
Texas Utilities (2018)	574	ERCOT utility savings: 214,333 kW reduction in demand 571,369 kWh energy savings Non-ERCOT utility savings: 28,006 kW reduction in demand 167,572 kWh energy savings
NV Energy	7,951	Savings: 555,840 kWh savings across between 23 to 40 events and 7,951 customers. 7,816,180 kWh savings due to non-event day optimization of energy consumption.
Alliant Energy (2017)	301 ³⁷	No evaluation found
CPS Energy ³⁸ (2015)	2,310 - Smart Thermostats	Savings: Smart Thermostats—705 kW across all customers across four demand response events
	278 - Curtailment Incentives	Curtailment incentives—56,358 kW across all customers across four demand response events
Duke Energy	14 ³⁹ (KY—2014) 186 ⁴⁰ (NC + SC—2016) 38 ⁴¹ (OH—2015)	Savings: KY—19.64 MWh total curtailed across four events among the 14 enrolled NC + SC—295.83 MW average curtailed in each of four events among the 186 enrolled OH—63.3 MW average curtailed in each of the two test events among the 38 enrolled. No true events triggered, only tests.
Florida Power & Light	Unknown	No evaluation found
Pacific Gas & Electric (2015)	208,804	Large C&I (>=200 kW) savings: 5.3% per customer per event 14.2 kW per customer per event day. 29.8 MW reduction per event across 2,093 large C&I customers.

⁹ Enrollment numbers for Alliant's Iowa and Wisconsin customers gathered from two webinars held by Alliant Energy in 2017: https://www.alliantenergy.com/-/media/Files/PartnersinEnergy/IowaElectricInterruptibleWebinar_May2017.pdf?la=en
<https://www.alliantenergy.com/.z/media/Files/PartnersinEnergy/WisconsinElectricInterruptibleWebinarMay2017.pdf?la=en>.

³⁸ <https://www.sanantonio.gov/Portals/0/Files/Sustainability/STEP/CPS-FY2015.pdf>

³⁹ Duke Energy Kentucky EM&V, February 2017: https://psc.ky.gov/pscecf/2017-00324/debbie.gates%40duke-energy.com/08152017042243/Case_No._2017-00324_Appendix_E-G.pdf.

⁴⁰ <http://www.energy.sc.gov/files/view/2017%20Duke%20Energy%20Carolinas%20Integrated%20Resource%20Plan.pdf>.

⁴¹ <http://dis.puc.state.oh.us/TiffToPdf/A1001001A17D17B45101G03468.pdf>.

Program Administrator	Customers Enrolled	Program Outcomes
San Diego Gas & Electric (2015)	1,207	<p>Small and medium (≥ 20 kW, < 200 kW) C&I savings:</p> <p>5.1 kW per customer per event. 5.8 MW reduction per event across 148,782 customers.</p> <p>Large C&I (≥ 200 kW) savings:</p> <p>8.6% per customer per event. 29.5 kW per customer per event. 24.4 MW reduction per event across 826 customers.</p>
Southern California Edison	811 (2012, Direct Control) 2,677 (2015, Critical Peak Pricing)	<p>Small and medium (≥ 20 kW, < 200 kW) C&I savings:</p> <p>6.5% per customer per event. 3.7 kW per customer per event. 1.3 MW reduction per event across 358 customers.</p> <p>Savings from Direct Control Units:</p> <p>14% per customer per event 4.7 kW per customer per event 4 MW reduction per event across 811 customers</p> <p>Savings from Critical Peak Pricing:</p> <p>large C&I (≥ 200 kW) savings:</p> <p>5% per customer per event 10.8 kW per customer per event 29 MW reduction per event across 2,677 customers</p> <p>Small and medium (≥ 20 kW, < 200 kW) C&I savings:</p> <p>1.6% per customer per event 1.2 kW per customer per event 0.2 kW reduction per event across 201 customers</p>
ERCOT	441 (2019)	<p>Three interruptions from 2011-2014. No other interruptions since end of 2014.</p>

Five out of eight utilities included in our benchmarking research had documentation highlighting energy savings and participation estimates. These estimates were found in publicly available EM&V

documentation^{42, 43, 44} based on impact evaluations conducted by a third-party. We encourage readers to investigate these in more detail.

For its PowerShare program with curtailment incentives, Duke Energy had a C&I base of 569,486, including 14 large C&I customers with at least 100 kW of curtailable load participated in the program during the 2014 program year. Duke Energy experienced savings of 19.64 MWh across all four events called during the 2014 program year. Duke Energy Carolinas called four events during PowerShare's 2016 program year, curtailing an average of 295.83 MW per event across the 186 participants. Duke Energy Ohio called no events during its 2015 program year but across its two tests curtailed an average of 63.3 MW across its 38 participants. Average per-event MWh savings across the 14 participants was 1.40 MWh. Average per-event MW savings per customer across Ohio and the Carolinas was 1.6 MW.

Pacific Gas & Electric had 668,179 C&I customers by the end of 2015. Under Peak Day Pricing, its critical peak pricing program, 208,804 were enrolled by the end of 2015. During Peak Day Pricing's 2015 program year, 150,875 customers participated in the 15 event days called. Across the 2,093 large C&I customers, there was an average of 5.3 percent savings per customer per event, a 14.2 kW reduction per customer per event. Aggregate savings among this customer segment amounted to 29.8 MW per event. Across the 148,782 small and medium C&I customers, there was an average of 0.8 percent savings per customer per event, a 5.1 kW reduction per customer per event. Aggregate savings among this customer segment amounted to 5.8 MW per event.

San Diego Gas & Electric had 156,575 C&I customers by the end of 2015. Of these, 1,207 were enrolled in critical peak pricing and participated in the five events that were called during 2015. Across the 826 large C&I customers under this rate schedule there was an average savings of 8.6 per customer per event, amounting to 29.5 kW per customer per event. Aggregate per-event savings amounted to 24.4 MW for this customer segment. Across the 358 small and medium C&I customers under this rate schedule there was an average savings of 6.5 percent per customer per event, amounting to 3.7 kW per customer per event. Aggregate per event savings amounted to 1.3 MW for this customer segment.

Southern California Edison had 642,263 C&I customers by the end of 2015. For its Summer Discount Plan with direct control units, 811 C&I customers were enrolled in 2012 (the most recent EM&V available). Savings of 14 percent per customer per event were estimated for the 2012 program year, amounting to 4.7 kW per customer per event. Aggregate per-event savings amounted to 4 MW for the Summer Discount Plan.

For Southern California Edison's critical peak pricing program, 2,677 C&I customers were enrolled and participated in the 12 events called in 2015. Across the 2,464 large C&I customers under this rate schedule there was an average savings of 5.1 percent per customer per event, amounting to 11.7 kW per customer per event. Aggregate per-event savings amounted to 28.8 MW for this customer segment. Across the 201 large C&I customers under this rate schedule there was an average savings of 1.6

⁴² Duke Energy Kentucky EM&V, February 2017: https://psc.ky.gov/pscecf/2017-00324/debbie.gates%40duke-energy.com/08152017042243/Case_No._2017-00324_Appendix_E-G.pdf.

⁴³ Southern California Edison EM&V of whole demand response portfolio, May 2013: [http://www3.sce.com/sscc/law/dis/dbattach5e.nsf/0/D34266A20AEE3D6888257B7C00769745/\\$FILE/R.07-01-041_DR%20OIR_SDP%20DR%20Portfolio%20Summary%202012%20-%20Final%20-%20Update%2020130530.pdf](http://www3.sce.com/sscc/law/dis/dbattach5e.nsf/0/D34266A20AEE3D6888257B7C00769745/$FILE/R.07-01-041_DR%20OIR_SDP%20DR%20Portfolio%20Summary%202012%20-%20Final%20-%20Update%2020130530.pdf).

⁴⁴ Pacific Gas & Electric, San Diego Gas & Electric, Southern California Edison EM&V of critical peak pricing, April 2016: http://www.calmac.org/publications/7._Statewide_2015_CPP_Report.pdf.

percent per customer per event, amounting to 1.2 kW per customer per event. Aggregate per-event savings amounted to 0.2 MW for this customer segment.

Conclusion

Texas utilities were found to be acting in accordance with industry best practices by having similar program eligibility requirements and incentive structures to other utilities that are offering curtailment incentives. All investor-owned Texas utilities offer CLM programs that employ the use of curtailment incentives as their only program offering. Other researched programs curtailed peak loads on event days via one-way direct control units, curtailment incentives, and critical peak pricing. Texas CLM programs are also only offered during the summer peak period. Some utilities offer programs throughout the year and there could be potential for expansion if beneficial to the Texas electric grid.

5.3.4.2 Program Staff Interviews

Key Finding #1: Programs are generally working well, with some modifications in incentive levels and the participant mix.

All of the utilities have been running commercial load management for many years. Utilities report the programs are working well and only minor “tweaks” have been made recently or are planned in the near future. Some utilities report looking for the “sweet spot” in incentive levels where the incentive is sufficient to retain participation and kW reductions without being set too high. Most utilities have either modified incentives recently or plan to do so. Non-ERCOT utilities report considering their independent system operator (ISO) needs when setting incentives even though they use statewide avoided costs. Utilities report that they often get “lucky” and customers reduce load more than they are required to do in their program participation contract. Many utilities compensate overperformances through a bonus if funds are available. In contrast, participants’ incentives are negatively affected if they underperform. Utilities either zero out savings if they do not curtail as required by the technical reference manual (TRM) or count negative savings, which is a more conservative estimate of kW reductions than currently required by the TRM.

Participation is fairly stable from year to year across all of the utilities. However, many of the utilities are experiencing some changes in their participation mix. ERCOT utilities have a mix of aggregators and self-sponsored customers participating in programs. Non-ERCOT utilities only have self-sponsored customers to-date but have been approached by aggregators. How quickly programs become fully subscribed depends on the utility. The larger utilities tend to have programs that immediately fill while the smaller utilities tend to have longer enrollment periods and recruit customers.

Regardless of how quickly their programs subscribe, most utilities are looking to expand the diversity and reach of their customer mix. In general, utilities try to improve their participant mix by diversifying participants, with the goal of having more strong performers than poor performers in terms of load reduction during curtailment events. Utilities have a fairly good understanding of how self-sponsored customers are responding to curtailment events. Several utilities collect this information as part of the program application process. Customers with back-up generators were reported as good candidates for the programs, as are customers with energy management systems. Several utilities also feel schools are good candidates for both the financial benefit to these organizations that experience funding constraints and the number of facilities school systems have that can shed load during an event.

Recommendation #1: Utilities should collect information from customers or aggregators annually on how they curtail load if they do not already do so.

5.3.4.3 Participant Surveys

The EM&V team completed a telephone survey with Commercial Load Management program participants in order to provide process insights for these programs. This section summarizes the survey findings from this survey effort. Below we describe study objectives and methodology, detailed findings, and recommendations for consideration.

Study Methodology

This process study assessed program participants' experiences with the program. Specifically, the evaluation aimed to characterize the customer experience in the following areas:

- Program awareness
- Decision-making
- Experience with curtailment events
- Satisfaction with the program
- Suggestions for program improvement.

The EM&V team completed telephone surveys with 77 Commercial Load Management program participants between January 15 and February 1, 2019. Table 5-10 documents the number of completed surveys by utility.

Table 5-10. Number of Surveys Completed

Utility	Number of Respondents
CenterPoint	18
AEP TCC	13
AEP TNC	2
El Paso Electric	8
Xcel Energy	5
SWEPCO	5
TNMP	6
Entergy	7
Oncor	13
Total	77

The sample of customers was drawn from the PY2018 tracking database. Texas utilities were responsive to the EM&V team's data request for this customer survey; however, the tracking data quality varied. While some utilities were able to provide detailed tracking data including key contact names for customers enrolled in demand response and/or load management programs, other utilities provided tracking data that was far less complete. This was especially true when a utility relied on a third party to implement its program.

The survey respondent data was composed of accounts from various businesses, with at least 10 respondents each coming from the following commercial sectors: cotton gins (18 percent of

respondents), wastewater treatment (17 percent), manufacturing (13 percent), education (13 percent), and warehousing (11 percent). Most of the respondents (63 percent) said that their businesses were open and/or online 24 hours a day; seven days a week.

Participant Description

Forty-five percent of respondents surveyed operate modern facilities, defined within this analysis as operating a facility that was built after 1980. Customer buildings varied in size—41 percent of respondent facilities were larger than 100,000 square feet and 27 percent of respondent facilities were smaller than 1,500 square feet. All other respondents had facilities ranging from 1,500 square feet and 100,000 square feet.

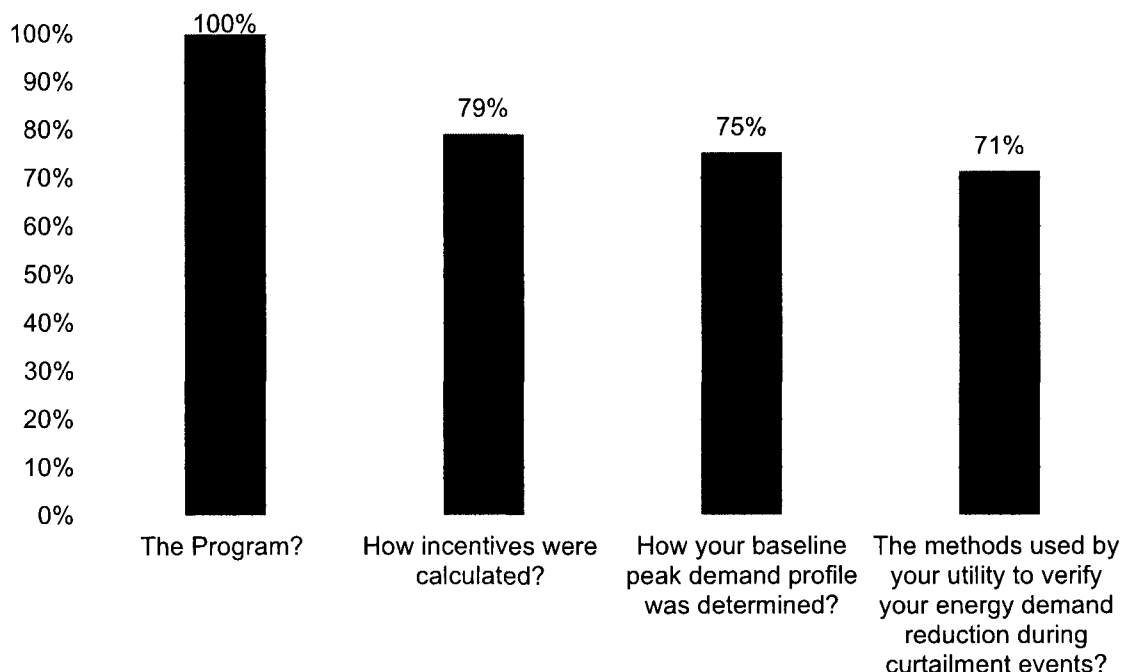
Approximately one-quarter of respondents (24 percent) reported undergoing organizational changes in the past year, such as recommissioning, adding floor area and/or capacity, renovating (two participants specifically noted recovering from Hurricane Harvey), and implementing energy efficiency protocols. More than half (58 percent) of respondents indicated that their operation schedule varied according to the season or production cycle.

Program Awareness and Understanding

Nearly all respondents attributed their program awareness to one of three main sources (multiple sources were allowed): a previous participant (54 percent), their utility (33 percent), or their third-party aggregator or ESCO (30 percent).

Surveyed respondents were asked to rate their familiarity with the program and program components using “very familiar,” “somewhat familiar,” or “not at all familiar.” All respondents expressed some level of familiarity with load management programs, and more than half (52 percent) said that they were “very familiar” with the programs offered. Respondents were slightly less knowledgeable in their understanding of other program details. Specifically, a portion of respondents said they were “not at all familiar” with calculation of incentives (21 percent), determination of baselines (25 percent), and curtailment of verification methods (29 percent). Figure 5-5 shows the percent of respondents who were either “very” or “somewhat” familiar with the program and program components.

Figure 5-5. Percent of Respondents Who Were Very or Somewhat Familiar with the Program and Program Components (n=77)



Source: Questions A2, A3, A3a, and A4.

Program Enrollment Process

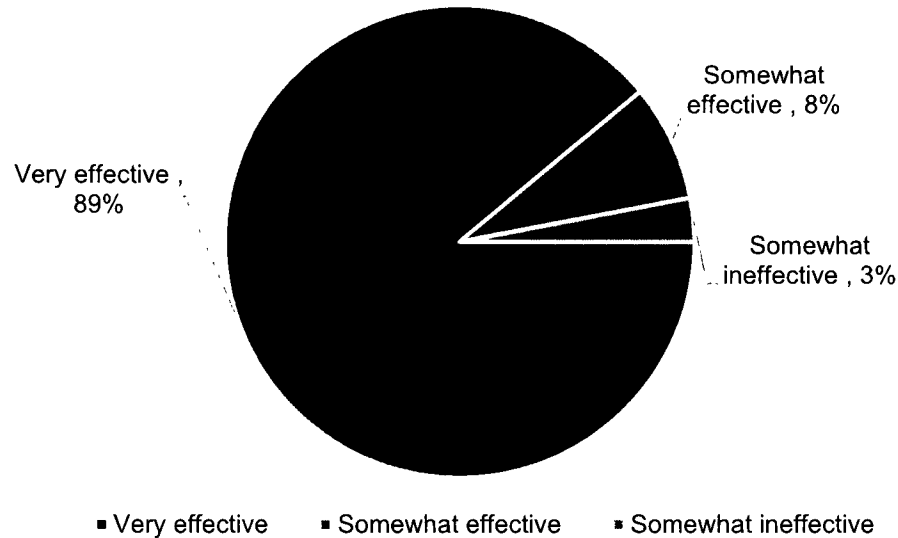
Surveyed respondents had different program sign-up experiences if they were self-sponsored instead of fostered through the program through a third-party aggregator or sponsor. For example, nearly all project-sponsored participants reported that either utility staff or a third-party aggregator initiated contact with them and explained the nature of the program. Almost all of these customers indicated that the assistance of utility staff or third-party aggregators was either “somewhat helpful” or “very helpful.” Another 40 percent of respondents said they signed up as an individual customer, without a project sponsor.

The Curtailment Process

Respondents were asked how they were notified of curtailment events in PY2018. (They could provide answers for more than one notice method.) Seventy-three percent of respondents said they received program emails, 62 percent said they received texts, and 56 percent said they received phone calls.

Figure 5-6 details how effective respondents thought these communications were. Among the 73 respondents who could recall the event notifications, 97 percent said the communications were “very” or “somewhat effective.”

Figure 5-6. Effectiveness of Curtailment Events (n=73)



Source: Question PA6. Don't know and refused responses were excluded from analysis

Ninety percent of respondents said that they were able to reduce their energy usage for all program events. The actual amount of curtailable load reported by respondents varied and ranged anywhere from 10 percent to 100 percent of peak load. Table 5-11 displays the range of answers presented by the surveyed respondents. Nearly one-third (32 percent) of respondents who could recall the amount of load shed during PY2018 events indicated they shed 100 percent of their load.

Table 5-11. Average Percent of Peak Energy Demand Load Shed During PY2018 Curtailment Events

Average Percent Shed	Percent of Respondents
0%	0%
1 to 10%	12%
11 to 25%	5%
26 to 50%	17%
51 to 75%	17%
76 to 99%	18%
100%	32%
Respondents (n)	60

Source: Question PA0

Only respondents who were able to curtail load were included in this table. *Don't know* and *refused* responses are excluded.

More than half of the respondents (53 percent) who curtailed load indicated that demand reductions were manually operated; others indicated that such reductions were either fully automated (23 percent) or partially automated (23 percent). Seventy-one percent of respondents who participated in PY2018

events reported no loss in “personal comfort or productivity” for themselves or the building occupants because of demand reduction actions, while 29 percent confirmed they did experience some loss due to program participation. When probed to understand the program impacts, two respondents who confirmed some loss or discomfort due to program participation categorized it as lost production time. Factors such as staff complaints over lost work hours, a warm/uncomfortable environment, financial impact, and “the manpower it takes to shut down” were mentioned by one respondent each. Others reporting loss due to program participation did not expand their comments.

The majority of respondents (78 percent) recalled experiencing one to three curtailment events occurring during the season. More than half of respondents (59 percent) reported the number of events met expectations, 38 percent indicated there were fewer events than they expected, and 3 percent of respondents reported the number of events were more than expected.

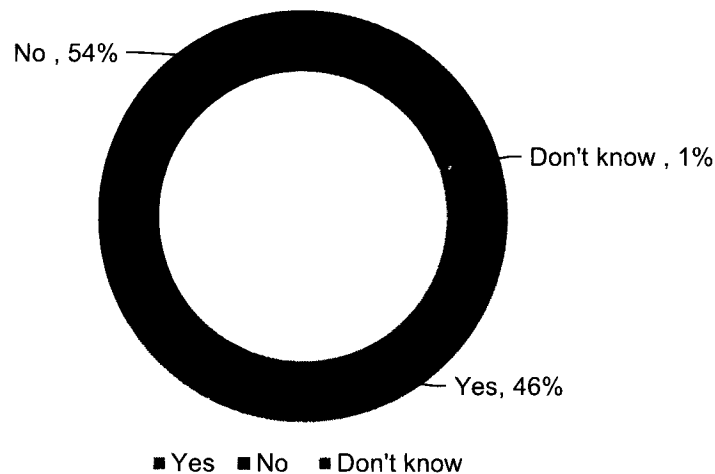
Few respondents (9 percent) reported not responding to curtailment events, but those who did cited examples such as “*could not reduce load on that particular event day*” (n=2) or “*inability to respond in time*” (n=2) as barriers. One respondent indicated they were already shut down on an event day and one respondent indicated that they did not receive an event notification in time. One respondent refused to give a reason for non-response to the curtailment event.

Customer satisfaction

In general, surveyed respondents were pleased with the program and overall program satisfaction was high. More than four out of every five respondents (87 percent) rated their overall program satisfaction an 8 or more, resulting in an overall mean satisfaction score of 9.0 on a 10-point scale (0=very dissatisfied, 10=very satisfied). High program satisfaction is further demonstrated by nearly all participants indicating they plan to continue participation in the program in PY2019; only two of 77 respondents indicated they would not. When asked why they would not continue participation, both attributed it to the uncertainty that came with a change in their third-party provider.

The high satisfaction scores continued when respondents were asked to recall their overall experience and satisfaction with their utility. Nine out of every 10 respondents (90 percent) rated their overall experience and satisfaction with their utility an 8 or more. The overall mean satisfaction score with the utility was 8.7 on a 10-point scale (0=very dissatisfied, 10=very satisfied). While there was high program and utility satisfaction, less than half (46 percent) of respondents have recommended the program to others, as presented in Figure 5-7.

Figure 5-7. Percent of Respondents that Recommended Program to Others (n=76)



Source: Question SAT5
Refused response is excluded

Customer Suggestions for Improvement

Surveyed respondents were asked for suggestions on how to improve the program. Seventy-five percent of respondents indicated that they did not have program feedback for change. Nearly one quarter (24 percent) of respondents did offer constructive feedback (multiple responses were allowed), and their comments are summarized in the paragraphs below. These suggestions reflect the statements made by surveyed respondents and are not necessarily endorsed by the EM&V team.

More advanced notification. When asked about the aspects of the program that should be changed, more advanced notification was mentioned by four respondents. Among the two that provided specifics about what they would welcome in notification changes, one mentioned that they wanted more than one key contact person notified by the program to increase opportunities for the company to become aware of approaching events. Another person requested notifications come earlier (more “advance warning”).

Change to curtailment events. Curtailment events may last up to four hours in duration and start and stop times can vary. Eleven respondents indicated they would like changes to the events themselves. Among those who expanded on their sentiment, one respondent would like events to have shorter duration, one would like them to be more specific, one would like them to come with more warning, and one would like them to be called less frequently.

Post-event follow-up. Four participants asked for more follow-up after events to have a better understanding if they curtailed properly, offering an opportunity to improve their program participation and ultimately, their incentive amounts.

Improve annual program application. Three participants explained the same scenario for program improvement—that they filled out an annual application to participate and the application seems to “lose” their information from year to year. Participants who continue on through the program would like the application to carry information across from year to year whenever possible.

Other suggestions for improvement. Other suggestions for improvement from respondents were: providing greater incentives, expand the program, and increase opportunities for automation.

5.3.4.4 Key Findings and Recommendations

Finding #1: Ninety-seven percent of respondents indicated the program communications surrounding events were “very” or “somewhat” helpful, and nearly all customers that received the alerts were able to curtail load throughout the season. Most respondents confirmed they received curtailment notifications through more than one of the communication channels (phone, text, and/or email); it is likely that the alerts across multiple channels increase the likelihood of participants receiving timely notification of the events.

Recommendation #1: Continue alerting Commercial Load Management program customers of events via multiple communication channels.

Finding #2: As noted earlier in this section, four participants asked for more follow-up after events to have a better understanding if they curtailed properly. Event feedback could be helpful to both the program—by helping to educate their participants on how to get the most out of each event—and to participants, as they gain the satisfaction of curtailing to the maximum amount possible for them and collecting the highest incentive amounts for their efforts.

Recommendation #2: Consider implementing an option to provide post-event follow-up.

Finding #3: Program tracking data lacked complete participation information when assembled by a third-party program partner.

Recommendation #3: Work with third-party program partners to improve participant tracking data.

5.4 RESIDENTIAL LOAD MANAGEMENT

This section summarizes the key findings and recommendations from the PY2018 evaluation of the Residential Load Management programs offered by three Texas utilities (El Paso Electric, CenterPoint Energy and Oncor). Other utilities did not offer a residential load management program.

5.4.1 EM&V Overview

Two utilities calculated savings using interval meter data following the TRM 5.0 calculation methodology. The third utility used deemed savings, also from TRM 5.0. Process evaluation activities included participant surveys, benchmarking research and program staff interviews.

5.4.2 Key Findings and Recommendations

Finding #1: Utilities demonstrated strong capabilities to apply the high 3 of 5 method in TRM 5.0 to savings.

The two utilities that applied the high 3 of 5 method to savings did so correctly and matched the EM&V team’s evaluated savings.

Recommendation #1: Continue implementing the demand savings algorithm described in TRM 5.0. If there are minor discrepancies in future program years, keeping active communications with the EM&V team to resolve minor calculation differences will be beneficial to both the EM&V team and the Texas utilities.

Finding #2: There was confusion surrounding language in the TRM 5.0 on how to apply the new deemed savings values.

PY2018 marked the first year in which utilities could calculate savings using a deemed saving approach if AMI meters are not installed on participating homes. Upon evaluation of this program by the EM&V team and subsequent comparison to utility calculated savings, language in TRM 5.0 was found to be confusing regarding what qualifies a “participant.” The EM&V team, the utility, and the organization that produced the deemed savings value came to a consensus on how to apply the deemed savings value and an evaluated savings result was agreed upon. There will be clarifications in the next version on TRM 5.0 to resolve this confusion as well as an update to the deemed savings value to reflect savings achieved by participants that do not opt-out of load control events.

Recommendation #2: Continue implementing the demand savings algorithm described in TRM 5.0 as agreed upon after the PY2018 evaluation. If there are minor discrepancies in future program years, keeping active communications with the EM&V team to resolve minor calculation differences will be beneficial to both the EM&V team and the Texas utilities.

Finding #3: The Texas Utilities that offer residential demand response programs are employing best practices by making smart thermostats in their demand response programs available to residential households.

The benchmarked utilities are increasingly moving away from traditional one-way direct control units to a more customer-friendly and transparent two-way smart thermostat.

Recommendation #3: Continue to offer these new technologies as a way for residential demand response programs to curtail peak load.

Finding #4: Texas utilities offer incentives that are larger than many other demand response programs, but this may also be resulting in larger demand reduction potential from these programs.

For its load control season spanning June 1 through September 30, customers enrolled in Texas utility residential demand response programs are eligible for incentives of up to \$38.00 per kW reduced during an event. This is a larger incentive than many other demand response programs with incentives between \$20.00 and \$40.00 per year. The Texas utilities per-customer savings were approximately \$1.32 kW per event on average in 2018. Per-customer savings are above those observed for many other utilities. For example, Southern California Edison’s direct control units was \$0.94 kW per customer and Pacific Gas & Electric’s critical peak pricing with optional direct load control was \$0.80 kW per customer per event.

Recommendation #4: If program cost-effectiveness is ever at risk, consider lowering incentives to regain cost-effectiveness while still maintaining participation.

Key Finding #5: While residential demand response programs have been growing in Texas, the benchmarking research indicates this resource could be increased if needed.

One of the Texas programs caps enrollment at 3,000 participants and the other two programs do not cap enrollment. The two programs that do not cap enrollment have a lower than average participant count when compared to benchmarked utilities. On average, the benchmarked utilities have 5 percent of their residential customer base enrolled in a residential demand response program, whereas the Texas utilities average 1 percent.

Recommendation #5: Consider allowing for additional participation if the residential demand response programs are under-performing with respect to peak load needs.

Key Finding #6: While residential programs are very popular with customers, utilities are seeing a need to modify incentive levels, program administration and participation limits.

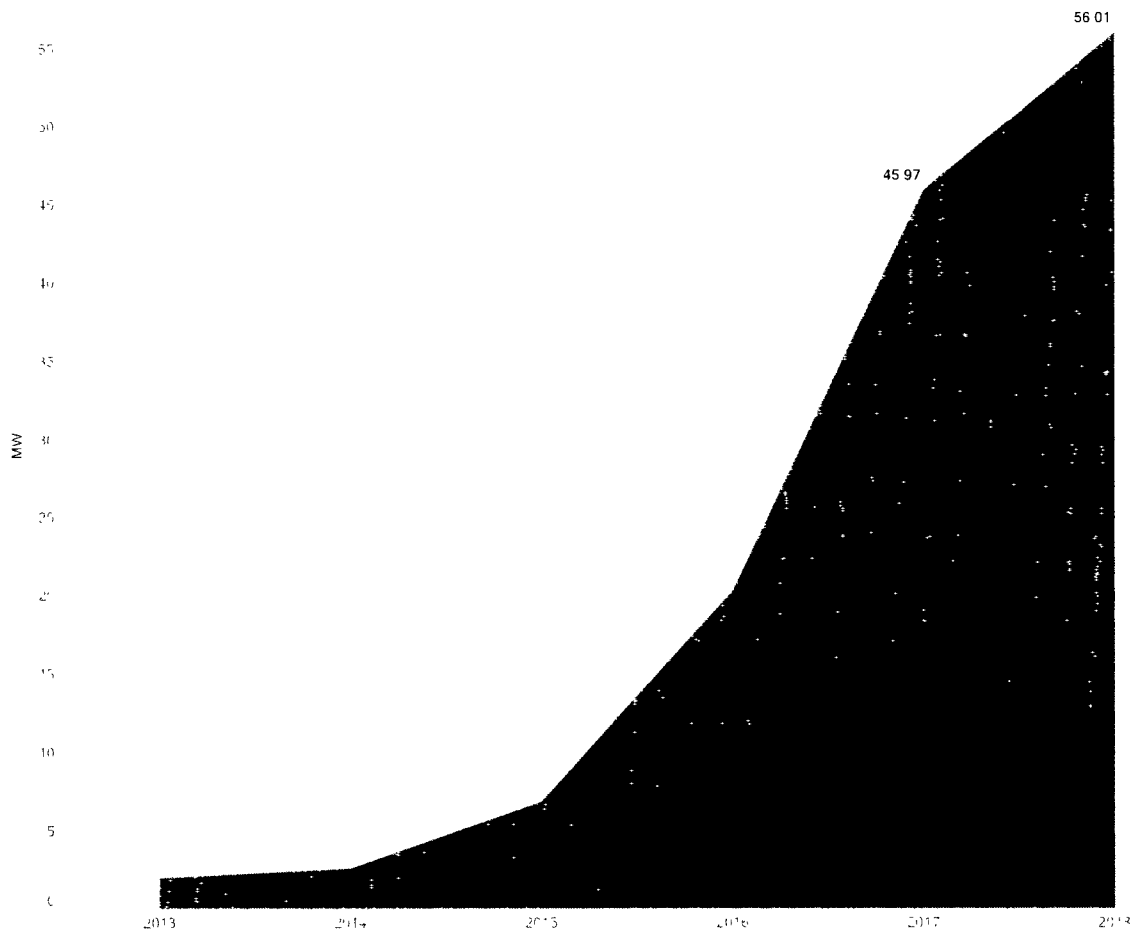
Even though the programs are a relatively new offering, participation has easily and quickly ramped up. Now, utilities are seeing the need for adjustments. Utilities are modifying their third-party implementation of the programs to be more cost-effective. Some service providers have been too costly and utilities either have recently or plan to decrease incentive levels for either the smart thermostat or the incentive per kW savings. One utility has already had to limit participation and turn interested parties away. Another utility is allowing some growth due to the uptake and interest in the program, but also anticipates the need to limit participation.

Recommendation #6: Consider available load relief comprehensively across residential and commercial offerings.

5.4.3 Impact

The total evaluated savings for the three programs were 51,010 kW and 264,250 kWh. These savings are up from PY2017 by approximately 5,000 kW and 6,000 kWh even though AEP dropped out of the residential demand response space. Oncor's and CenterPoint's programs were in their fourth year of implementation in PY2018. El Paso Electric's program was in its first year of implementation. Figure 5-8 shows total kW savings from residential demand response programs by program year.

Figure 5-8. Evaluated Demand Savings of Residential Load Management Programs (PY2012 – 2018)



Oncor and CenterPoint

Comparing the evaluated savings to the utility claimed savings from TRM 5.0 calculations shows agreement for both utilities. The EM&V team has worked with Oncor at a detailed level over the past three program years and, as a result, calculations matched exactly in PY2018. This agreement is supported by the fact that Oncor provided valuable documentation of how it addressed meters requiring specific treatment. The EM&V team and CenterPoint matched calculations exactly with documentation provided by CenterPoint about how special meters were handled.

El Paso Electric

For El Paso Electric, the EM&V team's calculations did not match the utility's calculations initially. Upon meeting with El Paso Electric, the evaluated savings calculated were found to be lower than what El Paso Electric was claiming. This difference in savings prompted a discussion between the EM&V team and El Paso Electric. During the discussion, the EM&V team found that the language in TRM 5.0 was being interpreted differently by each party. The TRM 5.0 language in question reads, "Event-level savings are calculated by multiplying kW savings per household/device by the participating number of devices on that event, then adding all the groups savings together." The EM&V team took this statement to mean that the kW savings per household/device was to be applied to meters that did not op-out of and otherwise had full participation in an event, whereas El Paso Electric applied the kW savings per household/device to meters that participated/were enrolled in the program during the 2018 program year, regardless of op-out status at the event level.

After this initial discussion with El Paso Electric, more clarification was needed to understand how the deemed savings value was calculated. At this time, Frontier Energy (the firm that produced the deemed savings value), was brought into the discussion. The deemed savings value was produced using a sample of 50 homes in the El Paso Electric territory; Frontier assumed that this sample of 50 homes would contain op-out rates similar to those the entire program population would exhibit. Therefore, the effects of op-out meters are accounted for in the deemed savings value. With an understanding of how the deemed savings value was calculated, the EM&V team agreed with El Paso Electric that the deemed savings value in TRM 5.0 is to be applied to participating meters in the program, regardless of participation at the event level.

With evaluated savings equaling calculated savings produced by utilities, residential demand programs received a realization rate of 100 percent for both kW and kWh.

5.4.4 Process

5.4.4.1 Benchmarking Research/ Documentation Review

This benchmarking study characterizes utility programs identified by the EM&V team as being of interest to review and compare against the Texas electric utilities' residential demand response programs. The utilities were selected for geographic coverage across the U.S. so that both coasts and territories in the middle are represented. Utilities chosen for the benchmarking study are similar to one or more of the Texas utilities in terms of number of customers served. The regulation or deregulation of the utilities varies considerably. The majority of the utilities are vertically integrated, which limits direct comparisons with the ERCOT utilities operating in a competitive retail space and these limitations should be kept in mind. Information collected for the target programs of interest included:

- **Program design:** Program control strategy,⁴⁵ program goals, outreach mediums, eligibility requirements, incentive structure
- **Program implementation and delivery:** Program procedures, notification strategies, demand response event dynamics, opt-out potential
- **Demand response outcomes:** Participation numbers and total demand reductions.

The benchmarking research was conducted via targeting of specific utilities, then gathering information about their residential demand response programs. Information gathered from these programs was collected by inspecting program documentation provided by each utility website, assessing evaluation documents pertaining to these programs, and, where available, inspection of any public commission documentation. Data on demand response programs were collected for eight utilities. Internet research was the main source of information. Utilities where Tetra Tech has current or recent EM&V work are noted with an * below and more information was available for those utilities. The following utilities are included in this benchmarking research:

- Commonwealth Edison (ComEd)
- Duke Energy Progress North Carolina*
- Entergy Arkansas*
- Florida Power & Light
- Kansas City Power & Light
- NV Energy*
- Pacific Gas & Electric
- Southern California Edison

In addition, the benchmarking research includes programs run by the Electric Reliability Council of Texas (ERCOT). Table 5-12 provides basic information about the utilities and ERCOT.

Table 5-12. Service Territory and Residential Customer Base

Program Administrator	Service Territory	Residential Customers Served
Commonwealth Edison	Northern Illinois	3,574,519
NV Energy	Northern and Southern Nevada	1,089,713
Duke Energy Progress N.C.	North Carolina	1,162,473
Entergy Arkansas	Central and Eastern Arkansas	589,522
Florida Power & Light	East Coast of Florida, some Gulf Coast areas	4,284,159
Kansas City Power & Light	Northwest Missouri, Eastern Kansas	469,606
Pacific Gas & Electric	Northern and Central California	4,760,208

⁴⁵ Control strategy refers to how load is reduced. The most common control strategy for residential programs is changes in central air conditioning in homes.

Program Administrator	Service Territory	Residential Customers Served
Southern California Edison	Puget Sound region, Washington	4,406,932
ERCOT	Majority of Texas	24 million total customers

Program Design

Program Control Strategy

For the past few decades, residential demand response used one-way direct control units. Some utilities in the benchmark review still use one-way direct control units, including Duke Energy Progress, Entergy Arkansas, Florida Power & Light, and Southern California Edison. Customer involvement with this technology tends to be low and customers do not always know their own energy savings resulting from program participation.

Installation of smart technologies over the past decade has provided utilities with an enhanced portfolio of options to employ in demand response programs. Residential demand response is transitioning from one-way devices to those with two-way communication. Two of the three Texas utilities that were reviewed in this research are at the forefront in advancing the use of this technology in their demand response programs. Enrolled customers with two-way devices are now more involved than ever in demand response programs, engaging with their devices via online portals, smartphone apps, and frequent notifications from their utility.

ComEd has begun to combine two-way devices with its underlying portfolio of one-way direct control units. ComEd has employed direct control units under its Smart Ideas central AC cycling program since the mid-1990s. ComEd has recently combined the program with a residential smart thermostat program, allowing participating customers to take advantage of Nest's Rush Hour Rewards.⁴⁶ Customers now have the choice between (1) exclusively participating in Smart Ideas central AC cycling via installation of a direct control unit on participating cooling units or (2) combining central AC cycling with the installation of a Nest thermostat connected to household Wi-Fi. Participation in option 2 requires enrollment in Nest's Rush Hour Rewards.

Kansas City Power & Light and NV Energy currently employ demand response programs using two-way smart thermostat technology exclusively. Kansas City Power & Light offers both a bring-your-own-thermostat (BYOT) and professional installation of free Nest thermostats for participating households. Like ComEd, installation of Nest thermostats and participation in demand response under Kansas City Power & Light requires registration in Nest's Rush Hour Rewards.

Instead of combining one- and two-way devices like ComEd, Pacific Gas & Electric has joined the use of one-way direct control units with critical peak pricing to further improve demand reduction during peak periods. Critical peak pricing was introduced in 2013 and with it came further incentives for customers to reduce use during peak periods. A reliable notification system has allowed customers to receive notice prior to an event being called. This improved the ability to curtail load effectively during events. Table 5-13 lists technologies offered by the different programs.

Table 5-13. Program Offerings

Program Administrator	Technologies Employed
Texas Utilities	Direct Control Unit and Smart Thermostat
NV Energy	Smart Thermostats

⁴⁶ <https://nest.com/support/article/What-is-Rush-Hour-Rewards>.

Program Administrator	Technologies Employed
ComEd	Direct Control Unit (with optional Smart Thermostat)
Duke Energy Progress N.C.	Direct Control Unit
Entergy Arkansas	Direct Control Unit
Florida Power & Light	Direct Control Unit
Kansas City Power & Light	Smart Thermostat
Pacific Gas & Electric	Critical Peak Pricing (with optional direct control unit)
Southern California Edison	Direct Control Unit
ERCOT	Curtailment Incentive

Program Goals

The secondary reviews conducted for the benchmarking efforts were not able to reveal set program goals. For five out of the eight analyzed programs, participation and savings goals were not clearly indicated in program documentation, commission records, or evaluation documents. ComEd and Entergy Arkansas, on the other hand, have clear savings goals. Ability to reach participation numbers is assessed on an annual basis by an independent third-party EM&V contractor for both utilities.

Outreach Media

Most program administrators in the benchmarking effort target existing residential customers via email, direct mail, and bill inserts as part of their outreach activities. Detailed program webpages are available for consumers to learn more about the program after receiving outreach materials, highlighting detailed information on incentive amounts and how to sign up or apply for the demand response program.

Eligibility Requirements

Administrators who include thermostats in their programs, like the Texas utilities, require customers to have a Wi-Fi connection. Other common requirements are fairly consistent in that customers need to have a central air conditioner or heat pump. Some unique requirements include Duke Energy Progress N.C. where participants must be in a geographic area, and Southern California Edison where participants must meet a usage criterion. Eligibility requirements associated with researched programs are highlighted in Table 5-14.

Table 5-14. Eligibility Requirements

Program Administrator	Program Name	Eligibility Requirements
Texas Utilities	Residential Demand Response	<p>Must have advanced metering infrastructure with the exception of one non-ERCOT utility, which is using a smart thermostat deemed savings.</p> <p>A load cannot be curtailed if it will negatively affect health or that is incentivized through another energy efficiency program.</p> <p>For smart thermostat control strategies: Single family homes with central air conditioning.</p>

Program Administrator	Program Name	Eligibility Requirements
NV Energy	PowerShift Smart Thermostat	Participants must bring their own Wi-Fi-enabled device. Central air conditioning Broadband Internet access and router with an open port (NV Energy does not provide Internet access)
ComEd	Smart Ideas Central AC Cycling	Residential homeowner with central air conditioning. Wi-Fi availability if also enrolling in Nest's Rush Hour Rewards.
Duke Energy Progress NC	EnergyWise Home	Central air conditioning or heat pump. Residential electric service in the applicant's name. Must be in coverage area for paging signal.
Entergy Arkansas	Summer Advantage Program	Residential rate classes. Central air conditioning or heat pump.
Florida Power & Light	OnCall	Central air conditioning or heat pump. No other information available.
Kansas City Power & Light	Residential Thermostat Program with Rush Hour Rewards	Residential homeowners. Central air conditioning or heat pump. Wi-Fi availability.
Pacific Gas & Electric	SmartRate, SmartAC	Central air conditioning or heat pump.
Southern California Edison	Summer Discount Plan	Customers with over 1.5 kWh usage during one prior event during the prior calendar year.
ERCOT	ERS	Aggregated residential loads 30 minute ramp product. Minimum demand savings of 100 kW. Must have AMI ("smart meter") metering capabilities. Must be able to curtail with a 10-30-minute notice. While there is nothing that would prevent aggregated residential loads from participating in the 10 minute option, to-date they have all participated in the 30 minute notice option as they are more suited to a 30 minute ramp product.

Incentive Structure

Incentives varied depending on the type of technologies employed under demand response programs. A detailed summary of incentives is shown in Table 5-15. Generally, programs with more customer involvement via notifications and customer-side online portals to monitor energy use entailed more extensive incentive offerings. Customer incentives were commonly received in the form of bill credits on

an annual basis, ranging from \$20.00 to \$40.00. Additional incentives are offered at the time of installation. All programs make these incentives clear in marketing materials.

Table 5-15. Incentive Structures of Researched Utilities

Program Administrator	Program Name	Incentive Levels
Texas Utilities	Residential Demand Response	ERCOT: \$38/kW Non-ERCOT: \$125 enrollment incentive + \$25/program year regardless of savings
NV Energy	PowerShift	Offers fixed rebates and participation rebates. Fixed Rebate: Legacy Meter: \$5.00 per summer month Standard Meter: \$7.50 per summer month Participation Rebate: Legacy Meters: \$0.33 per hour after the first 12 hours Standard Meter: Energy Rebate (R \$/kWh x S kWh) per hour
ComEd	Smart Ideas Central AC Cycling	\$5.00 per month that received cycling (50% option). Maximum \$20.00 annually. \$10.00 per month that received cycling (100% option). Maximum \$40.00 annually. \$100 rebate for Nest thermostats. Additional \$40.00 bill credit annually for those participating in Nest Rush Hour Rewards.
Duke Energy Progress NC	EnergyWise Home	\$25.00 bill credit after installation, \$25.00 bill credit per year enrolled thereafter.
Entergy Arkansas	Summer Advantage Program	\$25.00 bill credit after installation, \$25.00 per year enrolled thereafter (50% option). \$40.00 bill credit after installation, \$40.00 per year enrolled thereafter (75% option).
Florida Power & Light	OnCall	Monthly bill credit– totaling up to \$137 annually, depending on the equipment and program options selected
Kansas City Power & Light	Residential Thermostat Program with Rush Hour Rewards	Free installation of free Nest thermostat, plus \$25.00 bill credit annually (Option 1). \$50.00 incentive for DIY installation of Nest thermostat (self-purchased), plus \$25.00 bill credit annually (Option 2). Bring-your-own-thermostat (BYOT) and earn a \$100 incentive, plus \$25.00 bill credit annually (Option 3).
Pacific Gas & Electric	SmartRate, SmartAC	Rate reductions of \$0.024 per kWh between June 1 and September 30, excluding SmartDays.

Program Administrator	Program Name	Incentive Levels
		Bill protection for first-year participants in program.
Southern California Edison	Summer Discount Plan	Rebate for controlled loads, depending on the tonnage of the unit controlled.
ERCOT	ERS	Incentive depends on the kW reduction per event. This incentive is disclosed at the time of contract signing and depends on site-level characteristics.

Direct Control Units

Residential customers with direct control units received incentives in the form of bill credits. To reward new residential participants, Duke Energy Progress and Entergy Arkansas applied bill credits to participating customers within 30 to 60 days of a direct control unit being installed on qualifying systems. Duke Energy Progress applied a \$25.00 credit for new enrollees. Entergy Arkansas structured installation incentives so that these incentives would scale up depending on the cycling option elected by the customer. Customers opting for the 50 percent cycling option received a \$25.00 bill credit after installation, whereas those who opted for 75 percent cycling received a \$40.00 bill credit.

Bill credits were also given for those households continuing to participate in residential demand response. For ComEd Smart Ideas participants, bill credits were received depending on the number of events that were called and based on what cycling option chosen. Customers enrolled in the 50 percent cycling option would receive \$5.00 per month that had an event, whereas those enrolled in the 100 percent option would receive \$10.00 per month that had an event. The annual cap on bill credits for these customers was set at \$20.00 and \$40.00, respectively.

For Duke Energy Progress and Entergy Arkansas customers enrolled in demand response, bill credits were not paid contingent on whether an event was called. For Duke Energy Progress EnergyWise Home participants, a \$25.00 bill credit was received at the end of a program year, so long as the customer was still enrolled in the program. Entergy Arkansas Summer Advantage Program participants received scaled incentives depending on their cycling option, receiving \$25.00 if enrolled in the 50 percent cycling option and \$40.00 if enrolled in the 75 percent cycling option.

Incentive amounts received for having a direct control unit installed under Pacific Gas & Electric's SmartRate and SmartAC programs were not provided. Additional incentives were provided for participation in the critical peak SmartRate program, and these are provided below.

Southern California Edison's Summer Discount Plan paid out bill credits to participating households. Bill credits depended on the tonnage of the unit on which the control device is installed. Incentive amounts based on tonnage follow a specific formula outlined in Southern California Edison documentation and are also conditional on the household's current rate plan and actual energy use at the household.

Smart Thermostats

Comparable demand response programs with smart thermostats were examined for ComEd, NV Energy and Kansas City Power & Light. Incentives are structured similarly to those received under demand response programs with direct control units. For ComEd's Smart Ideas program, participants who want to install a Nest thermostat receive a \$100 rebate credit. In addition, \$40.00 in bill credits are received annually on top of direct control unit credits as a reward for participating in Nest's Rush Hour Rewards events when events are called by ComEd.

Kansas City Power & Light residential smart thermostat program with Rush Hour Rewards had an annual bill credit of \$25.00. Initial incentive amounts received by participating households depend on the installation option selected by the household. For households that opt for free installation of a free

Nest thermostat, no initial incentive is received aside from the free installation and free Nest device. Households may also opt to install a free Nest thermostat and enroll in the Rush Hour Rewards for an initial bill credit of \$50.00. Households that already have a Nest thermostat installed earn a \$100 bill credit after enrollment in Rush Hour Rewards.

Critical Peak Pricing

Critical peak pricing participation covered in this benchmarking is limited to Pacific Gas & Electric's SmartRate program. Incentives are received during the load control season, spanning June 1 through September 30 in Pacific Gas & Electric's service territory. On days that do not have an event called, a \$0.024 per kWh reduction in rates is applied for participating households. Additional discounts can be applied for customers as Pacific Gas & Electric observes an enrolled customer's demand. In exchange for participation in SmartRate, the customer agrees to \$0.60 per kWh added to his or her usual rate on an event day. For new customers, if participation in the program raises energy costs, bill protection is available to compensate for the difference. This is bounded by certain conditions on household energy use.

Program Implementation and Delivery

Program Procedures

To control load during a demand response event, utilities must trigger an event. For utilities using direct control units—ComEd, Duke Energy Progress, Florida Power & Light, NV Energy and Southern California Edison—direct control of cooling systems is managed in-house. A minority of utilities (for example, Entergy Arkansas) use a contractor for implementation but triggering of events is still managed in-house. Critical peak pricing used by Pacific Gas & Electric is also managed in-house.

For demand response programs using Nest smart thermostats, the utility needs to schedule an event with Nest directly. Through its Rush Hour Rewards program, Nest then triggers an event at a specified time for enrolled customers with Nest smart thermostats. Nest then releases control of the thermostat's set-point at the end of an event, returning the thermostat back to its customer-specified default temperature. Table 5-16 offers information on program delivery.

Table 5-16. Program Delivery

Program Administrator	Delivery Method
Texas Utilities	Internal with a third party (Ecofactor, Ecobee, Whisker Labs, Energy Hub, Reliant Energy Retail Services, Nest)
NV Energy	Internal, Third Party (Ecofactor, Ecobee)
ComEd	Internal, Third Party (Nest)
Duke Energy Progress NC	Internal
Entergy Arkansas	Internal, Third Party (Comverge)
Florida Power & Light	Internal
Kansas City Power & Light	Internal, Third Party (Nest, CLEARResult)
Pacific Gas & Electric	Internal
Southern California Edison	Internal
ERCOT	Internal

Notifications Strategies

Notifications received by enrolled residential households appear to be limited by the extent of technology employed in the demand response program. For programs with direct control units

employed, customers have the option of receiving email, phone, or text notifications. ComEd, however, appears to refrain from sending notifications about an event and instead only notifies its subset of customers who are enrolled in Nest's Rush Hour Rewards. Florida Power & Light has no specific documentation regarding the availability of notifications.

Customer involvement in demand response programs with smart thermostats employed tend to be among the highest in this benchmarking research. In addition to available notification via email, text, or phone, smart thermostats offered by Texas utilities, ComEd, and Kansas City Power & Light can receive notifications directly. Further, customers with smartphones can download a smartphone app to control their smart thermostats and be notified of any upcoming demand response events. Table 5-17 highlights availability of notifications prior to or during an event.

Table 5-17. Notifications

Program Administrator	Program Name	Notifications
Texas Utilities	Residential Demand Response	Email, web portal, text, and phone
NV Energy	PowerShift	Notification given 30 minutes prior to interruption. Email, text, phone, or smartphone app. Timing of notification unknown. Message on thermostat and registered notification device.
ComEd	Smart Ideas Central AC Cycling, Rush Hour Rewards	Email, text, phone, or smartphone app. Rush Hour Rewards only. Message on thermostat and registered notification device. Morning event – Customer warned day before. Afternoon event – Customer warned one-hour prior.
Duke Energy Progress NC	EnergyWise Home	Unknown.
Entergy Arkansas	Summer Advantage Program	Phone, text, email. Timing unknown.
Florida Power & Light	OnCall	Unknown.
Kansas City Power & Light	Residential Thermostat Program with Rush Hour Rewards	Email, text, phone, or smartphone app. Rush Hour Rewards only. Message on thermostat and registered notification device. Morning event – Customer warned day before. Afternoon event – Customer warned one-hour prior.
Pacific Gas & Electric	SmartRate, SmartAC	Phone, text, email. Notifications sent out by 2:00 PM the day prior to an event. Notifications can be sent to up to four individuals.
Southern California Edison	Summer Discount Plan	Phone, text, email.

Program Administrator	Program Name	Notifications
ERCOT	ERS	Online portal to monitor event days, personal energy use. Phone call 10-30 minutes prior to event to aggregator

Demand Response Event Dynamics

During a curtailment event, the utility can control the cooling unit for a set amount of time during each day during a specified period. More details on timing and limitations on demand response events are illustrated in Table 5-18. Demand response event limits are set by utilities engaging in direct control of participating households. These depend on the state the demand response program is operating in and unique climate and demand conditions that are foreseen by the utility.

Table 5-18. Load Control of Researched Utilities

Program Administrator	Load Control Season	Load Control Times	Load Control Limitations
Texas Utilities	June 1 – September 30, not including holidays and weekends.	ERCOT: 1:00 p.m. – 7:00 p.m. Non-ERCOT: 2:00 PM – 8:00 p.m.	ERCOT: 1-2 scheduled event(s) Unlimited unscheduled events 25 hours per year Non-ERCOT: Unknown number of events. 4-hour event maximum
NV Energy	June 1 – September 30, not including holidays and weekends (Southern NV) July 1 – September 30, not including holidays and weekends (Northern NV)	1:00 p.m. – 7:00 p.m.	2 hours per event 20 events per year
ComEd	June 1 – September 30, not including holidays and weekends	11:00 a.m. – 8:00 p.m.	Unknown
Duke Energy Progress N.C.	May 1 – September 30, not including holidays and weekends	1:00 p.m. – 7:00 p.m.	4 hours per event 60 hours per year
Entergy Arkansas	June 1 – September 30, not including holidays and weekends	12:00 p.m. – 7:00 p.m.	4 hours per event <= 3 consecutive days 60 hours per year
Florida Power & Light	April 1 – October 31, any day of week	Unknown	8 hours per event
Kansas City Power & Light	June 1 – September 30, any day of week	Any time	4 hours per event <= 3 consecutive days

Program Administrator	Load Control Season	Load Control Times	Load Control Limitations
			15 events per year
Pacific Gas & Electric	June 1 – September 30, any day of week	1:00 p.m.– 7:00 p.m.	4 hours per event 15 events per year
Southern California Edison	All year, any day of week	Anytime	6 hours per event 180 hours per year
ERCOT	February 1 ¹ – May 31, June 1 –September 30, October 1 – January 31	1:00 p.m.–7:00 p.m.	12-hour maximum event duration.
	Not including holidays and weekends		Unlimited maximum per season.

Direct Control Units

ComEd harnesses load control between June 1 and September 30 (known as a load control season). Weekends and holidays are exempt from direct control. During this time period, load control can be used between 11:00 a.m. and 8:00 p.m. During an event, a maximum of 15 minutes every half hour can be devoted to load control for the households enrolled in the Smart Ideas 50 percent option. For households enrolled in the 100 percent option, the cooling unit will be turned off for a period of up to three hours depending on the length of an event or, alternatively, it can be turned off for 15 minutes every half-hour over a period of up to six hours. ComEd does not appear to have a maximum number of events it can call during a load control season based on available information.

Duke Energy Progress uses a load control season of May 1 through September 30 and can use load control during an event between 1:00 p.m. and 7:00 p.m. Weekends and holidays are exempt from direct control. Events can last no longer than four hours if called. The enrolled air conditioner will have its compressor controlled for a portion of each half hour during the event. The amount of time per half hour is left to Duke Energy Progress' discretion. A limit of 60 event hours is placed on Duke Energy Progress per load control season.

Entergy Arkansas' load control season spans June 1 through September 30. An event can be called on non-holiday weekdays between 12:00 p.m. and 7:00 p.m. Events called during this time period can last no longer than four hours and can occur for no more than 3 consecutive days. A maximum of 60 hours may be called during the span of the load control season. If each event is four hours during a load control season, this limits Entergy Arkansas to 15 days of load control.

Southern California Edison has a load control season that spans the entire year. Southern California Edison is limited to a period of 180 hours per enrolled household per year of load control. On days when load control is used, air conditioners can be controlled for up to six hours per day. Under extenuating circumstances, SCE can exercise load control over a longer period of time. Extenuating circumstances include emergencies, overworked electrical grids, high wholesale energy prices, or testing.

Smart Thermostats

For Kansas City Power & Light and ComEd, Nest's Rush Hour Rewards are used to manage household energy use during a demand response event. Peak events are called by Kansas City Power & Light or ComEd and transmitted to Nest. Nest will then alter heating and cooling set-points for customers enrolled in Rush Hour Rewards to moderate energy use during peak events. Set-points will be changed depending on whether the customer is home at the time of an event.

Unlike the Texas utilities that use smart thermostats in their residential demand response programs, Kansas City Power & Light and ComEd customers can pre-cool their homes prior to an event. Pre-cooling will allow a target temperature to be reached by a certain time, usually by the start of an event. This target temperature is determined depending on customer preferences. Customers may opt out of the pre-cooling option at any time.

Customers can access their online portal highlighting past and current energy use at any time to view when Rush Hour events may have occurred during the last 10 days. Information about how their thermostat set-point changed during these times is also provided in the portal. This supposedly allows customers to course-correct their non-Rush Hour usage if they deem their thermostat set-point to be too strict on an average day.

Load control seasons for ComEd and Kansas City Power & Light span June 1 through September 30. For ComEd, weekends and holidays are exempt from events being called. During weekdays, load control can be used between 11:00 a.m. and 8:00 p.m. ComEd does not appear to face a maximum number of events it can call during a load control season based on available information. For Kansas City Power & Light, events may be called at any time of day during its load control season. The duration of events is currently capped at four hours, and a maximum of 15 peak events may be called at any time during the load control season. No more than three Rush Hour events may be called in a week.

Critical Peak Pricing

Pacific Gas & Electric will call an event—a “SmartDay” —anytime between June 1 and September 30, including weekends and holidays. Events are called between 1:00 p.m. and 7:00 p.m. during the load control season. A maximum of 15 events may be called during the load control season. During these events, electric rates for SmartRate customers will go up by the \$0.60 per kWh adder highlighted under the incentives and pricing section. Combined with the rate discounts available during non-event hours, events are expected to shift energy use to off-peak, non-event hours.

Opt-out Potential

Opt-out capabilities associated with demand response programs were observed to be bounded by the level of technology employed. One-way direct control units allow customers the ability to opt out of specific events by overriding the direct control device. Smart thermostat customers may also opt out of certain events by overriding the device’s thermostat set-point that is triggered by a demand response event. Critical peak pricing offers no such capability to opt out of specific events.

Of those customers enrolled in demand response programs with direct control units, Duke Energy Progress customers with direct control units may opt out for two days of the load control season without penalty. If this is exceeded, demand response enrollees will be disqualified from receiving an annual bill credit for the respective year. Entergy Arkansas customers may also opt out of specific demand response events, but are limited to two events per year before being removed from the program. Southern California Edison Customers may opt out of specific events, but have incentives reduced if this option is used. Further, overriding more than five event days will disqualify customers from receiving their annual incentive.

Of those enrolled in demand response programs with smart thermostats, customers may opt out of a specific event by changing their thermostat set-point. This will not disqualify the customer from future participation in Rush Hour Rewards. It does not appear that there are limits on the number of time Nest-covered demand response customers are able to opt out.

Demand Response Outcomes

Of the demand response programs covered in this benchmarking, five out of eight had EM&V documentation written by a third party publicly available. Table 5-19 provides, when available, the number of customers enrolled in demand response and demand response outcomes.

Table 5-19. Program Participation and Outcomes

Program Administrator	Residential Customer Base ⁴⁷	Customers Enrolled	Program Outcomes
Texas Utilities	5,492,803	44,625	Savings: 56,010 kW (2018)
NV Energy	1,104,293	974 (2014) ⁴⁸	Savings: 1,086 kW per event on average.
ComEd	3,732,896	84,018	Savings: 84 MW
Duke Energy Progress NC	1,177,640	9,215	Savings: 11.6 MW
Entergy Arkansas	600,652	23,075	Savings: 37.6 MW
Florida Power & Light	4,428,929	Unknown	Unknown
Kansas City Power & Light	500,045	51,396	Unknown
Pacific Gas & Electric	4,737,686	475,497	Savings: 38 MW
Southern California Edison	4,489,693	292,763	Savings: 277 MW
ERCOT	Unknown	441 (2019)	Three interruptions from 2011-2014. No other interruptions since end of 2014.

Participation Numbers and Total Energy Savings

A review of total residential customers compared to the number of residential customers enrolled in the reviewed programs show that Texas utility residential demand response programs are not achieving the same customer engagement as other programs. On average, Texas utilities enroll roughly 1 percent of their customer base into a residential demand response program, whereas the other utilities research enrolled around 5 percent. A review of program outreach (Table 5-19) sheds some light on why this is the case. All Texas utilities offer a program website for their residential demand response programs and only one of the three does not offer a program manual on the website. Other utilities that were researched aggressively market the program with e-mails, bill inserts, and outbound calling, to name a few.

Although participation may be less, average savings per customer enrolled in a Texas utility demand response program is greater than other utilities. On average, a customer enrolled in a Texas utility

⁴⁷ For all but the Texas utilities, U.S. Energy Information Administration, Form EIA-861 2017 data files, released November 14, 2018. EIA-861 includes self-reported data on accounts, revenues, demand response portfolios, and other pertinent utility data. Report is released annually in November for the prior operating year. More can be found at <https://www.eia.gov/electricity/data/eia861/>.

⁴⁸ https://www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/about-nvenergy/rates-regulatory/recent-regulatory-filings/north/irp/Vol_09_SPPC_IRP.pdf.

demand response program saved 1.26 kW per event whereas other utility demand response customers saved an average of 0.98 kW per event.

Conclusion

Based on our benchmarking findings highlighted above, Texas utilities demand response programs are among the frontrunners in the market portfolio of demand response programs. Diffusion of smart technologies over the past decade has allowed Texas utilities to push ahead into providing two-way smart thermostats to their customers. Texas utilities have high per-customer savings, which may be a result of offering incentives that are larger than similar programs offered by other utilities. There is room to grow residential demand response programs if needed, as, on average, a smaller percent of Texas utilities' residential customers participate when compared to benchmarked utilities, though participation numbers have been growing.

5.4.4.2 Participant Surveys

The EM&V team completed a telephone survey with Residential Demand Response program participants in order to provide process insights for these programs. This section summarizes the survey findings from this survey effort. Below we describe the study objectives and methodology, detailed findings, and recommendations for consideration.

Study Methodology

This process study assessed program participants' experiences with the program. Specifically, the evaluation aimed to characterize the customer experience in the following areas:

- Program awareness
- Decision-making
- Experience with curtailment events
- Satisfaction with the program
- Suggestions for program improvement.

The EM&V team completed telephone surveys with 59 Residential Demand Response program participants across two study periods: The first one ran in December 2018 and the second study ran in February 2019. Table 5-20 documents the number of completed surveys by utility.

Table 5-20. Number of Surveys Completed

Utility	Number of Respondents
CenterPoint	14
El Paso Electric	31
Oncor	14
Total	59

The sample for the telephone survey was drawn from the list of customers in the PY2018 tracking databases. Texas utilities were responsive to the EM&V team's data request for this customer survey; however, the tracking data quality varied. While some utilities were able to offer data that included full

names and contact information for end customers enrolled in Residential demand Response programs, other utilities offered tracking data that was far less complete. This was especially true when a utility relied on a third party to implement its program.

Participant Description

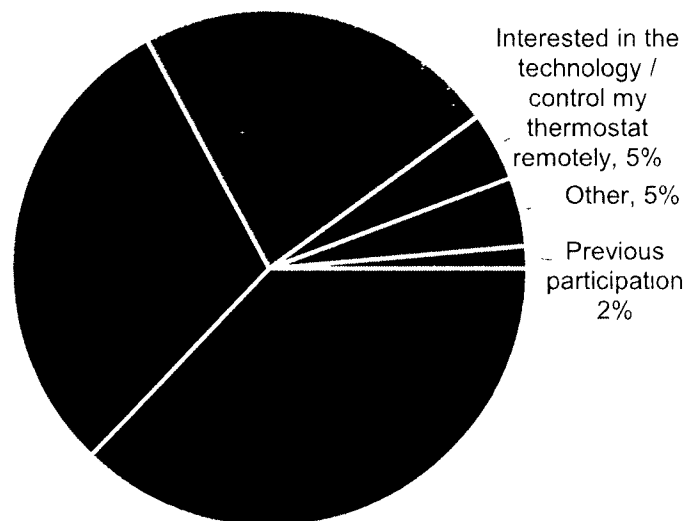
The telephone survey respondent data was composed mostly of homeowners, with 95 percent of the survey respondents saying that they owned their home and 5 percent saying they rent. Most respondents (89 percent) lived in single-family, detached homes; roughly half of the homes were built before or in 2000 and half after 2000. Nearly half (46 percent) of the respondents have lived in their homes for five years or less.

Program Awareness and Understanding

The top three sources to which respondents attributed their program awareness were email (33 percent), their smart thermostat vendor (27 percent), and word of mouth through family or friends (17 percent). Other sources mentioned less frequently, but by at least five participants, included other home energy or products vendors (i.e. Vivint, Reliant, Tri-Eagle Energy) or some other utility communication (i.e., social media).

Respondents were asked to share their reasons for participating in the program. As shown in Figure 5-9, respondents' reasons for participation varied and multiple responses were allowed. The available incentive was named by 47 percent of respondents as their main reason for participating in the program. Respondents also named saving energy (38 percent) or saving money on their energy bill (29 percent) as key participation drivers.

Figure 5-9. Main Motivation to Participate (n=55)



Source: Question PA2. Multiple responses were allowed; responses total more than 100 percent.

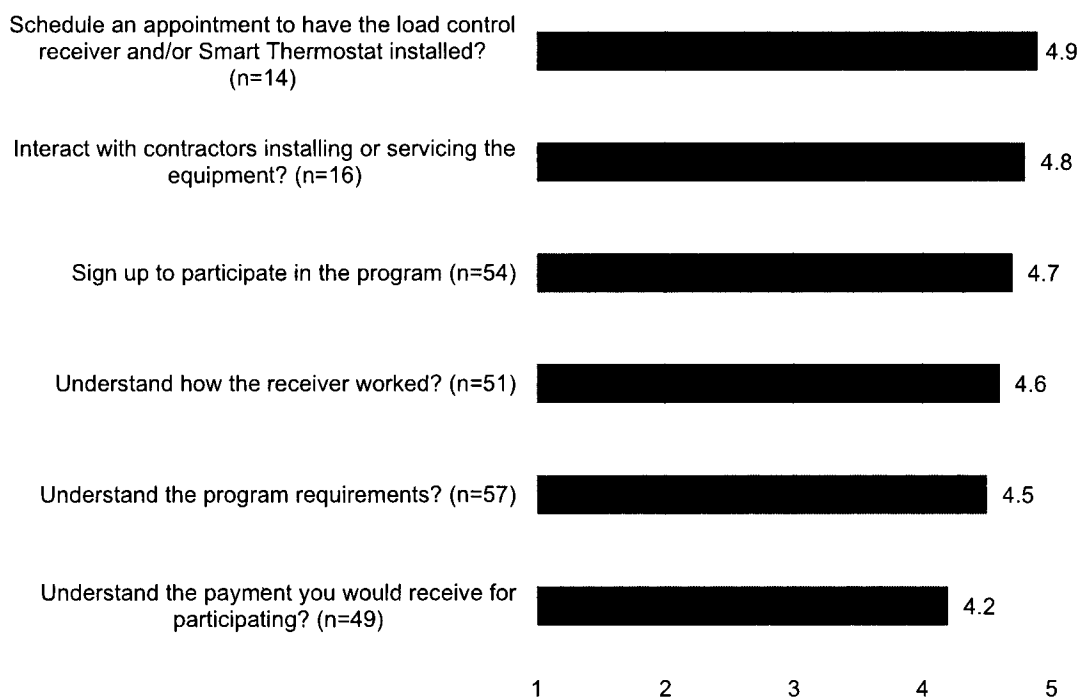
Program Experience

Survey respondents were asked to quantify how many cycling events they thought were called during the PY2018 summer season. Just over one-third of respondents (36 percent) reported they did not know. Respondents who thought they could recall events consistently named a value slightly higher than the actual number of cycling events for their utility territory.

Regardless of the respondent's perceptions about the number of events, the overall program experience did not appear to be impacted. That is, when respondents who could recall events were asked to report how a cycling event impacted them, 58 percent said the event had no effect. Among survey respondents who did say cycling events impacted them, the most mentioned response was that the temperature of their residence increased (32 percent of respondents). Other responses included *"we had to adjust the temperature setting"* (8 percent) and *"we used fans"* (2 percent).

Figure 5-10 details respondents' ease with various program components. Respondents were asked to use a 1 to 5 scale, where 1 was "very difficult" and 5 was "very easy" program interaction. All program components scored an average mean above 4, which is supported by the fact that nearly all respondents reported the process of scheduling an appointment to have a load control receiver and/or a smart thermostat installed as "very easy."

Figure 5-10. Ease with Various Aspects of the Residential Load Management Programs—Mean Scores



Source: Question P1a through P1f. Don't know, refused, and not applicable responses were excluded from analysis.

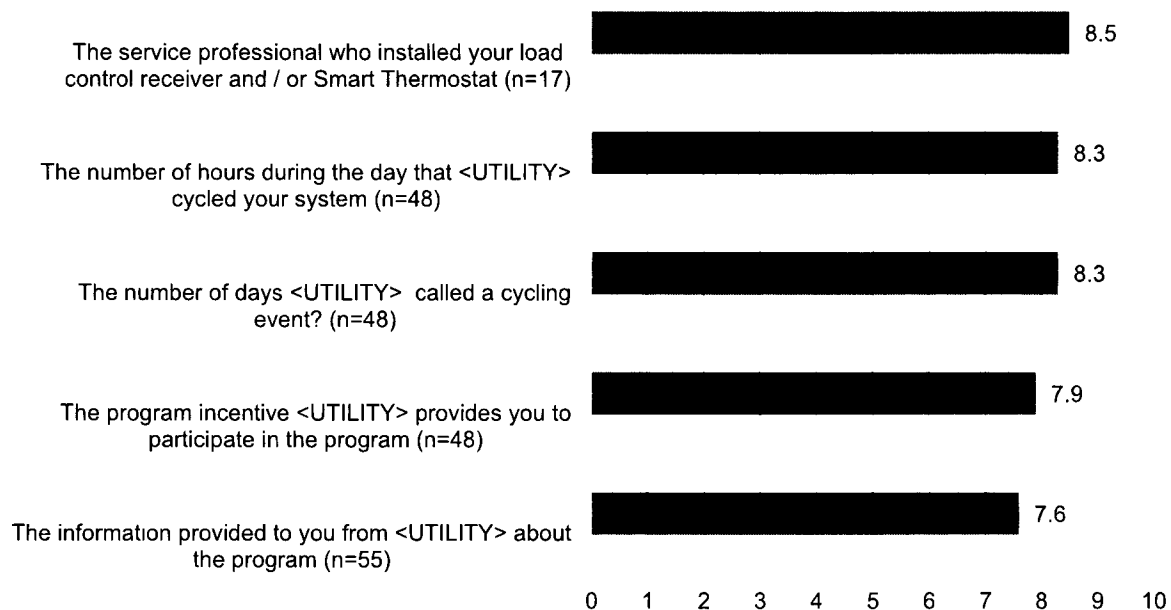
Eighty-one percent of survey respondents said that they had no initial concerns about participating in the program. Among those who did (11 respondents), five expressed concern about allowing the utility control of their home's energy systems during program events, three said that they thought the temperature increase would be uncomfortable during events, and one indicated that he/she had an installation concern, and in particular, was worried about the reliability of the home's internet.

connection. One participant was concerned that the payment may not be worth the effort of program participation.

Customer Satisfaction

In general, survey respondents were satisfied with their overall program experience. Respondents were asked to rate their satisfaction with various aspects of the Residential Demand Response programs on a scale of 0 to 10, where 0 was “very dissatisfied” and 10 was “very satisfied.” Four out of every five respondents (80 percent) rated their overall program satisfaction an 8 or more, resulting in an overall mean satisfaction score of 8.5 on the 10-point scale. High program satisfaction is further demonstrated among program components for the service professional who installed a respondent’s load control receiver and/or smart thermostat, the number of hours during the day that the respondent’s utility cycled his/her system, and the number of days a respondent’s utility called a cycling event. All program components and the associated mean satisfaction score appear in Figure 5-11.

Figure 5-11. Satisfaction with Residential Load Management Programs Components—Mean Scores



Source: Question SAT3a through SAT3e Don’t know, refused, and not applicable responses were excluded from analysis.

The high satisfaction scores continued when respondents were asked to recall their overall experience and satisfaction with their utility. More than four out of every five respondents (81 percent) rated their overall experience and satisfaction with their utility an 8 or more. The overall mean satisfaction score with the utility was 8.5 on a 10-point scale where 0 was “very dissatisfied” and 10 was “very satisfied.”

Additionally, nearly all (95 percent) respondents plan to continue their participation in the Residential Demand Response Programs into this next program year. Despite high program and utility satisfaction, respondents did not widely report recommending the program to others; 37 percent of respondents reported doing so. Given the high program and utility satisfaction that reportedly exists among respondents, there is a potential opportunity to encourage customers to promote their program experience through word of mouth or social media channels.

5.4.4.3 Key Findings and Recommendations

Finding #1: Hearing about the program from family and friends was a common way respondents claimed to have learned about the program, yet those that have participated did not report continuing to spread the word about the program. Given the high levels of program satisfaction and a generally positive program experience overall, current program participants could be a powerful marketing resource for the program going forward if increased participation is needed.

Recommendation #1: Encourage residential customers to spread the news of their positive program participation experience if increased participation is needed.

Finding #2: Program tracking data tended to lack complete participation information when assembled by a third-party implementation contractor.

Recommendation #2: Work with third-party program implementation contractor to improve participant tracking data.

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GLOSSARY: ACRONYMS/ABBREVIATIONS/DEFINITIONS

AC	Air conditioner
AEP TCC	American Electric Power Texas Central Division
AEP TNC	American Electric Power Texas North Division
CF	Coincidence factor
C&I	Commercial and industrial
CMTP	Commercial Market Transformation Program
CNP	CenterPoint Energy Houston Electric, LLC
CSOP	Commercial Standard Offer Program
DHP	Ductless heat pump
DI	Direct Install
ECM	Energy conservation measure
EECRF	Energy Efficiency Cost Recovery Factor
EEIP	Energy Efficiency Implementation Project
EEPR	Energy Efficiency Plan and Report
EESP	Energy efficiency service provider
EISA	Energy Independence and Security Act of 2007
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
EUMMOT	Electric Utility Marketing Managers of Texas
GSHP	Ground-source heat pump
HCIF	Heating/cooling interactive factor
HOU	Hours of use
HPwES	Home Performance with ENERGY STAR®
HTR	Hard-to-reach
HVAC	Heating, ventilation, and air conditioning
IECC	International Energy Conservation Code
IPMVP	International Performance Measurement and Verification Protocol
kW	Kilowatt
kWh	Kilowatt hour

LED	Light emitting diode
LI	Low income
LI/HTR	Low income/hard-to-reach
LM	Load management
mcf	1,000 cubic feet
MF	Multifamily
MTP	Market transformation program
M&V	Measurement and verification
NTG	Net-to-gross
PUCT	Public Utility Commission of Texas
PV	Photovoltaics
PY	Program Year
QA/QC	Quality assurance/quality control
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
TRM	Technical reference manual
WACC	Weighted average cost of capital
Xcel Energy SPS	Southwestern Public Service Company (Subsidiary of Xcel Energy)

1.0 INTRODUCTION

This document presents the utility impact evaluation results from the third-party evaluation, measurement, and verification (EM&V) results for energy efficiency portfolios implemented in program year (PY) 2018. It is a companion document to Volume 1 of the Statewide Energy Efficiency Portfolio Report. A summary report, “2018 Energy Efficiency Accomplishments,” is also available at www.puc.texas.gov.

PY2018 is the seventh program year evaluated as part of the statewide EM&V effort. The PY2018 scope is targeted impact evaluations for the savings areas of the highest uncertainty identified in the prior program years’ EM&V results. The targeted impact evaluations are concentrated on particular commercial and residential programs and end uses. At the same time, a combination of interval meter data analysis and tracking system reviews provide a due-diligence review of claimed savings for each utility portfolio.

The reviews provided an independent assessment of claimed savings and the accuracy of the program data. 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 PY2018 EM&V plans¹ are based on the prioritization for the EM&V effort. To briefly summarize, the EM&V team identified program types across utilities that have similar program design, delivery, and target markets. We reviewed each program type and prioritized (high, medium, low) based on the following considerations:

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

1.1 Report Organization

Section 1.2 summarizes the evaluation approach. Sections 2 through 10 detail the EM&V results for each utility’s portfolio.

This report contains two appendices. A visual representation of the EM&V database import, review, and validation process can be found in Appendix A. The calculations used for the program administrator

¹Public Utility Commission of Texas EM&V Plans for Texas Utilities’ Energy Efficiency and Load Management Portfolios—Program Year 2018, June 2018.

cost test (PACT, also known as the Utility Cost Test) cost-effectiveness methodology are in Appendix B.

1.2 Evaluation Approach

This section discusses the PY2018 EM&V methodology. The foundation of the evaluation process was to create a statewide EM&V database with a streamlined data request process and secure retrieval system. Complete PY2018 program data was requested from utilities and integrated into the database. A visual representation of the EM&V database import, review, and validation process can be found in Appendix A.

The EM&V database allowed the EM&V team to complete:

- Due-diligence review of claimed savings
- Program tracking system reviews
- Efficient sampling across utilities and programs.

1.2.1 Implementing Impact Evaluations

The impact evaluations are used to calculate realization rates. The realization rate is determined by dividing the evaluated savings by the utility claimed savings. Utility claimed savings are verified in the EM&V database from the tracking systems.

The EM&V team performed a tracking system review and series of desk reviews for an initial assessment of the reasonableness of the claimed savings. Primary data was then collected for sampled projects to further assess the accuracy of the claimed savings.

Demand-side management (DSM) program evaluations routinely employ 90 percent confidence intervals with ± 10 percent precision as the industry standard (“90/10”). A confidence interval is a range of values that is believed—with some stated level of confidence—to contain the true population quantity. The confidence level is the probability that the interval actually contains the target quantity. Precision provides convenient shorthand for expressing the interval believed to contain the estimator; for example, if the estimate is 530 kWh, and the relative precision level is 10 percent, then the interval is 530 ± 53 kWh.

In reporting estimates from a sample, it is essential to provide both the precision and its corresponding confidence level. In general, high levels of confidence can be achieved with wider intervals, while narrower, more precise intervals permit less confidence. In other words, when all else is held constant, there is a trade-off between precision and confidence. As a result, any statement of precision without a corresponding confidence level is incomplete and impossible to interpret. For example, assume the average savings among participants in an appliance program is estimated as 1,000 kWh per year and it is determined this estimate has 16 percent relative precision at the 9 percent confidence level. The same dataset and the same formulas may be used to estimate 10 percent relative precision at the 70 percent confidence level. If the confidence level is not reported, the second formulation would appear to have less uncertainty when in reality the two are identical.

The estimators commonly used in DSM evaluations generally have sampling errors that are approximately normal in distribution. In Texas, EM&V activities were designed to achieve 90/10 confidence and relative precision for gross evaluated savings estimates at the utility portfolio level. This level was achieved via the sampling process used to select a random sample of commercial

participants that received desk reviews, along with census reviews of residential deemed savings and load management savings.

1.2.1.1 Tracking System and Desk Reviews

For each residential program, the EM&V team reviewed the program tracking system and its linkage to any deemed savings tools or methods used to estimate savings at the measure and site level. Then for each medium or high priority program, the EM&V team reviewed a sample of applications entered into the utilities' tracking systems for accuracy and completeness.

Our review accomplished two primary objectives. First, it ensured that the measures installed are consistent with those listed in the tracking system. Second, the desk reviews verified that the savings estimates in the tracking system are consistent with the savings calculated in the deemed calculation tools or tables or M&V methods used to estimate project savings.

The desk reviews included a review of the assumptions used for the savings assumptions and, when available, utility M&V reports gathered through the supplemental data request for sampled projects.

1.2.1.2 On-site M&V

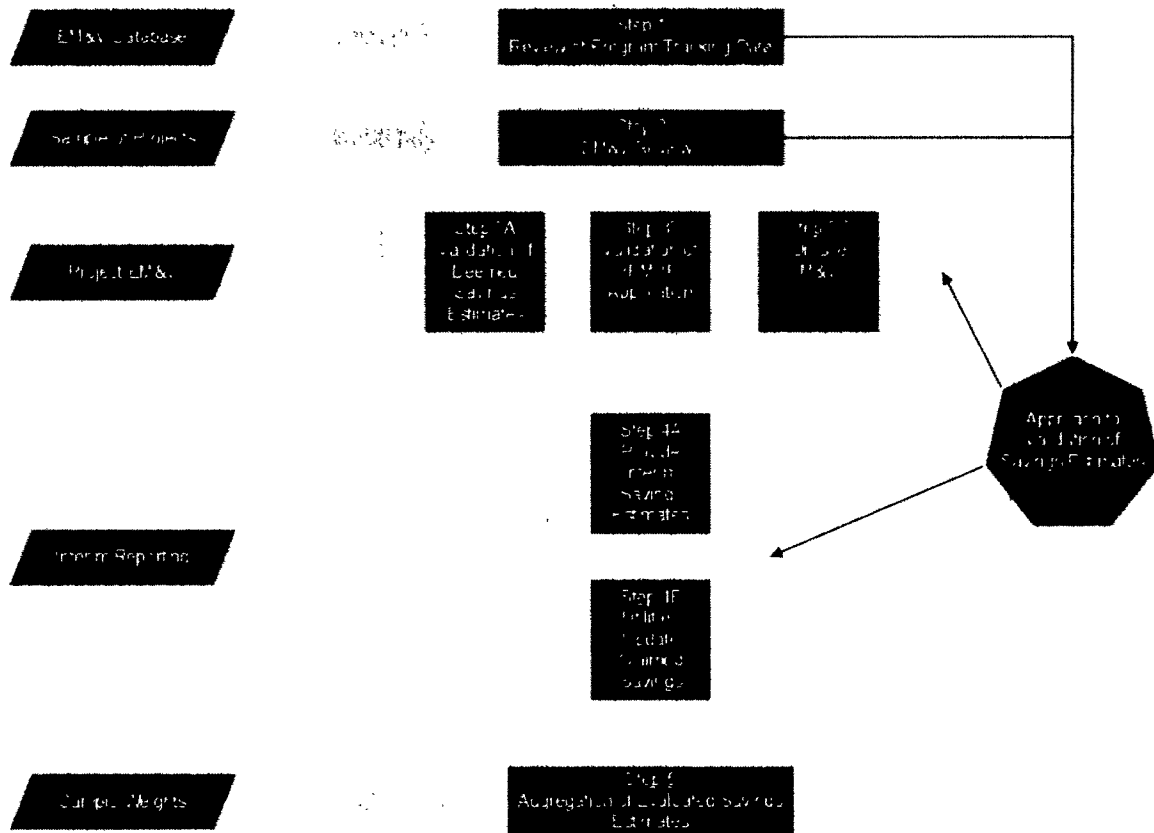
For sampled projects across each utility portfolio, the EM&V team conducted on-site M&V. The on-site visits had two principal objectives: (1) verify installation and operation of the equipment/systems and (2) verify key assumptions made in calculating claimed savings estimates.

- Installations were verified by collecting data on-site related to the number of measures installed, the location of the systems, equipment nameplate information and a visual inspection to ensure the systems are working as intended. This was a basic inspection audit that took approximately one to two hours to complete.
- Site measurements, spot metering, and/or short (and in some cases) long-term metering were completed to develop an independent estimate of savings to compare to the utility's claimed savings estimates. This was a more comprehensive audit that sought to verify key input assumptions used to develop ex-ante claimed savings estimates from deemed savings algorithms or M&V plans for custom projects such as baseline energy use, operating hours, efficiency performance, and potentially interactive effects.

1.2.1.3 Realization Rates

The evaluated savings are based on project-level realization rate calculations that are then weighted to represent program-level and then portfolio-level realization rates. These realization rates incorporate any adjustments for incorrect application of deemed savings values and any equipment details determined through the tracking system and desk reviews. For example, baseline assumptions or hours of use may be corrected through the evaluation and thus affect the realization rates. In order to calculate evaluated savings, we apply the realization rate determined from the EM&V sample to the population of projects. A flow chart of the realization rate calculations is shown in Figure 1-1.

Figure 1-1. Realization Rate Flowchart



1.2.1.4 Program Documentation Score

The EM&V team assigned a “program documentation” score of Good, Fair, or Limited based on the level of program documentation provided to complete a third-party, due-diligence review of claimed savings.

Program documentation scores were assigned as follows:

- **Good:** ≥ 90 percent of sampled projects have sufficient documentation.
- **Fair:** 70 percent–<90 percent of sampled projects have sufficient documentation; the remaining sampled projects had Limited or no documentation. Medium uncertainty was also given to nonresidential programs that had utility M&V results available to verify savings in place of other supporting documentation with the needed equipment quantity and specification information such as equipment cut sheets.
- **Limited:** <70 percent of sampled projects have sufficient documentation; the remaining sampled projects had Limited or no documentation.

Sufficient documentation is defined as the necessary information required to verify savings. For nonresidential programs, this included completed savings calculators, customer invoices, pre- and post-inspection reports, and equipment cut sheets. For residential programs, documentation provided all

inputs needed to replicate the savings calculations based on the deemed savings manual or the approved calculation method as well as supporting materials.

Limited documentation is defined as documentation was provided to verify some, but not all key inputs to savings calculations.

No documentation is defined as only the savings calculator or measure attributes were provided with no supporting materials.

1.2.2 Cost-effectiveness Testing

The EM&V team conducted cost-effectiveness testing using the PACT method using PY2018 actual results, except for low-income programs, as discussed below. Cost-effectiveness tests were run using a uniform model for all utilities. The EM&V team collected required inputs for the model from several sources, including program tracking data, deemed savings, and the PUCT and utilities. Table 1-1 lists the required inputs to the cost-effectiveness model and the sources of information.

Table 1-1. Cost-effectiveness Model Inputs and Sources

Model Input	Measurement Level	Source
Reported energy/demand savings	Measure type	EM&V database
Summer/winter peak coincidence factors	Measure type	Deemed savings
Effective useful life	Measure type	Deemed savings
Incentive payments	Program	EEPRs
Administrative and research and development (R&D) costs	Program/portfolio	EEPRs
EM&V costs ²	Program/portfolio	EM&V team budgets
Performance bonus ³	Portfolio	EEPRs
Avoided costs	Statewide	PUCT (utilities)
Weighted average cost of capital (WACC)	Utility	Utilities
Line loss factor (non-ERCOT utilities only)	Utility	Utilities
Realization rates	Program	Evaluation results

The EM&V team conducted PY2018 cost-effectiveness tests separately using claimed gross savings and evaluated gross savings. The model produces results at the portfolio, program category,⁴ and program levels.

All benefits and costs are expressed in program year dollars. Benefits resulting from energy savings occurring in future years are net to program year dollars using the utility's weighted average cost of capital (WACC) as the discount rate.

² EM&V costs were not known at the time of utilities' original cost-effectiveness analysis.

³ Performance bonuses as an input into cost-effectiveness testing came into effect in 2012.

⁴ Program categories are currently defined as Commercial, Residential, Low Income, Load Management, and Pilots.

When tests were conducted at a more disaggregated level than data was available, that data was allocated proportionate to costs (§ 25.181 (h)(6)). For example, the performance bonus was calculated for the overall portfolio and allocated to individual programs proportionate to the programs' costs associated with meeting demand and energy goals. These program costs include program administrative and incentive costs. Portfolio-level costs include the performance bonus, EM&V, administrative, and R&D costs.

Low-income programs were evaluated using the savings-to-investment ratio (SIR). This model only includes net incentive payments under program costs. The SIR methodology is only used when specifically testing the low-income programs.

Portfolio-level cost-effectiveness analyses are based on the PACT and are shown including and excluding low-income and low-income/hard-to-reach customers.

The calculations used for the PACT cost-effectiveness methodology are in Appendix B.

In addition, the EM&V team reported the cost per lifetime kWh and kW. This is calculated by attributing costs to energy savings and avoided demand based on their portion of total benefits and applying that proportion to the total program costs.

1.2.3 Reporting

There are two EM&V report deliverables per program year: (1) Interim Impact Evaluation reports and (2) the Annual Statewide Portfolio report. There are also a number of status reports, ad hoc reports, data collection and sampling deliverables, and interim results.

The Interim Impact Evaluation reports are delivered separately for each utility and discussed with the PUCT and each utility *prior to drafting the Annual Statewide Portfolio Report*. This allows the EM&V team to discuss the impact results with the PUCT and utilities, receive their input, and conduct supplemental analysis if needed prior to the Annual Statewide Portfolio report. The Annual Statewide Portfolio report is a comprehensive report across all utility portfolios.

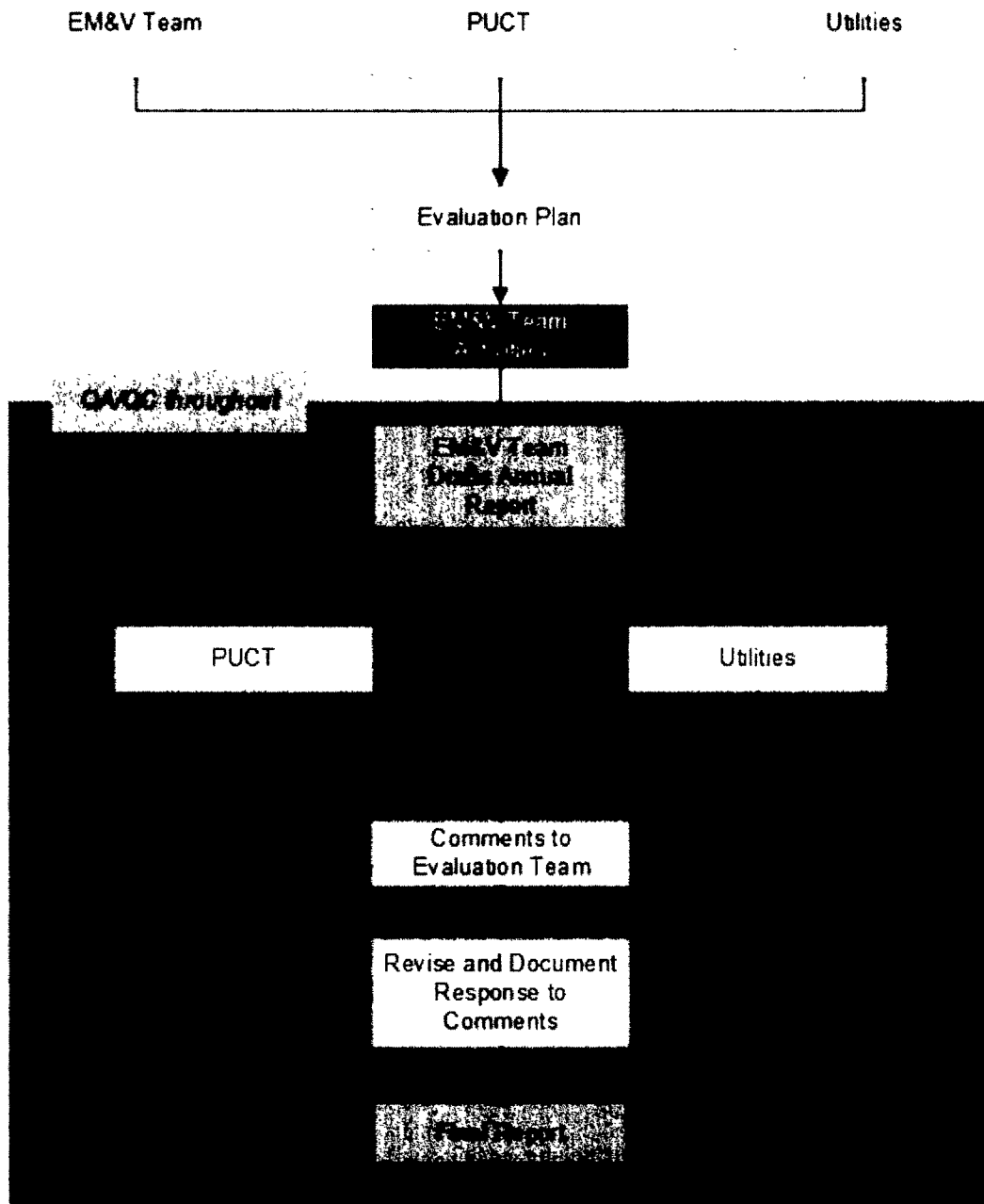
For PY2018, the metrics to be used as the basis for recommendations in the reports are the program's gross savings realization rate and associated program documentation score, tracking system and interval meter data reviews, desk review and on-site M&V findings including site-specific realization rates, and programs' cost-effectiveness.

The EM&V database is at the core of reporting results. It houses the claimed and evaluated savings. The database allows structured queries to provide results by utilities, program categories and types, measure types, and/or sectors. Quality assurance and quality control are conducted to ensure that results being entered into and extracted from the database are accurate. The EM&V team's quality assurance/quality control (QA/QC) plan for the reported evaluated savings is in Appendix C.

The EM&V team encourages feedback and comments on EM&V reports. The EM&V team reviews feedback and documents how it was taken into consideration in finalizing deliverables. While the interim impact reports are distributed and reviewed separately for each utility, the EM&V team seeks input from a larger group of stakeholders on the Annual Statewide Portfolio Report. These are presented and discussed at EEIP meetings between draft and final versions.

The flow chart in Figure 1-2 describes the general reporting process flow.

Figure 1-2. Reporting Flow Chart



2.0 AEP TCC IMPACT EVALUATION RESULTS

This section presents the evaluated savings and cost-effectiveness results for AEP TCC's energy efficiency portfolio. The key findings are summarized first, followed by details for each program in the portfolio that had a high or medium evaluation priority. Finally, we include a list of the low evaluation priority programs for which claimed savings were verified through the EM&V database.

2.1 Key Findings

2.1.1 Evaluated Savings

AEP TCC's evaluated savings for PY2018 were 43,812 in demand (kW) and 62,423,061 in energy (kWh) savings. The overall kW and kWh portfolio realization rates are 100 percent. AEP TCC was responsive to all EM&V recommendations to adjust claimed savings based on EM&V results (see Table 2-4), which also supported healthy realization rates.

Table 2-1 shows the claimed and evaluated demand savings for AEP TCC's portfolio and broad customer sector/program categories.

Table 2-1. AEP TCC PY2018 Claimed and Evaluated Demand Savings

Level of Analysis	Percent Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Precision at 90% Confidence
Total Portfolio	100.0%	43,812	43,812	100.0%	0.2%
Commercial	19.9%	8,733	8,733	100.0%	0.1%
Residential	24.2%	10,597	10,597	100.0%	0.8%
Low Income	1.8%	805	805	100.0%	n/a
Load Management	54.0%	23,677	23,677	100.0%	0.0%

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

Table 2-2 shows the claimed and evaluated energy savings for AEP TCC's portfolio and broad customer sector/program categories for PY2018.

Table 2-2. AEP TCC PY2018 Claimed and Evaluated Energy Savings

Level of Analysis	Percent Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Precision at 90% Confidence
Total Portfolio	100.0%	62,416,805	62,423,061	100.0%	0.1%
Commercial	64.9%	40,483,377	40,489,770	100.0%	0.1%
Residential	33.0%	20,600,854	20,600,716	100.0%	0.3%
Low Income	2.1%	1,308,897	1,308,897	100.0%	n/a

Level of Analysis	Percent Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Precision at 90% Confidence
Load Management	0.0%	23,677	23,677	100.0%	0.0%

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

Program-level realization rates are discussed in the detailed findings sub-sections. 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 program documentation score of Good, Fair, or Limited. For the overall utility program documentation score, the score of Good was given if 90 percent or more of the evaluated savings estimates received a score of Good or Fair due to program documentation received as indicated in detailed program findings. A score of Fair was given if 70 percent–89 percent of the evaluated savings estimates received a score of Good or Fair. A score of Limited was given if less than 70 percent of savings received score of Good or Fair. In general, a score of Good indicates the utility has established processes to collect sufficient documentation to verify savings; a score of Fair also indicates established processes with some areas of improvements identified; and a score of Limited indicates program documentation improvements across more individual programs and/or high savings programs have been identified.

AEP TCC received a Good program documentation score for all of its commercial and residential programs where documentation was reviewed by the evaluation team.

2.1.2 Cost-effectiveness Results

AEP TCC's overall portfolio had a cost-effectiveness of 2.16, or 2.34 excluding low-income programs. (See Table 2-3)

The more cost-effective programs were Commercial Solutions Market Transformation Program (MTP) and SCORE/CitySmart Market Transformation Program (MTP). The less cost-effective programs were CoolSaver A/C Tune-Up Market Transformation Program (MTP) and SMART Source Solar PV Market Transformation Program (MTP).

The lifetime cost of evaluated savings was \$0.010 per kWh and \$22.11 per kW.

Table 2-3. AEP TCC Cost-effectiveness Results

Level of Analysis	Claimed Savings Results	Evaluated Savings Results	Net Savings Results
Total Portfolio	2.16	2.16	1.95
Total Portfolio excluding low-income programs	2.34	2.34	2.10
Commercial	2.87	2.87	2.59
Commercial Solutions MTP	3.66	3.66	3.29
Commercial SOP	3.35	3.36	3.04
CoolSaver A/C Tune-Up MTP	1.34	1.34	1.07

Level of Analysis	Claimed Savings Results	Evaluated Savings Results	Net Savings Results
Open MTP	1.70	1.70	1.62
SCORE/CitySmart MTP	3.56	3.56	3.20
SMART Source Solar PV MTP	2.03	2.03	2.06
Residential	1.88	1.88	1.65
CoolSaver A/C Tune-Up MTP	1.15	1.15	0.92
High-Performance New Homes MTP	2.04	2.04	1.43
Residential SOP	2.12	2.12	1.88
SMART Source Solar PV MTP	1.22	1.22	1.23
Hard-to-Reach SOP	1.75	1.75	1.75
Low Income*	1.50	1.50	1.50
Targeted Low-Income Energy Efficiency Program*	1.50	1.50	1.50
Load Management	2.18	2.18	2.18
Load Management SOP	2.18	2.18	2.18

* The Low Income sector and Low Income Weatherization program are evaluated using the savings-to-investment ratio (SIR).

2.2 Claimed Savings Adjustments

Utilities are provided the opportunity to adjust savings at the project-level based on interim EM&V findings. Table 2-4 summarizes claimed savings adjustments recommended by the EM&V team. Realization rates assume the following adjustments will be included in AEP TCC's June 1 filing.

Table 2-4. EM&V Claimed Savings Adjustments by Program (Prior to EECR⁵ Filing)

Program	EM&V Demand Claimed Savings Adjustments (kW)	EM&V Energy Claimed Savings Adjustments (kWh)
Commercial Solutions MTP (Com)	1.10	2,566.00
Commercial SOP (Com)	15.70	491,545.00
Open MTP (Com)	-1.20	-6,921.10
SCORE/CitySmart MTP (Com)	15.20	103,782.00
Hard-to-Reach SOP (HTR)	-0.20	-319.50
Residential SOP (Res)	0.10	-218.90
Total	30.70	590,433.50

⁵ Energy Efficiency Cost Recovery

2.3 Detailed Findings—Commercial (Medium Evaluation Priority)

2.3.1 Commercial Solutions Market Transformation Program (MTP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (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%	1,083	1,083	100.0%	8.7%	5,459,625	5,458,222	100.0%	Good
Completed Desk Reviews*		On-Site M&V						
6		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 PY2018 Commercial Solutions MTP evaluation efforts focused on desk reviews and on-site M&V. The number of completed desk reviews and on-site M&V projects for this program are listed above.

The EM&V team adjusted the claimed savings for three projects. Two projects had adjustments of less than 5 percent and one project had adjustments greater than 5 percent compared to the original claimed savings. AEP TCC accepted the evaluated results and matched the claimed savings to those of the evaluations for the project with significant adjustments and therefore the final program realization rate is nearly 100 percent. Further details of the EM&V findings are provided below.

Participant ID 1133394: The energy efficiency project included an early replacement of HVAC equipment, interior lighting retrofits with controls, and exterior lighting retrofits at an office building. During the desk review and on-site M&V visit, the EM&V team adjusted the unit quantity in the HVAC portion of the project (11 units instead of 10 claimed) and corrected the capacity of the baseline equipment from nominal capacity to rated capacity. Because of the nature of the project, a 1-for-1 replacement calculation was not possible. One of the installed units was set to be ineligible by the implementer due to a rule that disqualifies savings for equipment sized outside of 20 percent of the pre-retrofit unit size. This rule was not applied in this specific case because the overall project difference between total cooling capacity of all pre- and post-equipment is minimal, only 1 ton out of 55-tons total, or about 2 percent difference. The cooling capacity was adjusted for six of eight baseline entries based on the Air-conditioning, Heating, and Refrigeration Institute (AHRI) rated cooling capacity. This resulted in a total rated cooling capacity baseline of 655,500 BTU/hr, which is close to the installed rated capacity of the 11 installed units, 643,500 BTU/hr. The reduced baseline capacity reduced the demand and energy savings, but the deemed efficiency values were unaffected. For the lighting and controls portion of the project, post-retrofit equipment inventory in the submitted calculator appeared to be entered erroneously. Therefore, several line items were removed from the final savings calculation. The EM&V team also adjusted the wattage for some interior fixtures using DLC certifications matching the model number listed in the invoice (2GTL4 A12 120 LP840), as the DLC certification provided was from 2015 and did not match the model number exactly. The wattage was adjusted from 39W claimed to 29W. This increased the peak demand and energy savings. Also, the model number of the outdoor wall pack fixture was identified as ANJEET WP-0041, which was claimed to be DLC-certified, but no certification was found for the model number. The EM&V team corrected the qualification from "DLC" to "Non-qualified." Overall, the adjustments for both portions of the project resulted in an

increase in demand and energy savings and realization rates of 107 percent kW and 104 percent kWh.

Participant ID 1154681: The energy efficiency project included interior lighting retrofits at a non-24-hr supermarket. During the desk review and on-site M&V visit, the EM&V team corrected fixture quantities. The post-retrofit 19W LED fixture quantity was adjusted to match the existing quantity of 27 fixtures, as seven more fixtures were installed per on-site findings. This adjustment slightly decreased the energy and demand savings and resulted in realization rates of 99 percent kW and kWh.

Participant ID 1153005: The energy efficiency project included interior lighting retrofits at a retail building. During the desk review, the EM&V team adjusted the LED tube wattage from 10W claimed to 10.5W to match DLC qualified products list since version 2018.5 of the LSF calculator allows for wattages in 0.5 increments (up to 25W). This adjustment resulted in a decrease in energy and demand savings and realization rates of 97 percent kW and kWh.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications, AHRI certifications) for all projects that had desk reviews completed because sufficient documentation was provided for the sites. Project documentation included invoices, QPL qualifications and/or AHRI certifications, pre- and post-inspection notes, the project savings calculators and photographic documentation of existing and new equipment, which are significant efforts by the utility to verify equipment conditions and quantities. Since sufficient documentation was provided for all projects, the EM&V team assigned a program documentation score of Good.

2.3.2 Commercial Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
7.4%	3,222	3,222	100.0%	29.4%	18,321,586	18,329,302	100.0%	Good

Completed Desk Reviews*	On-Site M&V
13	6

*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 PY2018 Commercial SOP evaluation efforts focused on desk reviews and on-site M&V. The number of completed desk reviews and on-site M&V projects for this program are listed above.

The EM&V team adjusted the claimed savings for eight projects. Three projects had adjustments of less than 5 percent and five projects had adjustments greater than 5 percent compared to the original claimed savings. AEP TCC accepted the evaluated results and matched the claimed savings to those of the evaluations for the projects with significant adjustments and therefore the final program realization rate is 100 percent. Further details of the EM&V findings are provided below.

Participant ID 1113074: The energy efficiency project included the installation of an Energy Star roof at a retail building. During the desk review and on-site M&V visit, the EM&V team reduced the total roof square footage by approximately 900 square feet based on on-site measurement. This

adjustment reduced demand and energy savings and resulted in realization rates of 95 percent kW and kWh.

Participant ID 1113079: The energy efficiency project included interior lighting retrofits with some controls at an office building. During the desk review and on-site M&V visit, the EM&V team corrected the building type selection for interior lighting from "Service Non-Food" to "Office." The on-site visit also found that all lighting controls were relay-switch only and did not qualify as automated controls. Therefore, post-retrofit equipment occupancy sensors were adjusted to "None." In addition, the pre-retrofit fixture code in the elevator was adjusted from 4-lamp to single lamp. The post-retrofit equipment wattage was also adjusted from 20W to 20.5W to match DLC qualified products list since version 2018.5 of the LSF calculator allows for wattages in 0.5 increments (up to 25W). Some flood lighting fixtures were moved from exterior inventory of Participant ID 1113080 to exterior inventory of Participant ID 1113079, as this project focused on the administration building. Overall, these adjustments resulted in a decrease in energy and demand savings and realization rates of 95 percent kW and 97 percent kWh.

Participant ID 1113080: The energy efficiency project included interior lighting retrofits with some controls, and exterior lighting retrofits at a non-food service shop. During the desk review and on-site M&V visit, the EM&V team adjusted the LED wattage for some of the installed interior and exterior fixtures using the DLC qualified products list, from 35W claimed to 28W, from 18W claimed to 21W, and from 80W claimed to 81W. In addition, some flood lighting fixtures were moved from exterior inventory of Participant ID 1113080 to exterior lighting of Participant ID 1113079, as that project focused on the administration building. Overall, the adjustments decreased energy and demand savings and resulted in realization rates of 98 percent kW and kWh.

Participant ID 1139122: The energy efficiency project included interior lighting retrofits at a non-refrigerated warehouse with attached offices. During the desk review and on-site M&V visit, the EM&V team corrected the building type selection from "Non-Refrigerated Warehouse" to "Office" for the deemed portion of the project. The coincidence factor (CF) for both building types is the same, however the annual operating hours (HOU) associated with office buildings is 3,737 hours more than a non-refrigerated warehouse, 3,501 hours, which slightly increased the savings. The EM&V team also adjusted the wattage of the 300W LED fixtures to 302W using the DLC qualified products list, which slightly decreased the evaluated savings. Overall, the adjustments resulted in realization rates of 100 percent kW and 101 percent kWh.

Participant ID 1141283: The energy efficiency project included interior lighting retrofits at a non-refrigerated warehouse. During the desk review and on-site M&V visit, the EM&V team adjusted the air conditioning type from "Air-Conditioned" to "None" and the pre- and post-install controls were corrected from "DL-On/Off" to "None." Overall, the adjustments resulted in a significant increase in energy and demand savings and realization rates of 126 percent kW and 132 percent kWh.

Participant ID 1139123: The energy efficiency project included interior lighting retrofits at an enclosed mall retail building. During the desk review and on-site M&V visit, the EM&V team adjusted the LED wattage for some of the installed fixtures using the DLC qualified products list, from 43W claimed to 26W, and from 13W claimed to 13.5W. The latter adjustment was a result of using version 2018.5 of the LSF calculator, which allows for wattages in 0.5 increments (up to 25W). In addition, some of the fixture qualifications were corrected from "Non-qualified" to "DLC." Overall, the adjustments increased demand and energy savings and resulted in realization rates of 106 percent kW and kWh.

Participant ID 1183625: The energy efficiency project included interior lighting retrofits at a retail building. During the desk review, the EM&V team corrected the building type selection for interior lighting from “Retail (Other)” to “Retail/Supermarket 24-hr.” This adjustment resulted in a significant increase in energy savings and realization rates of 106 percent kW and 188 percent kWh.

Participant ID 1183900: The energy efficiency project included interior and exterior lighting retrofits at a school. During the desk review, the EM&V team adjusted the LED wattage for some of the installed fixtures from 28W claimed to 29W using the DLC qualified products list. This adjustment resulted in a negligible decrease in energy savings and realization rates of 100 percent kW and kWh.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications, AHRI certifications) for all projects that had desk reviews completed because sufficient documentation was provided for the sites. Project documentation included invoices, QPL qualifications and/or AHRI certifications, pre- and post-inspection notes, the project savings calculators and photographic documentation of existing and new equipment, which are significant efforts by the utility to verify equipment conditions and quantities. However, partial documentation was provided for one lighting project. The final ex-ante calculator was missing for the project, but the EM&V team was able to complete the evaluation using other documentation such as invoices. Since sufficient documentation was provided for all projects, the EM&V team assigned a program documentation score of Good.

2.3.3 Open Market Transformation Program (MTP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (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%	844	844	100.0%	5.7%	3,536,803	3,536,884	100.0%	Good

Completed Desk Reviews*	On-Site M&V
10	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 PY2018 Open MTP evaluation efforts focused on desk reviews and on-site M&V. The number of completed desk reviews and on-site M&V projects for this program are listed above.

The evaluated savings differed from the original claimed savings for eight projects. Two projects had adjustments of less than 5 percent and six projects had adjustments greater than 5 percent compared to the original claimed savings. AEP TCC accepted the evaluated results and matched the claimed savings to those of the evaluations for the projects with significant adjustments and therefore the final program realization rate is 100 percent. Further details of the EM&V findings are provided below.

Participant ID 1131941: The energy efficiency project included interior lighting retrofits at a day care building. During the desk review and on-site M&V visit, the EM&V team adjusted the fixture

quantity for some LED tubes; 10 fewer 18W LED tubes were found in the interior spaces. This correction resulted in an increase in demand and energy savings and realization rates of 106 percent kW and kWh.

Participant ID 1133107: The energy efficiency project included interior lighting retrofits at a strip mall retail store. During the desk review, the EM&V team adjusted the LED fixture wattage using the DLC qualified products list. All 114 LED tubes were adjusted from 18W claimed to 21W. This correction decreased demand and energy savings and resulted in realization rates of 92 percent kW and kWh.

Participant ID 1133549: The energy efficiency project included interior and exterior lighting retrofits at an office building. During the desk review and on-site M&V visit, the EM&V team adjusted fixture wattages, fixture codes, and fixture quantities. Wattages were adjusted from 10W and 20W to 9.5W and 20.5W respectively since version 2018.5 of the LSF calculator allows for wattages in 0.5 increments (up to 25W) that match the rated wattages. In addition, the pre-retrofit fixture code of the compact fluorescent bulbs was adjusted from I30/1 to CF30/1-SCRW. This shifted savings from LED to Integrated Ballast LED. The baseline fixture counts were also adjusted from 112 to 116 per on-site findings. The installed LED tube count was adjusted from 124 to 132, as the project was a 2-lamp per fixture retrofit, and no additional indoor fixtures were added to existing inventory. Overall, the corrections resulted in a slight increase in demand and energy savings and realization rates of 102 percent kW and kWh.

Participant ID 1153229: The energy efficiency project included interior lighting retrofits at a retail building. During the desk review, the EM&V team adjusted the LED wattage for some of the installed fixtures from 18W claimed to 21W using the DLC qualified products list. This adjustment decreased demand and energy savings and resulted in realization rates of 92 percent kW and kWh.

Participant ID 1154642: The energy efficiency project included interior lighting retrofits at a strip mall retail store. During the desk review and on-site M&V visit, the EM&V team found slight differences in fixture quantities and minor corrections to fixture wattages to coincide with the site verified lighting model number installed and using the DLC qualified products list. The primary adjustment was the wattage of LED tubes, which was adjusted from 18W claimed to 21W. Overall, the corrections resulted in a decrease in demand and energy savings and realization rates of 88 percent kW and kWh.

Participant ID 1156862: The energy efficiency project included interior and exterior lighting retrofits at a strip mall retail store. During the desk review, the EM&V team corrected some of the fixtures from exterior to interior lighting. Twelve incandescent lamps were replaced with 12 LED lamps and were claimed as exterior lighting. However, the post-inspection photos indicated that the lamps were located inside the store. This adjustment increased demand and energy savings and resulted in realization rates of 108 percent kW and 101 percent kWh.

Participant ID 1156875: The energy efficiency project included interior lighting retrofits at a health out-patient building. During the desk review and on-site M&V visit, the EM&V team adjusted fixture wattages. Lighting tube wattages were adjusted from 15W and 17W to 14.5W and 17.5W respectively since version 2018.5 of the LSF calculator allows for wattages in 0.5 increments (up to 25W). In addition, the wattage of the existing halogen bulbs was adjusted from 35W to 38W based on the provided photo. Overall, the corrections resulted in a slight increase in demand and energy savings and realization rates of 102 percent kW and kWh.

Participant ID 1131889: The energy efficiency project included interior and exterior lighting retrofits at a non-food service building. During the desk review and on-site M&V visit, the EM&V team

adjusted fixture quantities and wattages. Several interior and exterior fixtures were removed from claimed savings per on-site findings. In addition, the EM&V team found that the existing wall pack fixture that was meant to be replaced was inoperable. The wattage of some interior LED fixtures was also adjusted from 120 to 116 using DLC qualified products list. The total quantity of this corncob style LED fixture was adjusted from 29 to 27 per on-site findings. Overall, the corrections decreased demand and energy savings and resulted in realization rates of 97 percent kW and 95 percent kWh.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications, AHRI certifications) for all projects that had desk reviews completed because sufficient documentation was provided for the sites. Project documentation included invoices, QPL qualifications and/or AHRI certifications, pre- and post-inspection notes, the project savings calculators and photographic documentation of existing and new equipment, which are significant efforts by the utility to verify equipment conditions and quantities. Since sufficient documentation was provided for all projects, the EM&V team assigned a program documentation score of Good.

2.3.4 SCORE/CitySmart Market Transformation Program (MTP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (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%	1,796	1,796	100.0%	14 3%	8,924,060	8,924,060	100 0%	Good

Completed Desk Reviews*	On-Site M&V
4	2

*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 PY2018 SCORE/CitySmart MTP evaluation efforts focused on desk reviews and on-site M&V. The number of completed desk reviews and on-site M&V projects for this program are listed above.

The EM&V team adjusted the claimed savings for one project. The project had adjustments greater than 5 percent compared to the original claimed savings. AEP TCC accepted the evaluated results and matched the claimed savings to those of the evaluations for the project with significant adjustments and therefore the final program realization rate is 100 percent. Further details of the EM&V findings are provided below.

Participant ID 1154607: The energy efficiency project included interior and exterior lighting retrofits at a school. During the desk review and on-site M&V visit, the EM&V team adjusted fixture wattages, fixture codes, and fixture quantities. For the interior lighting portion of the project, some pre-retrofit fixture codes were adjusted from F44T12 to F42T12, and the quantities for post-retrofit 18W LED fixtures were corrected from 204 claimed to 192, from 1,764 claimed to 1,756, and from 1,356 claimed to 1,362 per on-site findings. For the exterior lighting portion of the project, the EM&V team adjusted the post-retrofit wattage for some fixtures from 50W to 48W using DLC qualified products list. Qualification was also adjusted for three LED fixtures (LED048, LED152, and LED030) from "Non-Qualified" to "DLC" and "ENERGY STAR®" respectively. The quantities of

these fixtures were installed one for one. Overall, the corrections significantly increased demand and energy savings and resulted in realization rates of 131 percent kW and 137 percent kWh.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications, AHRI certifications) for all projects that had desk reviews completed because sufficient documentation was provided for the sites. Project documentation included invoices, QPL qualifications and/or AHRI certifications, pre- and post-inspection notes, the project savings calculators and photographic documentation of existing and new equipment, which are significant efforts by the utility to verify equipment conditions and quantities. Since sufficient documentation was provided for all projects, the EM&V team assigned a program documentation score of Good.

2.4 Detailed Findings—Residential (High/Medium Evaluation Priority)

2.4.1 High Performance New Homes Market Transformation Program (MTP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
2.4%	1,035	1,035	100.0%	4.6%	2,842,771	2,842,771	100.0%	Good

Completed Desk Reviews*	On-Site M&V
9	0

*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 PY2018 impact evaluation efforts focused on desk reviews. The number of sampled and completed desk reviews for this program is listed above.

The EM&V team focused on reviewing documentation for program homes. This program relies on a proprietary energy model; however, that model is built on DOE-2 energy modeling software that is listed as an acceptable savings estimation method in the TRM.

We received two types of documentation from the program: REM/Rate files that provided the inputs that fed into the energy models and detailed output files that provided the results of the energy model analysis. We reviewed the REM/Rate files to ensure that all homes met stated program requirements, and that the files contained all inputs required by the DOE-2-based model. We compared the results of the model to the claimed savings in the tracking database and found that all of the model output files matched the claimed savings in the tracking data. We did not recommend any adjustments for this program.

Documentation Score

For all sampled projects, the EM&V team was able to verify key inputs and assumptions (e.g., energy model inputs and detailed model outputs). Because sufficient documentation was provided for all the reviewed projects, the EM&V team assigned a program documentation score of Good.

2.4.2 Residential Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
14.5%	6,373	6,373	100.0%	17.0%	10,617,931	10,617,891	100.0%	Good

Completed Desk Reviews*	On-Site M&V
12	6

*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 PY2018 evaluation efforts focused on desk reviews and on-site M&V. The number of sampled and completed desk reviews and on-site M&V projects for this program are listed above.

The EM&V team made an adjustment of more than 5 percent to the claimed savings for five projects. Overall, the EM&V team assessed ex-ante claimed energy and demand savings across the following two activities:

- For a sample of projects, desk reviews were completed to check that measure data collected by contractors on forms aligned correctly with data in the tracking system.
- On-site M&V was completed for a sample of projects to verify that measures remained installed and matched project documentation.

Desk reviews were completed for 12 projects and resulted in desk review realization rates of 100.2 percent and 98.7 percent for demand and energy savings, respectively. There were minor differences between ex-ante and ex post savings for LEDs due to rounding. On-site M&V was completed for six projects and resulted in on-site realization rates of 99.8 percent and 96.1 percent for demand and energy savings, respectively. Further details for the projects where adjustments were made, including the EM&V findings, are provided below.

Participant ID 1113650: The energy efficiency project included implementation of air infiltration, duct sealing, and LED measures. The EM&V team's on-site testing resulted in a substantially higher reduction in air infiltration and duct sealing than what was documented by the program. Using a threshold of +/- 10 percent, the EM&V team's blower door test and duct blaster test results were quite a bit lower than the results found in the tracking data. Additionally, minor adjustments were made to the LED measure. Overall, the adjustments resulted in project level realization rates of 136.7 percent and 135.1 percent for demand and energy savings, respectively.

Participant ID 1113709: The energy efficiency project included implementation of air infiltration and duct sealing. The EM&V team verified that the results found in the tracking system data matched the results found in the documentation. The EM&V team initially calculated savings using the information in the tracking data and documentation but was unable to replicate the reported savings. The EM&V team then worked to replicate reported savings using alternative inputs for heating, cooling, or climate zone, but was unable to do so. As a result, the EM&V team adjusted savings based on the results found in the documentation package received for this project ID. Overall, the adjustments resulted in project level realization rates of 110.6 percent and 107.8 percent for demand and energy savings, respectively.

Participant ID 1114318: The energy efficiency project included implementation of duct sealing, low flow shower heads, low flow faucet aerators, and LED measures. Through the on-site visit, the

EM&V team found that the low flow showerhead had been uninstalled and replaced with a showerhead equivalent to the baseline. The EM&V team also measured the flow rate of the installed low flow faucet aerator and determined it was 1.0 gallons per minute and not 0.5 gallons per minute, per the tracking data. As a result, the EM&V team zeroed out savings for the low flow showerhead and adjusted the low flow faucet aerator savings accordingly. Overall, the adjustments resulted in project level realization rates of 68.0 percent and 71.8 percent for demand and energy savings, respectively.

Participant ID 1114684: The energy efficiency project included implementation of air infiltration, duct sealing, and LED measures. The EM&V team's on-site testing resulted in a substantially lower reduction in duct leakage than what was documented by the program. Using a threshold of +/- 10 percent, the EM&V team's duct blaster test results were still quite a bit higher than the results found in the tracking data. Overall, the adjustments resulted in project level realization rates of 82.6 percent and 82.9 percent for demand and energy savings, respectively.

Participant ID 1115659: The energy efficiency project included implementation of air infiltration, low flow shower heads, low flow faucet aerators, and LED measures. Through the on-site visit, the EM&V team found that the low flow showerhead had been uninstalled and replaced with a showerhead equivalent to the baseline. As a result, the EM&V team zeroed out savings for the low flow showerhead and adjusted accordingly. Overall, the adjustments resulted in project level realization rates of 89.0 percent and 80.1 percent for demand and energy savings, respectively.

Documentation Score

For all sampled projects, the EM&V team was able to verify key inputs and assumptions (e.g., pre- and post-condition test results) for air infiltration and duct efficiency. There was limited documentation for direct installs such as LEDs, low flow showerheads, and low flow faucet aerators. Because sufficient documentation was provided for most of the measures across all the reviewed projects, the EM&V team assigned a program documentation score of Good.

2.4.3 Hard-to-Reach Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
4.8%	2,113	2,113	100.0%	5.8%	3,592,816	3,592,719	100.0%	Good

Completed Desk Reviews*	On-Site M&V
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 PY2018 evaluation efforts focused on desk reviews and on-site M&V. The number of sampled and completed desk reviews and on-site M&V projects for this program are listed above.

The EM&V team made an adjustment of more than 5 percent to the claimed savings for one project. Overall, the EM&V team assessed ex-ante claimed energy and demand savings across the following two activities:

- For a sample of projects, desk reviews were completed to check that measure data collected by contractors on forms aligned correctly with data in the tracking system.
- On-site M&V was completed for a sample of projects to verify that measures remained installed and matched project documentation.

Desk reviews were completed for eight projects and resulted in desk review realization rates of 99.8 percent and 96.7 percent for demand and energy savings, respectively. On-site M&V was completed for four projects and resulted in on-site realization rates of 99.8 percent and 95.1 percent for demand and energy savings, respectively. Further details for the single project where adjustments were made, including the EM&V findings, are provided below.

Participant ID 1117483: The energy efficiency project included implementation of air infiltration and duct sealing. The EM&V team's on-site testing resulted in a substantially lower reduction in air infiltration than what was documented by the program. Using a threshold of +/- 10 percent, the EM&V team's blower door test results were quite a bit higher than the results found in the tracking data. The EM&V team noted that the HVAC closet ceiling had been cut away to make room for the gas furnace exhaust piping. Per the homeowner, they had the HVAC unit replaced after the initial project was implemented. The area cut away exposed a hole into the attic that likely contributed to the additional infiltration. Overall, the adjustments resulted in project level realization rates of 67.3 percent and 69.5 percent for demand and energy savings, respectively.

Documentation Score

For all sampled projects, the EM&V team was able to verify key inputs and assumptions (e.g., pre- and post-condition test results) for air infiltration and duct efficiency. There was limited documentation for direct installs such as LEDs. Because sufficient documentation was provided for most of the measures across all the reviewed projects, the EM&V team assigned a program documentation score of Good.

2.5 Detailed Findings—Load Management (High Evaluation Priority)

2.5.1 Load Management Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
54.0%	23,677	23,677	100.0%	0.0%	23,677	23,677	100.0%	Good

Completed Desk Reviews*	On-Site M&V
N/A	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 resulting level of load curtailment achieved for each event for all participants.

The EM&V team evaluated the AEP TCC Commercial Load Management Program by applying the TRM calculation methodology to interval meter data. The meter data was supplied in 15-minute increments at the Electric Service Identifier (ESI ID) level. Load management events occurred on the following dates and times:

- May 31, 2018, from 4:00 p.m. to 5:00 p.m. (scheduled)

- August 10, 2018, from 1:00 p.m.to 2:00 p.m. (scheduled)

The EM&V team received the interval meter data and a spreadsheet detailing the AEP TCC calculated event level savings for each ESI ID enrolled in the program. All ESI IDs participated in only one of the two scheduled events. The EM&V team found that all savings calculated by AEP TCC matched those of the EM&V Team. As such, no adjustments were made to the program savings.

Evaluated savings for the AEP TCC Load Management program are 23,677 kW and 23,677 kWh. The realization rate for both kW and kWh is 100.0 percent.

2.6 Summary of Low Priority Evaluation Programs

Table 2-5 provides a summary of claimed savings for AEP TCC's PY2018 low evaluation priority programs, which includes each program's overall contribution to portfolio savings. Low priority programs' claimed savings were verified against the final PY2018 tracking data provided to the EM&V team for the EM&V database.

Table 2-5. PY2018 Claimed Savings Low Evaluation Priority Programs

Program	Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)
CoolSaver A/C Tune-Up MTP	3.6%	1,573	1,573	100.0%	5.7%	3,541,794	3,541,794	100.0%
SMART Source Solar PV MTP	0.5%	215	215	100.0%	1.1%	699,508	699,508	100.0%
CoolSaver A/C Tune-Up MTP	2.1%	940	940	100.0%	4.9%	3,088,081	3,088,081	100.0%
SMART Source Solar PV MTP	0.3%	136	136	100.0%	0.7%	459,255	459,255	100.0%
Targeted Low-Income Energy Efficiency Program	1.8%	805	805	100.0%	2.1%	1,308,897	1,308,897	100.0%

3.0 AEP TNC IMPACT EVALUATION RESULTS

This section presents the evaluated savings and cost-effectiveness results for AEP TNC's energy efficiency portfolio. The key findings are summarized first, followed by details for each program in the portfolio that had a high or medium evaluation priority. Finally, we include a list of the low evaluation priority programs for which claimed savings were verified through the EM&V database.

3.1 Key Findings

3.1.1 Evaluated Savings

AEP TNC's evaluated savings for PY2018 were 8,948 in demand (kW) and 12,669,221 in energy (kWh) savings. The overall kW and kWh portfolio realization rates are approximately 100 percent. AEP TNC was responsive to all EM&V recommendations to adjust claimed savings based on EM&V results (see Table 3-4), which also supported healthy realization rates.

Table 3-1 shows the claimed and evaluated demand savings for AEP TNC's portfolio and broad customer sector/program categories.

Table 3-1. AEP TNC PY2018 Claimed and Evaluated Demand Savings

Level of Analysis	Percent Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Precision at 90% Confidence
Total Portfolio	100.0%	8,948	8,948	100.0%	0.5%
Commercial	19.8%	1,773	1,773	100.0%	0.1%
Residential	23.5%	2,104	2,105	100.0%	2.2%
Low Income	1.2%	107	107	100.0%	n/a
Load Management	55.5%	4,963	4,963	100.0%	0.0%

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

Table 3-2 shows the claimed and evaluated energy savings for AEP TNC's portfolio and broad customer sector/program categories for PY2018.

Table 3-2. AEP TNC PY2018 Claimed and Evaluated Energy Savings

Level of Analysis	Percent Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Precision at 90% Confidence
Total Portfolio	100.0%	12,669,276	12,669,221	100.0%	0.5%
Commercial	72.4%	9,171,126	9,170,588	100.0%	0.1%
Residential	26.1%	3,304,568	3,305,049	100.0%	1.9%
Low Income	1.5%	188,620	188,620	100.0%	n/a

Level of Analysis	Percent Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Precision at 90% Confidence
Load Management*	0.0%	4,963	4,963	100.0%	0.0%

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

Program-level realization rates are discussed in the detailed findings sub-sections. 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 program documentation score of Good, Fair, or Limited. For the overall utility program documentation score, the score of Good was given if 90 percent or more of the evaluated savings estimates received a score of Good or Fair due to program documentation received as indicated in detailed program findings. A score of Fair was given if 70 percent–89 percent of the evaluated savings estimates received a score of Good or Fair. A score of Limited was given if less than 70 percent of savings received score of Good or Fair. In general, a score of Good indicates the utility has established processes to collect sufficient documentation to verify savings; a score of Fair also indicates established processes with some areas of improvements identified; and a score of Limited indicates program documentation improvements across more individual programs and/or high savings programs have been identified.

AEP TNC received Good documentation scores for all of its residential and load management programs, and a majority of its commercial programs. Its Commercial SOP received a Fair documentation score, driven by a lack of key project notes and calculations within one project's files.

3.1.2 Cost-effectiveness Results

AEP TNC's overall portfolio had a cost-effectiveness of 2.05, or 2.26 excluding low-income programs. (See Table 3-3.)

The more cost-effective programs were Commercial SOP and Load Management SOP. The less cost-effective programs were the Targeted Low Income Energy Efficiency program and SMART Source Solar PV MTP. The Low Income program is falling slightly short of 1.0 using the savings-to-investment ratio test, as is standard for this program.

The lifetime cost of evaluated savings was \$0.010 per kWh and \$22.55 per kW.

Table 3-3. AEP TNC Cost-effectiveness Results

Level of Analysis	Claimed Savings Results	Evaluated Savings Results	Net Savings Results
Total Portfolio	2.36	2.36	2.18
Total Portfolio excluding low-income programs	2.61	2.61	2.41
Commercial	2.74	2.74	2.50
Commercial Solutions MTP	3.45	3.45	3.10
Commercial SOP	3.78	3.78	3.42

Level of Analysis	Claimed Savings Results	Evaluated Savings Results	Net Savings Results
Open MTP	1.59	1.59	1.51
SCORE/CitySmart MTP	2.80	2.80	2.51
SMART Source Solar PV MTP	1.34	1.34	1.36
Residential	2.35	2.35	2.18
Residential SOP	2.67	2.67	2.36
SMART Source Solar PV MTP	1.55	1.55	1.57
Hard-to-Reach SOP	2.08	2.09	2.09
Low Income*	0.94	0.94	0.94
Targeted Low Income Energy Efficiency Program*	0.94	0.94	0.94
Load Management	3.55	3.55	3.55
Load Management SOP	3.55	3.55	3.55

* The Low Income sector and Low Income Weatherization program are evaluated using the savings-to-investment ratio (SIR).

3.2 Claimed Savings Adjustments

Utilities are provided the opportunity to adjust savings at the project level based on interim EM&V findings. Table 3-4 summarizes claimed savings adjustments recommended by the EM&V team. Realization rates assume the following adjustments will be included in AEP TNC's June 1 filing.

Table 3-4. EM&V Claimed Savings Adjustments by Program (Prior to EECR⁶ Filing)

Program	EM&V Demand Claimed Savings Adjustments (kW)	EM&V Energy Claimed Savings Adjustments (kWh)
Commercial SOP (Com)	0.90	6,065.00
Open MTP (Com)	-1.70	-53,012.40
Hard-to-Reach SOP (HTR)	-1.80	-3,035.10
Total	-2.60	-49,982.50

⁶ Energy Efficiency Cost Recovery

3.3 Detailed Findings—Commercial (Medium Evaluation Priority)

3.3.1 Commercial Solutions Market Transformation Program (MTP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
7.5%	673	673	100.0%	29.2%	3,695,280	3,695,280	100.0%	Good

Completed Desk Reviews*	On-Site M&V
4	2

*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 PY2018 Commercial Solutions MTP evaluation efforts focused on desk reviews and on-site M&V. The number of completed desk reviews and on-site M&V projects for this program are listed above. The EM&V team did not suggest any savings adjustments and therefore the final program realization rate is 100 percent.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications, AHRI certifications) for all projects that had desk reviews completed because sufficient documentation was provided for the sites. Project documentation included invoices, QPL qualifications and/or AHRI certifications, pre- and post-inspection notes, the project savings calculators, and photographic documentation of existing and new equipment, which are significant efforts by the utility to verify equipment conditions and quantities. Since sufficient documentation was provided for all projects, the EM&V team assigned a program documentation score of Good.

3.3.2 Commercial Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
5.0%	445	445	100.0%	19.7%	2,490,444	2,489,631	100.0%	Good

Completed Desk Reviews*	On-Site M&V
4	2

*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 PY2018 Commercial SOP evaluation efforts focused on desk reviews and on-site M&V. The number of completed desk reviews and on-site M&V projects for this program are listed above.

The EM&V team adjusted the claimed savings for four projects. Three projects had adjustments of less than 5 percent and one project had adjustments greater than 5 percent compared to the original

claimed savings. AEP TNC accepted the evaluated results and matched the claimed savings to those of the evaluations for the project with significant adjustments and therefore the final program realization rate is nearly 100 percent. Further details of the EM&V findings are provided below.

Participant ID 1117493: The energy efficiency project included interior and exterior lighting retrofits at a retail building. During the desk review, the EM&V team corrected fixture wattages, quantities, lighting controls, and lighting qualification. For the interior lighting portion of the project, the post-retrofit wattages were adjusted for all fixtures from 53W claimed to 54W, and from 26W and 39W claimed to 15W using the DLC and ENERGY STAR® qualified products list. The quantities were corrected to reflect number of lamps replaced per fixture, and total number of LED lamps installed was confirmed with the provided invoice. In addition, the fixture code was adjusted from “SCRW” to “FIXT,” which shifted savings from the measure “Integrated Ballast LED” to the measure “LED.” Occupancy sensor controls were also added to pre- and post-fixtures per post-inspection notes findings. For the exterior lighting portion of the project, recessed fixtures (interior type) were determined to be eligible fixtures based on TRM allowances because it was on the ENERGY STAR qualified products list. Overall, the adjustments for both portions of the project increased demand and energy savings and resulted in realization rates of 126 percent kW and 132 percent kWh.

Participant ID 1117494: The energy efficiency project included interior and exterior lighting retrofits at a retail building. During the desk review and on-site M&V visit, the EM&V team adjusted the quantity of some outdoor fixtures from 17 claimed to 19 per on-site visit findings. This adjustment resulted in a negligible decrease in demand and energy savings and realization rates of 100 percent kW and kWh.

Participant ID 1140631: The energy efficiency project included exterior lighting retrofits at a retail building. During the desk review and on-site M&V visit, the EM&V team adjusted the wattage of some fixtures from 37W claimed to 38W using DLC qualified products list and corrected the quantity of installed canopy LED fixtures located on the south canopy from 6 to 4 per on-site visit findings. These adjustments resulted in a negligible increase in demand and energy savings and realization rates of 100 percent kW and kWh.

Participant ID 1140628: The energy efficiency project included interior and exterior lighting retrofits at a retail building. During the desk review, the EM&V team adjusted the quantities for several fixtures to match 1 for 1 LED tubes per T8 replaced and the metal halide fixtures replacement with 6 LED tubes. The total quantity of pre- and post-retrofit equipment for the project remained the same. The EM&V team also adjusted the wattage of some LED tubes from 18W claimed to 18.5W to match DLC qualified products list since version 2018.5 of the LSF calculator allows for wattages in 0.5 increments (up to 25W). Overall, these adjustments slightly decreased demand and energy savings and resulted in realization rates of 99 percent kW and kWh.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications, AHRI certifications) for all projects that had desk reviews completed because sufficient documentation was provided for the sites. Project documentation included invoices, QPL qualifications and/or AHRI certifications, pre- and post-inspection notes, the project savings calculators, and photographic documentation of existing and new equipment, which are significant efforts by the utility to verify equipment conditions and quantities. Since sufficient documentation was provided for all projects, the EM&V team assigned a program documentation score of Good.

3.3.3 Open Market Transformation Program (MTP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
4.0%	357	357	100.0%	12.2%	1,544,383	1,544,477	100.0%	Good
Completed Desk Reviews*		On-Site M&V						
4		2						

*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 PY2018 Open MTP evaluation efforts focused on desk reviews and on-site M&V. The number of completed desk reviews and on-site M&V projects for this program are listed above.

The EM&V team adjusted the claimed savings for four projects. Three projects had adjustments of less than 5 percent and one project had adjustments greater than 5 percent compared to the original claimed savings. AEP TNC accepted the evaluated results and matched the claimed savings to those of the evaluations for the project with significant adjustments and therefore the final program realization rate is 100 percent. Further details of the EM&V findings are provided below.

Participant ID 1133186: The energy efficiency project included exterior lighting retrofits at a retail building. During the desk review and on-site M&V visit, the EM&V team adjusted the wattage of some fixtures from 130W claimed to 128W and from 162W claimed to 163W using DLC qualified products list and photos. In addition, the fixture code was corrected from "SCRW" to "FIXT" for a 500W pre-retrofit equipment, which shifted savings from the measure "Integrated Ballast LED" to the measure "LED." Overall, these adjustments resulted in a negligible decrease in demand and energy savings and realization rates of 100 percent kW and kWh.

Participant ID 1133629: The energy efficiency project included exterior lighting retrofits at a retail building. During the desk review, the EM&V team used the 2018.5 LSF calculator, which adjusted the annual operating hours (HOU) and coincidence factor (CF) to match the Texas TRM 5.0. (Earlier versions of the 2018 LSF calculator had wrong HOU and CF values for retail buildings.) In addition, the EM&V team adjusted the bulb wattage from 9W claimed to 9.5W since version 2018.5 of the LSF calculator allows for wattages in 0.5 increments (up to 25W). Overall, these adjustments slightly decreased demand and energy savings and resulted in realization rates of 98 percent kW and 99 percent kWh.

Participant ID 1133630: The energy efficiency project included interior lighting retrofits at a retail building. During the desk review, the EM&V team noticed some of the cells in the submitted calculator described custom adjustments, which were not supported by documentation. The corrections slightly increased demand and energy and resulted in realization rates of 101 percent kW and kWh.

Participant ID 1153125: The energy efficiency project included interior and exterior lighting retrofits at a manufacturing facility. During the desk review and on-site M&V visit, the EM&V team adjusted the building type from "Manufacturing 3-shift" to "Manufacturing 1-shift" based on on-site visit findings confirming that one shift is the normal operation of the facility. This significantly reduced the energy savings (kWh). The air conditioning type was also adjusted to "none" for the shop areas in the facility because they were not air conditioned. In addition, the EM&V team corrected

fixture wattages and lighting controls type. The wattage for 11 outdoor wall packs was adjusted from 66W claimed to 65W; the wattage for 40 high bay linear LED fixtures in the manufacturing area was adjusted from 166W claimed to 158W using the DLC qualified products list; and photocell controls were added to outdoor lighting controls, as the project claimed ODL savings (with ex-ante calculator showing no pre/post ODL controls). Overall, these corrections resulted in a significant decrease in demand and energy savings and realizations rates of 89 percent kW and 53 percent kWh.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications, AHRI certifications) for all projects that had desk reviews completed because sufficient documentation was provided for the sites. Project documentation included invoices, QPL qualifications and/or AHRI certifications, pre- and post-inspection notes, the project savings calculators, and photographic documentation of existing and new equipment, which are significant efforts by the utility to verify equipment conditions and quantities. Since sufficient documentation was provided for all projects, the EM&V team assigned a program documentation score of Good.

3.3.4 SCORE/CitySmart Market Transformation Program (MTP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
2.7%	245	245	100.0%	10.2%	1,289,705	1,289,887	100.0%	Good

Completed Desk Reviews*	On-Site M&V
2	1

*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 PY2018 SCORE/CitySmart MTP evaluation efforts focused on desk reviews and on-site M&V. The number of completed desk reviews and on-site M&V projects for this program are listed above.

The EM&V team adjusted the claimed savings for one project. The project had adjustments of less than 5 percent compared to the original claimed savings and therefore the final program realization rate is 100 percent. Further details of the EM&V findings are provided below.

Participant ID 1131808: The energy efficiency project included interior and exterior lighting retrofits at an office building. During the desk review and on-site M&V visit, the EM&V team adjusted the wattage of 93 fixtures from 11.5W claimed to 12W using the DLC qualified products list. This adjustment resulted in a negligible increase in demand and energy savings and resulted in realization rates of 100 percent kW and kWh.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications, AHRI certifications) for all projects that had desk reviews completed because sufficient documentation was provided for the sites. Project documentation included invoices, QPL qualifications and/or AHRI certifications, pre- and post-inspection notes, the project savings calculators, and photographic documentation of existing and new equipment, which are significant

efforts by the utility to verify equipment conditions and quantities. Since sufficient documentation was provided for all projects, the EM&V team assigned a program documentation score of Good.

3.4 Detailed Findings—Residential (Medium Evaluation Priority)

3.4.1 Residential Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
15.2%	1,360	1,360	100.0%	16.3%	2,065,028	2,065,028	100.0%	Good

Completed Desk Reviews*	On-Site M&V
6	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 PY2018 evaluation efforts focused on desk reviews and on-site M&V. All on-site M&V projects also had desk reviews. The number of completed desk reviews and on-site M&V projects for this program are listed in the table above.

The EM&V team did not make any adjustments to this program. Overall, the EM&V team assessed ex-ante claimed energy and demand savings across the following two activities:

- For a sample of projects, desk reviews were completed to check that measure data collected by contractors on forms aligned correctly with data in the tracking system.
- On-site M&V was completed for a sample of projects to verify that measures remained installed and matched project documentation.

Desk reviews were completed for six projects and resulted in desk review realization rates of 100 percent and 100 percent for demand and energy savings, respectively. On-site M&V was completed for three projects and resulted in on-site realization rates of 100 percent and 100 percent for demand and energy savings, respectively.

Documentation Score

For all sampled projects, the EM&V team was able to verify key inputs and assumptions (e.g., pre- and post-condition) for central air conditioners and air infiltration. There was limited documentation for direct installs such as low flow showerheads and LEDs. Because sufficient documentation was provided for most of the measures across all the reviewed projects, the EM&V team assigned a program documentation score of Good.

3.4.2 Hard-to-Reach Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
7.5%	669	670	100.1%	7.8%	993,767	994,248	100.0%	Good
Completed Desk Reviews*				On-Site M&V				
6				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 PY2018 evaluation efforts focused on desk reviews and on-site M&V. All on-site M&V projects also had desk reviews. The number of completed desk reviews and on-site M&V projects for this program are listed in the table above.

The EM&V team made an adjustment of more than 5 percent to the claimed savings for one project. Overall, the EM&V team assessed ex-ante claimed energy and demand savings across the following two activities:

- For a sample of projects, desk reviews were completed to check that measure data collected by contractors on forms aligned correctly with data in the tracking system.
- On-site M&V was completed for a sample of projects to verify that measures remained installed and matched project documentation.

Desk reviews were completed for six projects and resulted in desk review realization rates of 99.8 percent and 96.7 percent for demand and energy savings, respectively. On-site M&V was completed for four projects and resulted in on-site realization rates of 106.2 percent and 105.4 percent for demand and energy savings, respectively. Further details for the single project where adjustments were made, including the EM&V findings, are provided below.

Participant ID 1140930: The energy efficiency project included implementation of the ceiling insulation and duct sealing measures. TRM 5.0 Volume 2 contains an eligibility requirement for the ceiling insulation measure, the application of which led to a difference in claimed and evaluated savings for this project. TRM 5.0 Volume 2 states for any reported pre-retrofit R-value that falls below R-5, all contractors are required to provide sufficient evidence including two pictures: 1) a picture showing the entire attic floor, and 2) a close-up picture of a ruler that shows the measurement of the depth of the insulation. In the absence of evidence demonstrating pre-retrofit ceiling insulation below R-5, the lowest level of pre-retrofit ceiling insulation that can be claimed is the R-5 to R-8 range. The baseline reported was less than R-5 level insulation and the EM&V team determined the documentation provided did not meet the TRM 5.0 Volume 2 requirement and, as a result, adjusted the baseline to R-5. Overall, the adjustment resulted in project level realization rates of 40.7 percent and 38.3 percent for demand and energy savings, respectively.

Additionally, the overall realization rates were influenced by five measures within four projects that fell within the 5 percent project-level adjustment threshold. Of these four projects, one project contained both air infiltration and duct sealing measures. Per protocol, the Texas IOUs are not required to make savings modifications for project-level adjustments within the 5 percent threshold, and as such, AEP

TNC elected to not adjust these projects. In summary, high-level findings for these four projects includes:

- Using a threshold of +/-10 percent, the EM&V team's on-site testing for one air infiltration project and one duct sealing project yielded substantially higher reduction than what was reported by the program.
- The EM&V team's on-site testing also found substantially lower reduction for three duct sealing projects and one air infiltration project.

Documentation Score

For all sampled projects, the EM&V team was able to verify key inputs and assumptions (e.g., pre- and post-condition test results) for air infiltration and duct efficiency. There was limited documentation for direct installs such as LEDs, low flow shower heads, and low flow faucet aerators as well as the single ceiling insulation measure. Because sufficient documentation was provided for most of the measures across all the reviewed projects, the EM&V team assigned a program documentation score of Good.

3.5 Detailed Findings—Load Management (High/Medium Evaluation Priority)

3.5.1 Load Management Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
55.5%	4,963	4,963	100.0%	0 0%	4,963	4,963	100.0%	Good

Completed Desk Reviews*	On-Site M&V
NA	NA

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

The EM&V team evaluated the AEP TNC Commercial Load Management Program by applying the TRM calculation methodology to interval meter data. The meter data was supplied in 15-minute increments at the Electric Service Identifier (ESI ID) level. A single load management event occurred on May 29, 2018, from 4:00 p.m. to 5:00 p.m.

The EM&V team received the interval meter data and a spreadsheet detailing the AEP TNC calculated event level savings for each ESI ID enrolled in the program. All ESI IDs participated in only one of the two scheduled events. The EM&V team found that all savings calculated by AEP TNC matched those of the EM&V team. As such, no adjustments were made to the program savings.

Evaluated savings for the AEP TNC Load Management program are 4,963 kW and 4,963 kWh. The realization rate for both kW and kWh is 100.0 percent.

3.6 Summary of Low Priority Evaluation Programs

Table 3-5 provides a summary of claimed savings for AEP TNC's low evaluation priority programs in PY2018, including programs' overall contribution to portfolio savings. Low priority programs' claimed savings were verified against the final PY2018 tracking data provided to the EM&V team for the EM&V database.

Table 3-5. PY2018 Claimed Savings Low Evaluation Priority Programs

Program	Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)
SMART Source Solar PV MTP (Commercial)	0.6%	52	52	100.0%	1.2%	151,314	151,314	100.0%
SMART Source Solar PV MTP (Residential)	0.8%	75	75	100.0%	1.9%	245,773	245,773	100.0%
Targeted Low Income Energy Efficiency Program	1.2%	107	107	100.0%	1.5%	188,620	188,620	100.0%

4.0 CENTERPOINT IMPACT EVALUATION RESULTS

This section presents the evaluated savings and cost-effectiveness results for CenterPoint's energy efficiency portfolio. The key findings are summarized first, followed by details for each program in the portfolio that had a high or medium evaluation priority. Finally, we include a list of the low evaluation priority programs for which claimed savings were verified through the EM&V database.

4.1 Key Findings

4.1.1 Evaluated Savings

CenterPoint's evaluated savings for PY2018 were 176,346 in demand (kW) and 162,355,222 in energy (kWh) savings. The overall kW and kWh portfolio realization rates are 100 percent. CenterPoint was responsive to all EM&V recommendations to adjust claimed savings based on EM&V results (see Table 4-4), which also supported healthy realization rates.

Table 4-1 shows the claimed and evaluated demand savings for CenterPoint's portfolio and broad customer sector/program categories.

Table 4-1. CenterPoint PY2018 Claimed and Evaluated Demand Savings

Level of Analysis	Percent Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Precision at 90% Confidence
Total Portfolio	100.0%	176,346	176,346	100.0%	0.0%
Commercial	8.4%	14,799	14,799	100.0%	0.0%
Residential	15.5%	27,266	27,266	100.0%	0.0%
Low Income	2.4%	4,174	4,174	100.0%	n/a
Load Management	73.8%	130,107	130,107	100.0%	0.0%
Pilot	0.0%	0	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 resulting level of load curtailment achieved for each event for all participants.

Table 4-2 shows the claimed and evaluated energy savings for CenterPoint's portfolio and broad customer sector/program categories for PY2018.

Table 4-2. CenterPoint PY2018 Claimed and Evaluated Energy Savings

Level of Analysis	Percent Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Precision at 90% Confidence
Total Portfolio	100.0%	162,355,214	162,355,222	100.0%	0.0%
Commercial	52.7%	85,487,606	85,487,614	100.0%	0.0%
Residential	42.5%	68,951,860	68,951,860	100.0%	0.0%
Low Income	4.2%	6,745,990	6,745,990	100.0%	n/a

Level of Analysis	Percent Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Precision at 90% Confidence
Load Management	0.5%	781,166	781,166	100.0%	0.0%
Pilot	0.2%	388,592	388,592	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 resulting level of load curtailment achieved for each event for all participants.

Program-level realization rates are discussed in the detailed findings sub-sections. 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 program documentation score of Good, Fair, or Limited. For the overall utility program documentation score, the score of “Good” was given if 90 percent or more of the evaluated savings estimates received a score of Good or Fair due to program documentation received as indicated in detailed program findings. A score of “Fair” was given if 70 percent to 89 percent of the evaluated savings estimates received a score of Good or Fair. A score of “Limited” was given if less than 70 percent of savings received scores of Good or Fair. In general, a score of “Good” indicates the utility has established processes to collect sufficient documentation to verify savings; a score of “Fair” also indicates established processes with some areas of improvements identified; and a score of “Limited” indicates program documentation improvements across more individual programs and/or high savings programs have been identified.

Commercial Program Documentation: CenterPoint received a documentation score of “Good” for its Large Commercial SOP, while it received a “Fair” score for its Commercial MTP due to partial documentation available within three of its 14 project desk reviews. It received a score of “Limited” within its Retro-commissioning MTP. The evaluation team awarded this score due several factors, including lack of proof of purchase documentation, missing project photos, and limited project reports, which only included information about measured, target, and energy savings but did not include engineering plans and/or calculation methodologies.

Residential Program Documentation: Nearly all of CenterPoint’s high or medium evaluation priority Residential programs received a documentation score of “Good.” The exception was its Multifamily HTR MTP, which received a score of “Fair,” as the team was unable to verify key post-condition inputs and assumptions during this program’s desk reviews.

4.1.2 Cost-effectiveness Results

CenterPoint’s overall portfolio had a cost-effectiveness of 2.36, or 2.54 excluding low income programs. (See Table 4-3.)

The more cost-effective programs were Advanced Lighting and High Efficiency Homes MTP. The less cost-effective programs were Smart Thermostat Program (Pilot) and REP (CoolSaver & Efficiency Connection), neither of which passed cost-effectiveness. Pilots in their first year of operation are not required to pass cost-effectiveness.

The lifetime cost of evaluated savings was \$0.009 per kWh and \$19.30 per kW.

Table 4-3. CenterPoint Cost-effectiveness Results

Level of Analysis	Claimed Savings Results	Evaluated Savings Results	Net Savings Results
Total Portfolio	2.36	2.36	2.06
Total Portfolio excluding low-income programs	2.54	2.54	2.20
Commercial	2.19	2.19	1.97
Large Commercial SOP	2.63	2.63	2.38
Commercial MTP (SCORE, Healthcare , Data Center)	2.08	2.08	1.87
Retro-Commissioning MTP	0.99	0.99	0.89
REP (Commercial CoolSaver)	0.87	0.87	0.70
Advanced Lighting Commercial	7.24	7.24	6.52
Residential	3.34	3.34	2.70
CenterPoint Energy High Efficiency Homes MTP	3.93	3.93	2.75
REP (CoolSaver & Efficiency Connection)	1.01	1.01	0.91
Residential & SC SOP	1.70	1.70	1.51
Advanced Lighting Residential	9.86	9.86	8.87
Residential Pool Pump & A/C Distributor MTP	1.94	1.94	1.63
Multi-Family MTP	2.57	2.57	2.05
Hard-to-Reach SOP	1.13	1.13	1.13
Multi-Family MTP (HTR)	1.50	1.50	1.50
Low Income*	2.79	2.79	2.79
Targeted Low Income MTP (Agencies in Action)*	2.79	2.79	2.79
Load Management	1.71	1.71	1.71
Large Commercial Load Management SOP	1.83	1.83	1.83
Residential Demand Response Program	1.23	1.23	1.23
Pilot	0.41	0.41	0.35
Smart Thermostat Program (Pilot)	0.41	0.41	0.35

* The Low Income sector and Low Income Weatherization program are evaluated using the savings-to-investment ratio (SIR).

4.2 Claimed Savings Adjustments

Utilities are provided the opportunity to adjust savings at the project level based on interim EM&V findings. Table 4-4 summarizes claimed savings adjustments recommended by the EM&V team. Realization rates assume the following adjustments will be included in CenterPoint's May 1 filing.

Table 4-4. EM&V Claimed Savings Adjustments by Program (Prior to EECR⁷ Filing)

Program	EM&V Demand Claimed Savings Adjustments (kW)	EM&V Energy Claimed Savings Adjustments (kWh)
Commercial MTP (SCORE, Healthcare, Data Center) (Com)	-152.10	-879,206.20
Large Commercial SOP (Com)	-1.10	-2,814.00
Retro-Commissioning MTP (Com)	-703.10	-1,404,332.80
Residential Pool Pump & A/C Distributor MTP (Res)	-6.00	-9,850.10
Total	-862.30	-2,296,203.10

4.3 Detailed Findings—Commercial (Medium Evaluation Priority)

4.3.1 Large Commercial Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
3.7%	6,554	6,554	100.0%	24.9%	40,416,097	40,416,105	100.0%	Good

Completed Desk Reviews*	On-Site M&V
16	8

*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 PY2018 Large Commercial SOP evaluation efforts focused on desk reviews and on-site M&V. The number of completed desk reviews and on-site M&V projects for this program are listed above.

The EM&V team adjusted the claimed savings for nine projects. Seven projects had adjustments of less than 5 percent and two projects had adjustments greater than 5 percent compared to the original claimed savings. CenterPoint accepted the evaluated results and matched the claimed savings to those of the evaluations for all projects with adjustments and therefore the final program realization rate is 100 percent. Further details of the EM&V findings are provided below.

Participant ID 1137685: The energy efficiency project included exterior lighting retrofits at a parking garage. During the desk review and on-site M&V visit, the EM&V team adjusted the pre- and post-retrofit lighting quantities per on-site visit findings. Since the site contact confirmed that the project was a one-for-one retrofit without any additional fixtures added, the baseline quantities were adjusted to match the final post-retrofit quantities. The fixture quantity in the stairwells was adjusted from 20 to 22 fixtures and the quantity in the parking area was adjusted from 155 to 156

⁷ Energy Efficiency Cost Recovery

fixtures. The minor adjustments negligibly decreased the energy savings, but the demand savings were unaffected, and resulted in realization rates of 100 percent kW and kWh.

Participant ID 1137692: The energy efficiency project included the new construction of interior and exterior lighting fixtures at a non-refrigerated warehouse. During the desk review, the EM&V team adjusted the operating hours and Coincidence Factor (CF) to match the Texas TRM 5.0 since the submitted savings calculation for exterior lighting was set up to use a custom calculation for savings at 7,380 operating hours and CF of 83 percent, which is much higher than the value recommended by the TRM (3,996 operating hours and CF of 61 percent). The correction resulted in a decrease in demand and energy savings and realization rates of 98 percent kW and 97 percent kWh.

Participant ID 1137695: The energy efficiency project included interior and exterior lighting retrofits at an office building. During the desk review and on-site M&V visit, the EM&V team corrected the wattage of the 28W fixtures to 26W using the DLC qualified products list. This adjustment resulted in a negligible decrease in demand and energy savings and realization rates of 100 percent kW and kWh.

Participant ID 1137713: The energy efficiency project included an early replacement of HVAC equipment at a public assembly-type building. During the desk review and on-site M&V visit, the EM&V team found that two of the 6-ton units were different from what had been reported. The capacity and efficiency were adjusted per literature and AHRI testing, which increased the energy savings and resulted in realization rates of 100 percent kW and 110 percent kWh.

Participant ID 1137687: The energy efficiency project included exterior lighting retrofits at a 24-hr supermarket. During the desk review, the EM&V team corrected the quantities of several LED fixtures. The quantity was adjusted for the 175W fixtures from 19 to 15, for the 43W fixtures from 19 to 8, for the 511W fixtures from 14 to 16, and for the 453W fixtures from 8 to 4. In addition, the wattage of the wall pack fixtures was corrected from 42.5W claimed to 43W because the 0.5 increment was only allowable to a maximum of 25W. Overall, these adjustments resulted in an increase in demand and energy savings and realization rates of 112 percent kW and kWh.

Participant ID 1137696: The energy efficiency project included exterior lighting retrofits at a retail building. During the desk review, the EM&V team adjusted the quantity of the 4-head pole light fixtures installed from 19 to 17 per post inspection notes and invoice. This correction slightly increased the demand and energy savings and resulted in realization rates of 101 percent kW and kWh.

Participant ID 1137709: The energy efficiency project included the new construction of interior lighting at a non-refrigerated warehouse. During the desk review and on-site M&V visit, the EM&V team corrected the LED fixture wattages using the DLC qualified products list for the fixtures in the pump room from 29W claimed to 26W, and for the fixtures in the stairway from 29W claimed to 43W. In addition, the quantities of fixtures in two office rooms were adjusted from 77 to 78 and from 21 to 22 respectively per on-site visit findings. Overall, these corrections resulted in a slight decrease in demand and energy savings and realization rates of 99 percent kW and 100 percent kWh.

Participant ID 1161420: The energy efficiency project included exterior lighting retrofits at a parking lot. During the desk review and on-site M&V visit, the EM&V team adjusted the quantities of fixtures in two parking levels from 17 to 18 and from 42 to 47 respectively and corrected the lighting controls for another parking level from "OS" to "None" per on-site visit findings. Overall, these adjustments decreased the demand and energy savings and resulted in realization rates of 97 percent kW and kWh.

Participant ID 1164261: The energy efficiency project included exterior lighting retrofits at a parking lot. During the desk review and on-site M&V visit, the EM&V team corrected the wattages using the DLC qualified products list for some fixtures from 503W claimed to 516W. This correction resulted in a slight decrease in demand and energy savings and realization rates of 99 percent kW and kWh.

Documentation Score

The EM&V team was able to verify key inputs and assumptions (e.g., equipment quantity, equipment capacity, QPL qualifications, AHRI certifications) for all projects that had desk reviews completed because sufficient documentation was provided for the sites. Project documentation included invoices, QPL qualifications and/or AHRI certifications, pre- and post-inspection notes, the project savings calculators, and photographic documentation of existing and new equipment, which are significant efforts by the utility to verify equipment conditions and quantities. Since sufficient documentation was provided for all projects, the EM&V team assigned a program documentation score of Good.

4.3.2 Retro-commissioning Market Transformation Program (MTP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
0.4%	769	769	100.0%	2.5%	4,067,882	4,067,882	100.0%	Limited
Completed Desk Reviews*		On-Site M&V						
4		2						

*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 PY2018 Retro-commissioning MTP evaluation efforts focused on desk reviews and on-site M&V. The number of completed desk reviews and on-site M&V projects for this program are listed above.

The EM&V team reviewed four projects but adjusted the claimed savings for six projects. The two additional projects were similar to two of the four projects reviewed by the EM&V team and therefore received similar adjustments as described below. All six projects had adjustments greater than 5 percent compared to the original claimed savings. CenterPoint accepted the evaluated results and matched the claimed savings to those of the evaluations for all projects with adjustments and therefore the final program realization rate is 100 percent. Further details of the EM&V findings are provided below.

Participant ID 1133756: The energy efficiency project included the retro-commissioning of existing HVAC equipment at a school. During the desk review and on-site M&V visit, the EM&V team made an adjustment to one implemented measure. For the M1.2 measure, the parameter "Diversity F" for the building load points was adjusted from 100 percent to 90 percent at an outside air temperature of 98 degrees F. This was done to match calculations completed for the measures M2.1 and M2.4, which used a diversity factor of 90 percent at the same facility. This was assumed to be a more typical and conservative way of estimating HVAC design load. Overall, the correction decreased the demand and energy savings and resulted in realizations rates of 99 percent kW and 91 percent kWh.

Participant ID 1133757: The energy efficiency project included the retro-commissioning of existing HVAC equipment at a school. During the desk review, the EM&V team made adjustments to four implemented measures. For measure M1.1, the parameter "Diversity F" for the building load points was corrected from 100 percent to 90 percent at an outdoor air temperature of 98 degrees F. This was done to match other measures that used a diversity factor of 90 percent at the same facility and was assumed to be a more typical and conservative way of estimating HVAC design load. For measure M2.1, the EM&V team adjusted the reduction in cooling energy (enthalpy) percentage based on proposed increased indoor air temperatures and adjusted the total hours of cooling in different temperature intervals in the calculator. Reported savings used the reduction in cooling enthalpy percentage difference between hour 1 temperature and baseline temperature, between hour 2 temperature and hour 1 temperature, and between hour 3 temperature and hour 2 temperature. The EM&V team adjusted this so that each hour's temperature reduction enthalpy was compared directly to the baseline enthalpy because each hour should be directly compared to the baseline enthalpy. For reported savings, total number of hours of different outdoor temperature intervals were recorded on the "PIVOT TABLE INFO" sheet in the calculator, which showed a school schedule of unoccupied time in 1-hour increments (3-4 p.m., 4-5 p.m., 5-6 p.m.). Each 1-hour time period showed total interval hours of 406 hours, which is not possible. School generally runs August through part of June, about 200 school days so, at most, planned setbacks during unoccupied time periods (3-4 p.m., 4-5 p.m., 5-6 p.m.) could not exceed approximately 200 hours in each time group. The EM&V team divided total number of hours in each temperature interval by 2 to estimate hours in each interval. For measure M2.4, the reported savings used incorrect enthalpy of reported current indoor air conditions. The reported conditions were 73 DB and 60 percent RH = 29.92 btu/lb dry air. The enthalpy at these conditions, however, is 28.92 btu/lb of dry air, which was adjusted accordingly. For measure M3.1, incorrect enthalpy was used for two summer peak probability hours. The enthalpy used for Month 8, Day 12, hours ending 16 and 17 were 32.52 btu/lb and 31.57 btu/lb respectively. The calculator file noted that these values should be approximately 39 and 41 btu/lb. The EM&V team changed these values to the approximate values identified in the calculator notes. Overall, the corrections to the four measures increased the demand savings but reduced the energy savings and resulted in realization rates of 112 percent kW and 94 percent kWh.

Participant IDs 1158686, 1159635, 1162300 and 1166219: The energy efficiency projects included the implementation of several retro-commissioning measures at large office buildings. Two desk reviews were completed, with one including an on-site M&V visit. This review found that the projects claimed savings based upon calculations, but custom M&V process should have been used. This finding was applied to the additional similar projects, which were completed by the same team at different buildings on the office building campus. The EM&V team adjusted the savings to 40 percent of the calculated savings for all four projects. The remainder of the energy savings can be claimed in 2019 based upon the actual M&V at the properties. This is consistent with other utilities that claim a maximum of 40 percent in the implementation year with the remainder claimed when M&V is complete and actual data has been collected to confirm the savings calculations.

Documentation Score

The EM&V team was not able to verify key inputs and assumptions for most of the projects that had desk reviews completed, because partial documentation was provided for the sites. For two projects, limited information was provided about the engineering plan or how the measurement/calculation method was done on the site; the reports only covered measured, target, and final energy savings. For the rest of the projects, documentation lacked onsite M&V information. In addition, documentation did not include any proof of purchase or installation of some equipment and photographs. Complete documentation enhances the accuracy and transparency of project savings and the ease of evaluation.

Since sufficient documentation was not provided for most of the projects, the EM&V team assigned a program documentation score of Limited.

4.3.3 Commercial Market Transformation Program (MTP) (SCORE, Healthcare, Data Center)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
3.9%	6,837	6,837	100.0%	24.0%	38,977,944	38,977,944	100.0%	Fair
Completed Desk Reviews*		On-Site M&V						
14		7						

*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 PY2018 Commercial MTP evaluation efforts focused on desk reviews and on-site M&V. The number of completed desk reviews and on-site M&V projects for this program are listed above.

The EM&V team adjusted the claimed savings for five projects. Three projects had adjustments of less than 5 percent and two projects had adjustments greater than 5 percent compared to the original claimed savings. CenterPoint accepted the evaluated results and matched the claimed savings to those of the evaluations for all projects with adjustments and therefore the final program realization rate is 100 percent. Further details of the EM&V findings are provided below.

Participant ID 1132953: The energy efficiency project included an early replacement of HVAC equipment at a school. During the desk review, the chiller efficiencies were slightly adjusted based on the manufacturer's product literature, which claims to be Air-conditioning, Heating, and Refrigeration institute (AHRI) certified based on AHRI 550/590 standard rating conditions. The AHRI certificate provided in the supporting documentation was for a smaller capacity chiller (210 series vs. 225 series), which has different capacity and efficiencies. The reported chiller specified a unit with options that were not included in the actual chiller installed. Installed equipment capacity and efficiencies were corrected in the ACE calculator based on the manufacturer's product data (AHRI 550/590): capacity was adjusted from 206.2 to 206.1 tons; the energy efficiency ratio (EER) was adjusted from 9.771 to 9.80; and the integrated energy efficiency ratio (IEER) was adjusted from 16.42 to 16.40. These adjustments slightly increased the demand savings and reduced the energy savings and resulted in realization rates of 102 percent kW and 100 percent kWh.

Participant ID 1133529: The energy efficiency project included interior lighting retrofits at an office. During the desk review and on-site M&V visit, the EM&V team found that the fixtures in one of the office rooms were not retrofitted. In addition, the quantity of post-retrofit fixtures in another room was also corrected from 20 claimed to 25 per on-site visit findings. Overall, these adjustments resulted in a negligible increase in demand and energy savings and realization rates of 100 percent kW and kWh.

Participant ID 1133530: The energy efficiency project included interior lighting retrofits and early replacement of a chiller at a college building. During the desk review and on-site M&V visit, the EM&V team made adjustments to both portions of the project. For the HVAC portion of the

project, the building type was corrected from the reported "Secondary School" to "Education: College." The project documentation indicated that this building was a college and not a secondary high school. This increased the operating hours (HOU) and coincidence factor (CF), which increased the energy and demand savings for this project. For the lighting portion of the project, the EM&V team adjusted the lighting controls for some fixtures to "OS" since the fixtures were installed with integrated occupancy sensors. Changing the post-install retrofit controls resulted in an increase of savings for controls of 10.34 kW and 51,440 kWh, which was outside the scope of the project; however, this reduced the lighting equipment measure savings. Overall, these corrections resulted in realization rates of 101 percent kW and 103 percent kWh.

Participant ID 1159242: The energy efficiency project included the new construction of interior lighting fixtures, high efficiency motors, and building envelope measures (roofing system and window replacement) at a healthcare facility. During the desk review, the EM&V team removed the savings that occurred from the motors measure since it is not eligible for new construction projects. For the lighting portion of the project, the building type was adjusted from "Parking Structure" to "Health: In-Patient," which reduced demand and energy savings. For the window replacement portion of the project, the calculation was augmented from an ENERGY STAR® roof calculator, which accounted for temperature and solar radiation to provide the exterior temperature of the insulation. Since the windows are a single structure, the solar radiation does not impact the U-Value calculation, therefore the exterior temperature was reduced to 100 degrees F from the variable calculation, which included the solar radiation and increased the temperature from 112 to 167 degrees F. This adjustment significantly reduced the impact of the increased U-Value. Overall, these corrections resulted in realization rates of 76 percent kW and 74 percent kWh.

Participant ID 1162381: The energy efficiency project involved several energy savings measures at a data center building including the new construction of HVAC units and interior lighting, and interior lighting and UPS retrofits. During the desk review and on-site M&V visit, the EM&V team corrected the quantity of units for the HVAC portion of the project to 49 based on on-site verification. Six units were planned to be installed, but at the time of the on-site visit, the installations were not completed. For the lighting portion of the project, the building type was adjusted from "Office" to "Data Center" to match the predominant building type for the site. Overall, these corrections resulted in a significant decrease in demand and energy savings and realization rates of 90 percent kW and 90 percent kWh.

Documentation Score

The EM&V team was able to verify key inputs and assumptions for 11 of the 14 projects that had desk reviews completed because sufficient documentation was provided for the sites. However, partial documentation was provided for the other three projects. For one new construction project, documentation lacked invoices and engineering plans. For another new construction project, documentation lacked key information such as square footage of the site, square footage of exempt areas with non-qualified fixtures, roofing specs, and invoices. Complete documentation enhances the accuracy and transparency of project savings and ease of evaluation. Since sufficient documentation was not provided for all projects, the EM&V team assigned a program documentation score of Fair.

4.4 Detailed Findings—Residential (High/Medium Evaluation Priority)

4.4.1 High Efficiency Homes Market Transformation Program (MTP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
7.5%	13,148	13,148	100.0%	13.1%	21,247,896	21,247,896	100.0%	Good

Completed Desk Reviews*	On-Site M&V
27	NA

*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 PY2018 impact evaluation efforts focused on desk reviews. The number of sampled and completed desk reviews for this program is listed above.

The EM&V team focused on reviewing documentation for program homes. This program relies on the REM/Rate energy modeling software that is widely used in the home rating industry and is listed in the TRM as an accepted energy model.

The program established at the beginning of the year that savings would be claimed based on the report built into REM/Rate that compares the program home's characteristics with IECC 2015 code. This report aligns with the TRM v5.0 baseline home since the TRM specifications are derived from IECC 2015 code specifications. For all evaluated homes, the program accurately claimed savings based on the REM/Rate report.

Documentation Score

For all sampled projects, the EM&V team was able to verify key inputs and assumptions (e.g., energy model inputs, and detailed model outputs). Because sufficient documentation was provided for all the reviewed projects, the EM&V team assigned a program documentation score of Good.

4.4.2 Hard-to-Reach Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
0.8%	1,397	1,397	100.0%	1.1%	1,862,128	1,862,128	100.0%	Good

Completed Desk Reviews*	On-Site M&V
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 PY2018 evaluation efforts focused on desk reviews and on-site M&V. All on-site M&V projects also had desk reviews. The number of completed desk reviews and on-site M&V projects for this program are listed in the table above.

The EM&V team did not make any adjustments to this program. Overall, the EM&V team assessed ex-ante claimed energy and demand savings across the following two activities:

- For a sample of projects, desk reviews were completed to check that measure data collected by contractors on forms aligned correctly with data in the tracking system.
- On-site M&V was completed for a sample of projects to verify that measures remained installed and matched project documentation.

Desk reviews were completed for eight projects and resulted in desk review realization rates of 100 percent and 100 percent for demand and energy savings, respectively. On-site M&V was completed for four projects and resulted in on-site realization rates of 100 percent and 100 percent for demand and energy savings, respectively.

Documentation Score

For all sampled projects, the EM&V team was able to verify key inputs and assumptions (e.g., pre- and post-condition) for ceiling insulation. Because sufficient documentation was provided across all the reviewed projects, the EM&V team assigned a program documentation score of Good.

4.4.3 Residential & Small Commercial (SC) Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
0.3%	486	486	100.0%	0.6%	1,030,029	1,030,029	100.0%	Good

Completed Desk Reviews*	On-Site M&V
6	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 PY2018 evaluation efforts focused on desk reviews and on-site M&V. All on-site M&V projects also had desk reviews. The number of completed desk reviews and on-site M&V projects for this program are listed in the table above.

The EM&V team did not make any adjustments to this program. Overall, the EM&V team assessed ex-ante claimed energy and demand savings across the following two activities:

- For a sample of projects, desk reviews were completed to check that measure data collected by contractors on forms aligned correctly with data in the tracking system.
- On-site M&V was completed for a sample of projects to verify that measures remained installed and matched project documentation.

Desk reviews were completed for six projects and resulted in desk review realization rates of 100 percent and 100 percent for demand and energy savings, respectively. On-site M&V was completed for three projects and resulted in on-site realization rates of 100 percent and 100 percent for demand and energy savings, respectively.

Documentation Score

For all sampled projects, the EM&V team was able to verify key inputs and assumptions (e.g., pre- and post-unit capacity) for central air conditioners and central heat pumps. Because sufficient documentation was provided across all the reviewed projects, the EM&V team assigned a program documentation score of Good.

4.4.4 Residential Pool Pump & A/C Distributor Market Transformation Program (MTP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
1.6%	2,850	2,850	100.0%	4.3%	6,977,204	6,977,204	100.0%	Good

Completed Desk Reviews*	On-Site M&V
4	0

*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 PY2018 evaluation efforts focused on desk reviews. The number completed desk reviews for this program is listed above.

The EM&V team made an adjustment of more than 5 percent to the claimed savings for two projects. Overall, the EM&V team assessed ex-ante claimed energy and demand savings across a sample of projects by completing desk reviews to check that measure data collected by contractors on forms aligned correctly with data in the tracking system.

Desk reviews were completed for four projects and resulted in desk review realization rates of 56.0 percent and 61.5 percent for demand and energy savings, respectively. Further details for the two projects where adjustments were made, including the EM&V findings, are provided below.

Participant ID 1133813: The energy efficiency project included the early retirement of two central air conditioner units. The reported baseline age was 16 years for both units. After a review of the documentation, the EM&V team found that age of the equipment was 24 years for one unit and 25 years for the other unit. The EM&V team adjusted savings accordingly. Overall, the adjustment resulted in project level realization rates of 52.6 percent and 62.0 percent for demand and energy savings, respectively.

Participant ID 1142790: The energy efficiency project included implementation of one central heat pump system. The reported baseline was a 3.5-ton air conditioner and electric resistance furnace. After a review of the documentation, the EM&V team found that the baseline should be a 3-ton heat pump system. The EM&V team adjusted savings accordingly. Overall, the adjustment resulted in project level realization rates of 13.7 percent and 19.6 percent for demand and energy savings, respectively.

Documentation Score

For all sampled projects, the EM&V team was able to verify key inputs and assumptions (e.g., pre- and post-unit capacity) for central air conditioners and central heat pumps. Because sufficient

documentation was provided across all the reviewed projects, the EM&V team assigned a program documentation score of Good.

4.4.5 Multifamily Market Transformation Program (MTP) (Hard-to-Reach (HTR))

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
0.3%	518	518	100.0%	0.6%	964,203	964,203	100.0%	Fair

Completed Desk Reviews*	On-Site M&V
3	1

*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 PY2018 evaluation efforts focused on desk reviews and on-site M&V. The single on-site M&V project also had a desk review. The number of completed desk reviews and on-site M&V projects for this program are listed in the table above.

The EM&V team did not make any adjustments to this program. Overall, the EM&V team assessed ex-ante claimed energy and demand savings across the following two activities:

- For a sample of projects, desk reviews were completed to check that measure data collected by contractors on forms aligned correctly with data in the tracking system.
- On-site M&V was completed for a sample of projects to verify that measures remained installed and matched project documentation.

Desk reviews were completed for three projects and resulted in desk review realization rates of 100 percent and 100 percent for demand and energy savings, respectively. On-site M&V was completed for one project and resulted in on-site realization rates of 100 percent and 100 percent for demand and energy savings, respectively.

Documentation Score

The EM&V team was able to verify all key inputs and assumptions (e.g., pre- and post-condition) for the sampled boiler project. For direct installs such as low flow showerheads and LEDs, the EM&V team was able to verify key inputs and assumptions for pre-condition, but they were not available for the post-condition. Because sufficient documentation was provided for some of the measures across all the reviewed projects, the EM&V team assigned a program documentation score of Fair.

4.5 Detailed Findings—Load Management (High Evaluation Priority)

4.5.1 Large Commercial Load Management Standard Offer Program (SOP)

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
62.7%	110,626	110,626	100.0%	0.4%	663,756	663,756	100.0%	Good

Completed Desk Reviews*	On-Site M&V
NA	NA

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

The EM&V team evaluated the CenterPoint Large Commercial Load Management program by applying the TRM calculation methodology to interval meter data. The meter data was supplied in 15-minute increments at the Electric Service Identifier (ESI ID) level. Load management events occurred on the following dates and times:

- June 6, 2018, from 2:00 p.m. to 5:00 p.m.
- July 23, 2018, from 2:00 p.m. to 5:00 p.m.

The EM&V team received the interval meter data and spreadsheets detailing the CenterPoint calculated savings results for the event and each ESI ID. The EM&V team was able to calculate savings for each of the participating ESI IDs with the results matching those of the program. As such, no adjustments were made to the program savings.

Evaluated savings for the CenterPoint Large Commercial Load Management program are 110,626 kW and 663,756 kWh. The realization rate for kW and kWh is 100.0 percent.

4.5.2 Residential Demand Response Program

Program Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Program Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Program Documentation Score
11.0%	19,481	19,481	100.0%	0.1%	117,411	117,411	100.0%	Good

Completed Desk Reviews*	On-Site M&V
NA	NA

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

The EM&V team evaluated the CenterPoint Residential Demand Response Program by applying the TRM calculation methodology to interval meter data. The meter data was supplied in 15-minute increments at the ESI ID level. Load management events occurred on the following dates and times:

- June 6, 2018, from 2:00 p.m. to 5:00 p.m.
- July 23, 2018, from 2:00 p.m. to 5:00 p.m.

The EM&V team received the interval meter data and spreadsheets detailing the CenterPoint calculated savings results for the event and each ESI ID. The EM&V team was able to calculate savings for each of the participating ESI IDs with the results matching those of the program. As such, no adjustments were made to the program savings.

Evaluated savings for the CenterPoint Residential Demand Response Program are 19,481 kW and 117,411 kWh. The realization rate for kW and kWh is 100.0 percent.

4.6 Summary of Low Priority Evaluation Programs

Table 4-5 provides a summary of claimed savings for CenterPoint's low evaluation priority programs in PY2018, including programs' overall contribution to portfolio savings. Low priority programs' claimed savings were verified against the final PY2018 tracking data provided to the EM&V team for the EM&V database.

Table 4-5. PY2018 Claimed Savings Low Evaluation Priority Programs

Program	Contribution to Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Contribution to Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)
Advanced Lighting Commercial	0.2%	325	325	100.0%	1.0%	1,603,501	1,603,501	100.0%
REP (Commercial CoolSaver)	0.2%	313	313	100.0%	0.3%	422,182	422,182	100.0%
Advanced Lighting Residential	3.5%	6,166	6,166	100.0%	18.7%	30,382,118	30,382,118	100.0%
REP (CoolSaver & Efficiency Connection)	0.9%	1,605	1,605	100.0%	2.8%	4,574,603	4,574,603	100.0%
Multi-Family MTP	0.6%	1,095	1,095	100.0%	1.2%	1,913,679	1,913,679	100.0%
Targeted Low Income MTP (Agencies in Action)	2.4%	4,174	4,174	100.0%	4.2%	6,745,990	6,745,990	100.0%
Smart Thermostat Program (Pilot)	0.0%	0	0		0.2%	388,592	388,592	100.0%

5.0 EL PASO ELECTRIC IMPACT EVALUATION RESULTS

This section presents the evaluated savings and cost-effectiveness results for El Paso Electric's energy efficiency portfolio. The key findings are summarized first, followed by details for each program in the portfolio that had a high or medium evaluation priority. Finally, we include a list of the low evaluation priority programs for which claimed savings were verified through the EM&V database.

5.1 Key Findings

5.1.1 Evaluated Savings

El Paso Electric's evaluated savings for PY2018 were 16,846 in demand (kW) and 20,726,303 in energy (kWh) savings. The overall kW and kWh portfolio realization rates are 100 percent. El Paso Electric was responsive to all EM&V recommendations to adjust claimed savings based on EM&V results, which also supported healthy realization rates.

Table 5-1 shows the claimed and evaluated demand savings for El Paso Electric's portfolio and broad customer sector/program categories.

Table 5-1. El Paso Electric PY2018 Claimed and Evaluated Demand Savings

Level of Analysis	Percent Portfolio Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings (kW)	Realization Rate (kW)	Precision at 90% Confidence
Total Portfolio	100.0%	16,846	16,846	100.0%	0.0%
Commercial	19.5%	3,283	3,283	100.0%	0.0%
Residential	13.0%	2,185	2,185	100.0%	0.0%
Load Management*	57.0%	9,604	9,604	100.0%	0.0%
Pilot	10.5%	1,774	1,774	100.0%	0.0%

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

Table 5-2 shows the claimed and evaluated energy savings for El Paso Electric's portfolio and broad customer sector/program categories for PY2018.

Table 5-2. El Paso Electric PY2018 Claimed and Evaluated Energy Savings

Level of Analysis	Percent Portfolio Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate (kWh)	Precision at 90% Confidence
Total Portfolio	100.0%	20,726,303	20,726,303	100.0%	0.0%
Commercial	74.6%	15,465,503	15,465,503	100.0%	0.0%
Residential	25.1%	5,193,636	5,193,636	100.0%	0.0%
Load Management*	0.1%	24,591	24,591	100.0%	0.0%
Pilot	0.2%	42,574	42,574	100.0%	0.0%

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

Program-level realization rates are discussed in the detailed findings sub-sections. 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 program documentation score of Good, Fair, or Limited. For the overall utility program documentation score, the score of Good was given if 90 percent or more of the evaluated savings estimates received a score of Good or Fair due to program documentation received as indicated in detailed program findings. A score of Fair was given if 70 percent–89 percent of the evaluated savings estimates received a score of Good or Fair. A score of Limited was given if less than 70 percent of savings received score of Good or Fair. In general, a score of Good indicates the utility has established processes to collect sufficient documentation to verify savings; a score of Fair also indicates established processes with some areas of improvements identified; and a score of Limited indicates program documentation improvements across more individual programs and/or high savings programs have been identified.

El Paso Electric received a Good program documentation score for its evaluated Commercial, Load Management and Residential programs, and a Fair documentation score for its Demand Response Pilot program.

5.1.2 Cost-effectiveness Results

El Paso Electric's overall portfolio had a cost-effectiveness of 2.60. (See Table 5-3.)

The more cost-effective programs were Large C&I Solutions MTP and Small Commercial Solutions MTP. The less cost-effective programs were Demand Response Pilot Program and Texas Appliance Recycling MTP.

The lifetime cost of evaluated savings was \$0.009 per kWh and \$19.99 per kW.

Table 5-3. El Paso Electric Cost-effectiveness Results

Level of Analysis	Claimed Savings Results	Evaluated Savings Results	Net Savings Results
Total Portfolio	2.60	2.60	2.39
Commercial	3.50	3.50	3.19
Small Commercial Solutions MTP	3.08	3.08	2.93
Large C&I Solutions MTP	4.52	4.52	4.06
Texas SCORE MTP	1.52	1.52	1.41
Residential	1.99	1.99	1.82
Residential Solutions MTP	2.64	2.64	2.35
LivingWise MTP	1.88	1.88	1.50
Texas Appliance Recycling MTP	1.40	1.40	1.40
Hard-to-Reach Solutions MTP	1.69	1.69	1.69
Load Management	1.54	1.54	1.54
Load Management SOP	1.54	1.54	1.54
Pilot	0.58	0.58	0.58
Demand Response Pilot Program	0.58	0.58	0.58

5.2 Claimed Savings Adjustments

Utilities are provided the opportunity to adjust savings at the project-level based on interim EM&V findings. Table 2-4 summarizes claimed savings adjustments recommended by the EM&V team. Commercial adjustments through the third quarter were made prior to the Energy Efficiency Plan and Report (EEPR) filing on April 1, 2018. Realization rates assume all adjustments will be included in El Paso Electric's May 1 filing.

Table 5-4. EM&V Claimed Savings Adjustments by Program (Prior to EECR⁸ Filing)

Program	EM&V Demand Claimed Savings Adjustments (kW)	EM&V Energy Claimed Savings Adjustments (kWh)
Large C&I Solutions MTP (Com)	-2.40	3,942.00
Small Commercial Solutions MTP (Com)	-0.40	-24,076.60
Residential Solutions MTP (Res)	0.00	52.60
Total	-2.80	-20,082.00

⁸ Energy Efficiency Cost Recovery