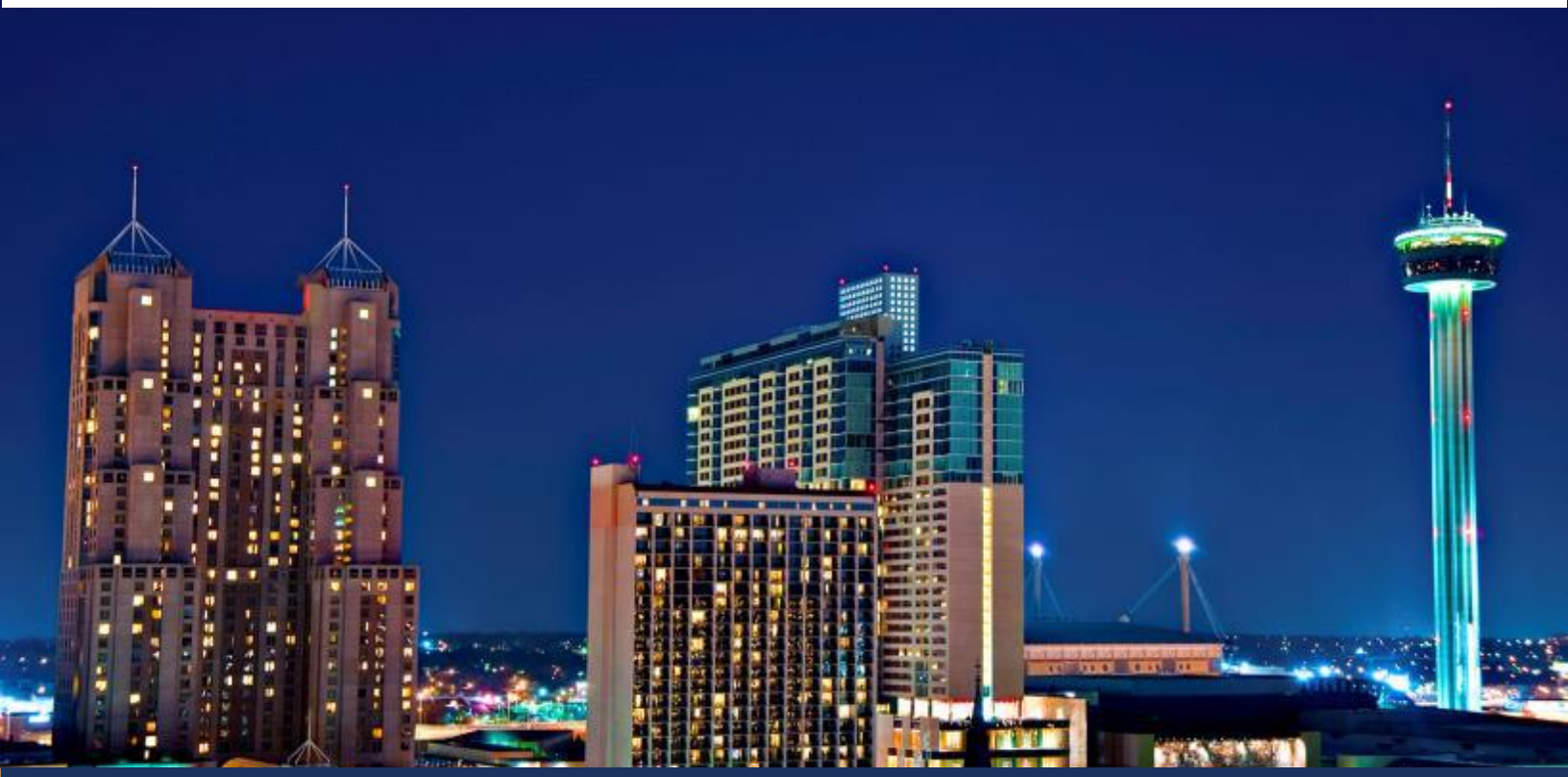


EVALUATION, MEASUREMENT & VERIFICATION OF CPS ENERGY'S FY 2019 DSM PROGRAMS

July 18, 2019

CONTENTS

FIGURES

TABLES

1. EXECUTIVE SUMMARY

CPS Energy retained Frontier Energy ("Frontier") to conduct a comprehensive and independent evaluation, measurement, and verification (EM&V) of CPS Energy's Fiscal Year (FY) 2019 demand side management (DSM) programs. FY 2019 runs from February 1, 2018 through January 31, 2019. This report encompasses all DSM program activity accounted for by CPS Energy within this time. This report describes the EM&V methodology and process and presents the findings of the evaluation.

The evaluation focused primarily on verifying the energy and demand savings achieved by CPS Energy's FY 2019 DSM programs on an annualized basis. Additionally, the evaluation reviewed program expenditures to calculate program cost-effectiveness and recommended enhancements to program design and implementation for CPS Energy's consideration.

1.1 CUMULATIVE PROGRESS TOWARD MEETING STEP GOALS

CPS Energy's Save for Tomorrow Energy Plan (STEP) is an initiative that aims to save 771 MW of electricity from 2009 to 2020. In FY 2019, CPS Energy delivered 94 MW towards the STEP goal. Annual STEP contributions are counted as the net avoided non-coincident peak (NCP) MW delivered by incremental program participants in FY 2019.

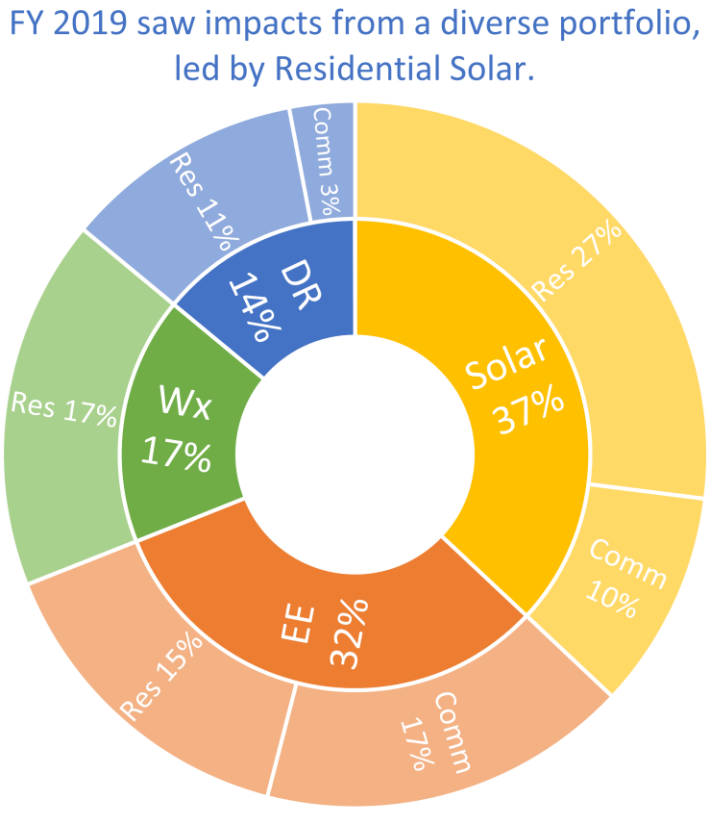


Figure 1-1: FY 2019 Contribution toward STEP Goal by Portfolio and Sector

At the end of FY 2019, Frontier determined CPS Energy had accomplished 714 MW of cumulative demand savings since STEP's inception. CPS Energy's cumulative progress is shown in Figure 1-2. Expiring commercial lighting measures caused 8.08 MW of decay in FY 2019.

As can be seen by the trend, CPS Energy is advancing towards the STEP goal ahead of schedule and is expected to reach the target during FY 2020. Recent years show particularly notable trends in individual portfolio contributions. STEP success is attributable to multiple factors, including:

- The CPS Energy STEP team exhibits great care in portfolio planning with a balanced approach between analytical and customer-focused decision making.
- Solar and Energy Efficiency programs have seen outstanding increases in participation in recent years.
- The *CPS Energy Guidebook* enables methodological, prospective program planning and cost-effective M&V.
- CPS Energy shows agility in responding to new technologies and innovative program ideas.

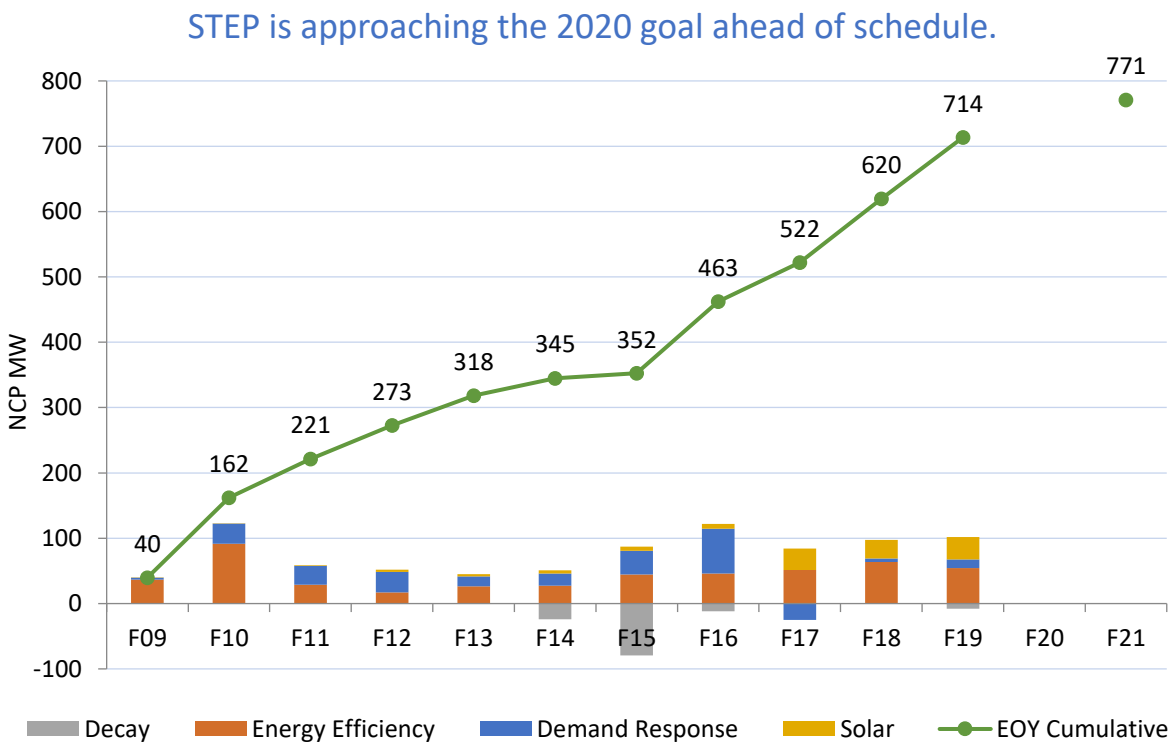


Figure 1-2: Cumulative Progress toward Meeting STEP Goal

1.2 PORTFOLIO ENERGY AND DEMAND IMPACTS AND COST-EFFECTIVENESS

The FY 2019 portfolio consists of Energy Efficiency programs contracted out to two implementers with Solar and Demand Response programs implemented internally by CPS Energy. This year's report includes Frontier's evaluation of 25 different programs.[1] Net energy and demand savings are listed in Table 1-1. The savings are represented on an annualized basis to simplify the reporting structure and for easy comparison from year to year.

Table 1-1: FY 2019 Portfolio Impacts and Cost-Effectiveness

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Weatherization Program									
Weatherization	100%	13,463,844	5,516	15,749	5,264	$16,566,801	$1,886,917	$18,453,718	0.86
Energy Efficiency Programs									
Residential HVAC	95%	15,697,173	6,826	6,901	5,800	$3,949,136	$145,785	$4,094,921	4.21
Home Efficiency	93%	2,903,160	1,018	2,283	990	$1,059,219	$38,451	$1,097,670	3.01
New Home Construction	100%	1,584,930	967	1,362	1,111	$1,952,173	$75,089	$2,027,262	1.47
Retail Channel Partnerships	77%	5,061,832	508	2,515	795	$1,194,821	$34,389	$1,229,210	2.67
Energy Savings Through Schools	95%	1,184,254	71	412	84	$289,987	$8,346	$298,333	1.37
Home Energy Assessments	84%	2,267,904	216	1,058	328	$1,338,810	$56,186	$1,394,996	0.87
Multi-Family	92%	153,548	16	73	24	$105,499	$4,729	$110,228	0.79
Cool Roof	100%	31,348	27	55	36	$15,109	$6,493	$21,602	2.79
Residential Subtotal		28,884,149	9,648	14,658	9,170	$9,904,754	$369,468	$10,274,222	2.78

[1] Legacy Programs from 2018 no longer exist as they are now part of the Franklin/CLEAResult programs.

Table continues on next page.

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Energy Efficiency Programs (cont.)									
C&I Solutions	96%	44,870,338	7,467	10,921	7,297	$6,713,486	$285,382	$6,998,867	3.58
Schools & Institutions	96%	9,748,345	3,372	3,919	2,871	$2,966,322	$124,573	$3,090,894	2.22
Small Business Solutions	85%	27,988,174	5,199	6,808	5,210	$3,206,468	$129,739	$3,336,207	4.20
Whole Building Optimization	96%	14,185,675	1,946	2,009	1,741	$1,877,322	$76,408	$1,953,730	0.92
Legacy Projects	100%	1,309,113	25	316	29	$350,679	$12,875	$363,554	1.32
Commercial Subtotal		98,101,646	18,009	23,973	17,148	$15,114,278	$628,977	$15,743,253	3.06
Energy Efficiency Subtotal		126,985,794	27,657	38,631	26,318	$25,019,032	$998,445	$26,017,475	2.95
Demand Response Programs									
Smart Thermostat	100%	918,788	37,457	43,632	35,447	$3,077,518	$102,706	$3,180,223	3.59
Reduce My Use (Behavioral DR)	100%	564,638	7,617	12,327	6,402	$419,000	$11,458	$430,458	2.52
Nest DI	100%	7,632,510	22,911	26,732	21,197	$3,890,848	$115,664	$4,006,512	3.18
BYOT	100%	9,072,235	32,149	37,539	30,027	$1,572,783	$48,300	$1,621,083	5.67
Home Manager**	100%	49,284	2,182	3,351	2,400	$560,775	$54,066	$614,841	0.00
C&I DR	100%	2,658,296	79,216	96,152	77,128	$4,910,195	$189,998	$5,100,193	2.26
Auto DR	100%	122,441	3,987	5,835	3,347	$212,435	$7,183	$219,618	3.07
Demand Response*** Subtotal		21,018,191	185,519	225,567	175,946	$14,643,553	$529,375	$15,172,927	3.13

Table continues on next page.

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Renewable Energy Programs									
Res. Solar Rebates	100%	41,991,569	12,072	24,885	10,864	$15,118,988	$655,569	$15,774,557	3.30
Comm. Solar Rebates	100%	14,799,189	4,450	8,801	3,876	$2,744,191	$118,987	$2,863,178	6.54
Roofless Solar	100%	0	0	0	0	$0	$18,040	$18,040	0.00
Solar Host SA****	100%	1,131,040	340	673	296	$0	$0	$0	0.97
Solar Energy Subtotal		57,921,797	16,862	34,359	15,037	$17,863,179	$792,596	$18,655,775	3.63
Grand Total		219,389,627	235,553	314,307	222,565	$74,092,565	$4,207,333	$78,299,895	2.68

*The Program Administrator benefit cost ratio (PACT) is the ratio of the net present value (NPV) of avoided energy and capacity benefit, divided by the program's incentives and administrative costs, expressed as:

$$Benefit\ Cost\ Ratio = \frac{NPV\ of\ Avoided\ Cost\ Benefit}{Program\ Incentives + Admin\ Costs}$$

A PACT ratio of greater than 1 indicates that the program delivered more benefits than costs incurred.

** Home Manager did not have any incremental participation. Therefore, no PACT score is calculated. Savings and costs reported are for end-of-year participation.

***The PACT for Demand Response Programs is calculated based on the net present value of avoided cost benefits divided by the net present value of program costs *attributable to new, incremental participants during the program year.* Because total program costs in the table represent the costs attributable to all participants, the PACT for Demand Response Programs cannot be directly calculated from data presented in the table. Demand response program net energy and demand savings (in lighter shade) represent end-of-year program capability, based on end-of-year enrollment.

**** In calculating the PACT for the SolarHostSA Pilot program, Frontier considered all energy purchases and bill credits paid to host site customers as part of the program costs. This differs from CPS Energy's accounting, which shows $0 in rebates paid to customers. Thus, the PACT for the SolarHostSA Pilot program cannot be directly calculated from the data presented in the table.

Additional table notes: Net savings = gross savings * Net to Gross ratio / (1 – line loss factor). Rows may not sum to total due to rounding

1.3 SUMMARY OF SAVINGS EVALUATION APPROACH

Frontier applied evaluation standards as published in the CPS Energy Technical Guidebook for Energy Efficiency and Demand Response Programs (Guidebook). The Guidebook provides a single common reference for estimating energy and peak demand savings resulting from the installation or implementation of energy efficiency and demand response measures provided through CPS Energy's programs. The methodologies described by and used in the Guidebook are based on the Public Utility Commission of Texas' (PUCT) Technical Reference Manual (TRM), with certain modifications required to accommodate CPS Energy's weather zone and STEP program goals and metrics. The Guidebook is intended to be updated annually to provide a common reference to Frontier's evaluation methodology.

1.4 SUMMARY OF ECONOMIC IMPACTS

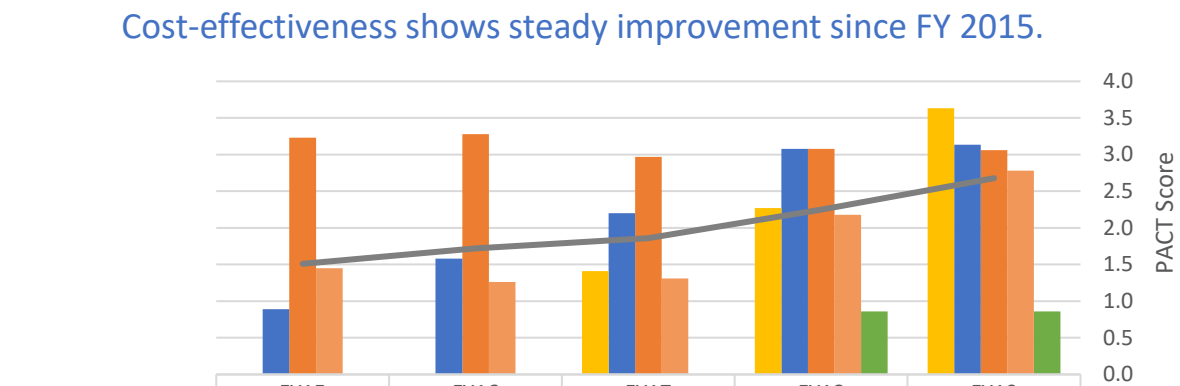
Frontier's evaluation included collecting administrative, management, and marketing costs as well as total incentives paid. The following economic impact metrics were calculated as described in section 2.5:

- Cost of Saved Energy (CSE), which represents the levelized program cost per annual kWh saved, was $0.0363/kWh.
- Net Avoided Cost Benefit, or Reduction in Revenue Requirements (RRR), which represents the total avoided costs, or net reduction in utility costs, due to the impact of the energy efficiency improvements, was $137,921,517.
- Benefit-Cost Ratio, representing the output of the program administrator cost test, was 2.68.

1.5 YEAR BY YEAR COST-EFFECTIVENESS COMPARISON

CPS Energy's STEP portfolio continues to deliver improved overall performance as measured by the program administrator cost test (PACT). These trends should be considered along with the following notes on structural changes to STEP programming:

- In 2015 and 2016, solar programs were included in Residential and Commercial Energy Efficiency.
- In 2015 through 2017, Weatherization was included in Residential Energy Efficiency.



	FY15	FY16	FY17	FY18	FY19
Wx				0.86	0.86
Res EE	1.45	1.26	1.31	2.18	2.78
Comm EE	3.23	3.28	2.97	3.08	3.06
DR	0.89	1.58	2.20	3.08	3.13
Solar			1.41	2.27	3.63
Portfolio Total	1.51	1.72	1.86	2.25	2.68

Figure 1-3: STEP Cost-Effectiveness from FY 2015 through FY 2019.

2. EVALUATION METHODS

2.1 ENERGY IMPACTS

Frontier's approach to this evaluation has been to leverage existing EM&V work previously conducted for CPS Energy and other electric utilities in Texas. For the past 16 years, investor-owned utilities, EM&V consultants, and stakeholder groups have collaborated to develop accurate and comprehensive "deemed" savings for hundreds of residential and commercial energy efficiency measures, under the auspices of the Public Utility Commission of Texas (PUCT). This extended effort informs ongoing updates to the *Texas Technical Reference Manual* (Texas TRM),[2] a compendium of algorithms, baseline efficiency data, efficiency standards, energy savings calculations and data tables.

In 2016, Frontier adapted the Texas TRM to be applicable to CPS Energy's service territory. This provides CPS Energy with energy and demand impact estimates that have been vetted numerous times by independent third parties and are consistent with impact estimates being used by all of the investor-owned utilities in Texas. The adapted Texas TRM, along with other measures required for CPS Energy programs, can be found in the *CPS Energy Guidebook* and has been applied to the STEP evaluation since FY 2017.

For this analysis, the *CPS Energy Guidebook* dated June 2018 was used except where noted.

2.2 PEAK DEMAND IMPACTS

To calculate coincident peak demand savings, Frontier employed a probabilistic analysis using San Antonio TMY3 hourly weather data.[3] This approach relates actual historical weather data for San Antonio, day-of-week, and time-of-day variables to Electric Reliability Council of Texas (ERCOT) zonal peak conditions. Those historical relationships are then applied to TMY3 hourly weather data to estimate the hours in a TMY data file most likely to coincide with hours of high demand in ERCOT's CPS Energy-San Antonio zone. To determine hours of highest demand in this zone, Frontier used ERCOT data and added back in demand savings attributable to DR deployments. Estimates of the impacts of various energy efficiency measures during the top twenty hours associated with high demand in the TMY data are identified, and the probability-weighted estimate of an energy efficiency measure's demand savings during those peak hours is then calculated. This approach was adopted for use in the Texas TRM v. 3.1, used by all investor-owned electric utilities beginning in 2016.

[2] Public Utility Commission of Texas (PUCT) Technical Reference Manual (TRM). Most recent version available for download at: http://texasefficiency.com/index.php/regulatory-filings/deemed-savings

[3] Typical Meteorological Year (TMY) are data sets of hourly values of solar radiation and meteorological elements for a 1-year period. TMY3 is the most recent version of this data. Data collected at the Kelly Field Air Force Base (Kelly AFB) station were generally used, since the temperature data series collected at the San Antonio International Airport is inexplicably higher than the readings collected at other local weather stations. (See Itron, CPS Energy June 2014 Electricity Forecast, Sept. 2014, pp. 8-9.)

Based on Frontier's analysis, the hours presented in Table 2-1 have the highest probability of occurring during CPS Energy's peak (listed in order of probability, from highest to lowest). Additional hours are shown because some hours, such as those occurring on weekends or holidays, are eliminated for some measures. This analysis was completed in 2016 using weather and load data from 2010 to 2015.

The estimated coincident peak savings is the probability-weighted average of the kW in the top twenty applicable time periods for each measure. This approach was used for all measures, except where noted.

Table 2-1: Top Hours in a TMY3 Weather File from Probabilistic Analysis

Month	Day	Hour (start)	Temp (°F)	Peak Probability (with DR addback)	Month	Day	Hour (start)	Temp (°F)	Peak Probability (with DR addback)
6	19	15	104	0.939953	8	18	15	97.88	0.048491
6	19	16	102.92	0.923473	8	19	15	97.88	0.048491
6	20	16	102.92	0.923473	8	17	16	96.98	0.045171
6	20	15	101.84	0.627406	8	23	16	96.98	0.045171
6	19	14	102.92	0.600033	8	20	14	98.96	0.043431
6	20	14	102.92	0.600033	8	23	14	98.96	0.043431
6	19	17	100.94	0.411083	7	30	16	98.96	0.043252
6	10	15	100.94	0.399418	7	31	14	100.94	0.041583
6	18	15	100.94	0.399418	6	17	17	97.88	0.028802
6	10	16	99.86	0.338925	6	18	17	97.88	0.028802
7	31	15	102.02	0.311633	6	13	15	97.88	0.027479
8	20	15	99.86	0.282339	6	14	15	97.88	0.027479
8	19	16	98.96	0.267512	6	21	15	97.88	0.027479
8	20	16	98.96	0.267512	6	5	16	96.98	0.025559
8	17	15	98.96	0.134484	6	11	16	96.98	0.025559
7	31	16	100.04	0.121139	6	13	16	96.98	0.025559
8	18	16	97.88	0.106969	6	21	16	96.98	0.025559
6	20	17	98.96	0.082923	6	17	14	98.96	0.024555
6	17	15	98.96	0.079315	8	18	17	96.98	0.020688
6	12	16	97.88	0.062276	8	19	17	96.98	0.020688
6	16	16	97.88	0.062276	8	20	17	96.98	0.020688
6	17	16	97.88	0.062276	7	31	17	98.96	0.019788
6	18	16	97.88	0.062276	7	30	14	100.04	0.016847
6	10	14	99.86	0.059918	8	7	16	95.9	0.015279
6	18	14	99.86	0.059918	8	28	16	95.9	0.015279

2.3 NET IMPACTS

To derive net impacts, Frontier applies net-to-gross (NTG) ratios and line loss factors to the gross energy and peak demand impacts for each measure.

NTG ratios are estimated at the level of individual programs, and account for the net effects of free ridership and spillover. Free riders are defined as customers who would have delivered energy or demand savings without any program incentives but who received a financial incentive or rebate anyway. Spillover effects derive from customers who delivered energy or demand savings because of the program but did not participate in the program or receive a financial incentive or rebate. NTG ratios were provided by CPS Energy.

Line loss factors account for the fact that utilities must generate or import a greater amount of energy or demand than is required at the customer or end-user level because some energy is lost in distribution. Separate line loss factors relating to energy and demand are based on a 2016 energy system loss study provided by CPS Energy.

2.4 AVOIDED COST BENEFITS

2.4.1 Avoided Capacity and Energy

Avoided cost benefits were calculated using avoided energy and capacity costs provided by CPS Energy, and CPS Energy's standard discount rate. For this year's analysis, CPS Energy provided avoided energy costs as the nominal $/MWh of the marginal variable cost of production using the load forecast without STEP programs being funded beyond February 1, 2019. For the purpose of calculating avoided energy benefits, annual kWh were allocated into the following seasonal blocks based on day of the week and hour of the day. Frontier developed or adopted appropriate 8760-hour load shapes for each STEP measure to assign annual kWh to corresponding cost periods.

- Summer On-Peak
- Summer Mid-Peak
- Summer Off-Peak
- Non-Summer Mid-Peak
- Non-Summer Off-Peak

Avoided capacity costs (nominal $/kW-yr) were developed for on-peak and off-peak STEP measures. On-peak avoided capacity cost was defined as the forecasted capital and fixed operation and maintenance cost of a Reciprocating Internal Combustion Engine (RICE) brownfield plant with SCR & CO catalyst post combustion controls, annuitized over 35 years. Off-peak avoided capacity cost was defined as the blended cost of CPS Energy's forecasted capital and fixed operation and maintenance cost of a RICE and a natural gas combined cycle (NGCC GE Flex 1X1), with the blending ratio defined as the ratio of the added NGCC/RICE capacity in CPS Energy's 25-year expansion plan.

2.4.2 Avoided Transmission Cost of Service (ERCOT 4CP TCOS)

ERCOT recovers the costs of transmission incurred by transmission service providers via a charge on load-serving entities, including CPS Energy. The charge is allocated to load-serving entities based on each entity's average demand during four ERCOT system peaks (known as "four coincident peaks," or "4CP events") from June to September each year. To minimize this charge, CPS Energy anticipates likely 4CP events and deploys demand response resources to reduce demand accordingly. Energy efficiency measures also contribute to demand reduction during 4CP events.

To estimate gross demand reduction during FY 2019 4CP events within each demand response program/subprogram we multiplied the estimated load reduction per participant by the number of active participants and a "deployment success rate," the rate at which CPS Energy correctly anticipated and deployed each resource during FY 2019 4CP events.

For energy efficiency and renewable energy programs, we used hourly load shapes for each program measure to estimate the impacts during 4CP event hours for each weekday during the months of June through September. These monthly impacts were then averaged to estimate the 4CP impact for each program. The total reduction to 4CP demand is then valued at the expected future TCOS provided by CPS Energy.

2.4.3 Avoided Price Spikes Savings (kWh)

Avoiding intervals of especially high energy prices in the ERCOT market is another benefit of Demand Response (DR) programs. In ERCOT energy prices may go up to $9,000/MWh ($9/kWh), which is over 300 times the average wholesale price of energy ($30.10 in the CPS Energy zone) in 2018. By reducing demand during price spikes, CPS Energy benefits by avoiding high energy prices, or by selling energy from its own or contracted generation sources into the market. Avoided price spike savings are calculated for DR programs, which can sometimes be deployed in anticipation of price spike events.

Price spikes in the ERCOT market have a number of causes, occur irregularly, and are hard to predict. Price spikes are difficult to react to in a timely manner with some demand response resources. For example, a program that requires day-ahead notice to the program implementer would make rapid response to an unexpected price spike event impossible.

To estimate the value of energy (kWh) saved during FY 2019 price spike events, we compiled energy savings from all DR programs for every deployment interval and multiplied the sum within each interval by the corresponding ERCOT load zone energy price less CPS Energy's avoided cost of energy during the summer peak period. This method estimates the value of energy savings achieved during DR events without double counting the value of avoided energy costs.

2.5 ECONOMIC ANALYSIS

The following cost-effectiveness metrics were calculated for CPS Energy's programs. For results, see section 1.4:

Cost of Saved Energy (CSE) is the cost per kWh of energy efficiency and/or demand response program impact. The CSE is the ratio of the levelized program costs divided by the annual energy kWh savings. Levelized program costs are calculated using a Capital Recovery Factor (CRF), which incorporates the estimated useful life (EUL)[4] of the savings (weighted by measure) and an annual discount rate.

$$CSE = \frac{Levelized\ Program\ Costs}{Annual\ kWh\ savings}$$

Net Avoided Cost Benefit, or reduced revenue requirement (RRR) is the net reduction in utility costs from the energy and demand saved by CPS Energy's programs, calculated as the avoided cost benefit minus the total Program costs.

$$RRR = PV\ of\ Avoided\ Energy + PV\ of\ Avoided\ Demand - Total\ Program\ Costs$$

Program Administrator Benefit-Cost (PACT) Ratio is the ratio of the net present value (NPV) of avoided energy and capacity benefit, divided by the program's incentives and administrative costs, expressed as:

$$Benefit\ Cost\ Ratio = \frac{NPV\ of\ Avoided\ Cost\ Benefit}{Program\ Incentives + Admin\ Costs}$$

For all DR programs except for ADR, benefit-cost calculations consider only the cohort of participants added in FY 2019. ADR participants are contracted for 10 years, but because the costs and impacts change each year, benefit-cost is calculated with an EUL of one year and the impacts include all active participants in FY 2019. This approach is consistent with other program benefit-cost calculations, but caution is advised when comparing DR results to benefit-cost calculations from prior years. This is especially the case where there are significant differences between cohorts from FY 2019 and other years, since significant differences in the composition of cohorts from year to year affect the outcome.

[4] The Estimated Useful Life (EUL) values from the Texas TRM were utilized for all STEP measures, except where noted.

3. WEATHERIZATION PROGRAM

3.1 WEATHERIZATION PROGRAM IMPACTS

3.1.1 Overview

CPS Energy's residential weatherization program provides comprehensive retrofits for income-eligible customers. The weatherization program assists families in need to reduce their monthly utility bills. Eligible participants may receive free upgrades designed to increase the energy efficiency of their homes.

In FY 2019, the program provided a range of services to 3,608 customers, compared with 3,623 customers in FY 2018. Installed measures included repair, health & safety, and energy-saving measures. The energy-saving measures may be categorized as follows:

- LED light bulbs
- Wall insulation
- Attic insulation
- Floor insulation
- Solar screens
- Water heater pipe insulation
- Water heater insulation
- Low-flow showerheads
- Air infiltration reduction
- Duct system improvement
- Faucet aerators

The measure mix is diverse, but envelope measures (including wall insulation, attic insulation, floor insulation, solar screens, air infiltration reduction) are by far the largest contributors to total program impacts for both energy and demand savings.

- Attic insulation is the largest single measure contributing almost 30% of energy savings and almost 40% of NCP kW impacts.
- Air infiltration reduction is the 2nd highest contributor with roughly 20% of energy and NCP kW impacts.
- Lighting and wall insulation each contribute roughly 14% of energy impacts, but wall insulation has higher peak impacts than lighting measures.
- Domestic hot water measures offered almost negligible program impacts, delivering only 1.8% of energy impacts and less than 0.25% of coincident peak demand impacts.

Percent contribution to gross program-level energy and demand impacts are shown in Figure 3-1.

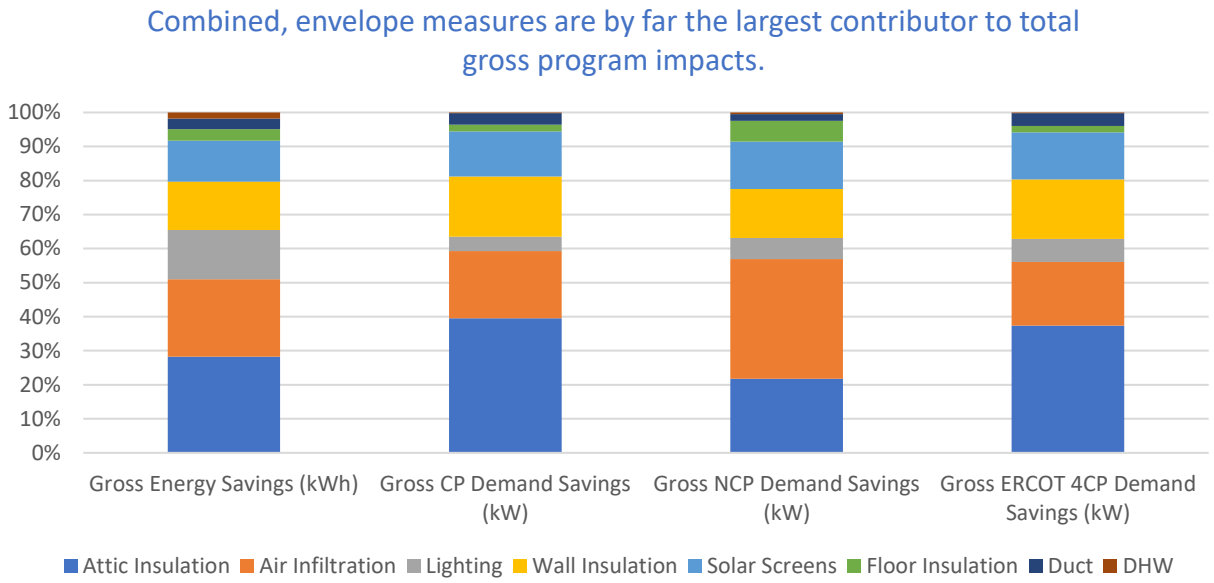


Figure 3-1: Weatherization – Gross Energy and Demand Impact Percentages by Measure

3.1.2 Savings Calculation Method

Frontier conducted a desk review for a sample of projects designed to deliver 90% confidence and 10% precision at the measure level. Frontier's desk review of sampled projects indicated that project documentation largely supported the reported project data. Minor adjustments were made to project-level input assumptions where the reported measure inputs did not match the post-inspection documentation.

For each of the measures, Frontier determined energy savings using methodology from the *CPS Energy Guidebook*. Projects completed between February 1, 2018 and May 31, 2018 (PY2) were evaluated against the November 2017 *CPS Energy Guidebook*. Projects completed between June 1, 2018 and January 31, 2019 (PY3) were evaluated against the June 2018 *CPS Energy Guidebook*. For programs or measures where other methods were used, those are referenced in each section.

3.1.2.1 Envelope Measures

Energy savings for this measure are determined using calibrated simulation models developed using NREL's BEopt 2.6 software running EnergyPlus 8.4 as the underlying simulation engine. Coincident, non-coincident,[5] and 4CP peak demand savings were determined using building energy simulation models developed by subtracting the whole house energy use in each hour of the post-retrofit models from the energy use in the pre-retrofit models. Additional detail on savings determination is presented in the *CPS Energy Guidebook*.

[5] It should be noted that for some envelope measures installed in homes with electric heating, the non-coincident peak occurs during the non-summer months.

Simulation models for envelope measures assumed homes had central air conditioning. For homes with room or window air conditioners, adjustment factors were applied. See the *CPS Energy Guidebook* for detail on those adjustment factors.

The following figures show frequency of installation and relative energy and demand impacts by envelope measure.

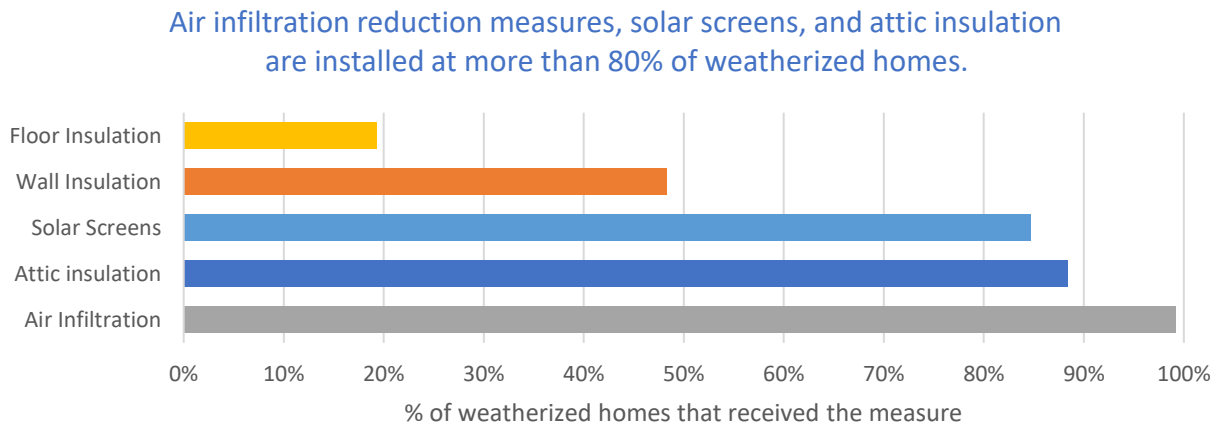


Figure 3-2: Weatherization – Frequency of Installation by Envelope Measure

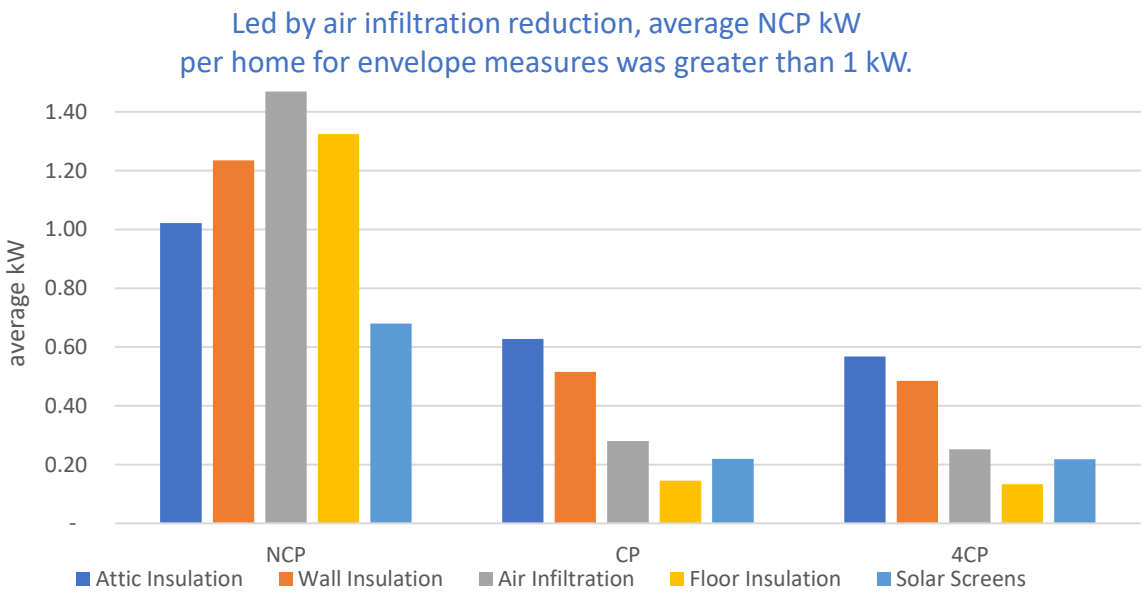


Figure 3-3: Weatherization – Average per Home NCP kW by Envelope Measure

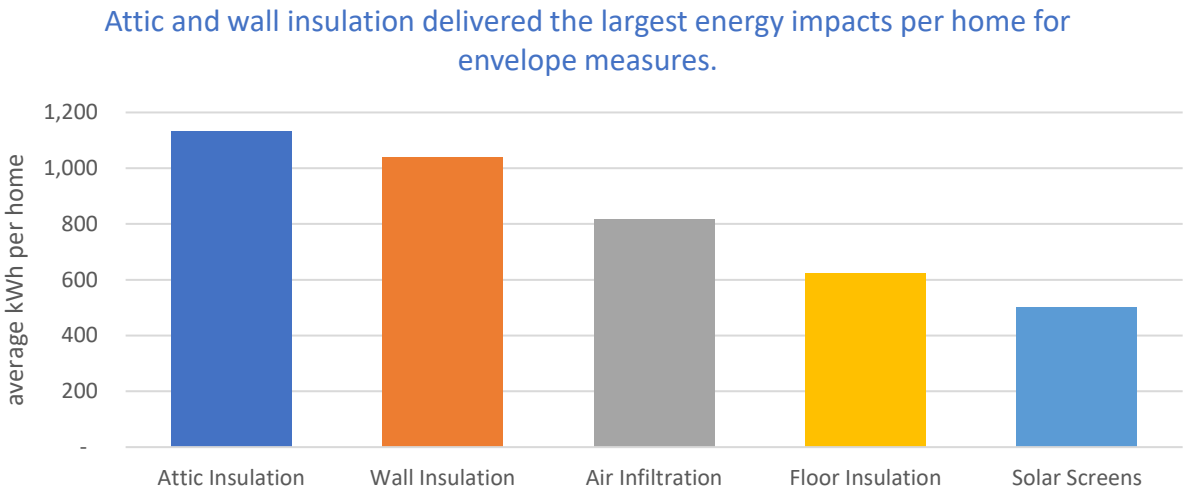


Figure 3-4: Weatherization – Average per Home kWh by Envelope Measure

Attic Insulation

As part of the weatherization program, Franklin Energy installed attic insulation in 3,189 homes during FY 2019. Average gross impacts per home for attic insulation are 1,131 kWh, 0.63 CP kW, 1.02 NCP kW, and 0.57 4CP kW.

Savings are determined per square foot of attic insulation installed and vary by heating and cooling system type and pre- and post-insulation levels. Adjustments to claimed savings were made as necessary to apply the appropriate savings factors for each project site.

Wall Insulation

Franklin Energy installed wall insulation in 1,742 homes during FY 2019. Energy and demand savings assume that an under-insulated wall cavity is insulated to bring it to R-13, typically by blowing in cellulose insulation. Average gross impacts per home for wall insulation are 1,039 kWh, 0.52 CP kW, 1.23 NCP kW, and 0.49 4CP kW.

Savings are determined per square foot of wall insulation installed and vary by heating and cooling system type. Adjustments to claimed savings were made as necessary to apply the appropriate savings factors for each project site.

Air Infiltration Reduction

As part of the Weatherization program, Franklin Energy installed air infiltration control measures in 3,578 homes during FY 2019. Average gross impacts per home for air infiltration reduction are 815 kWh, 0.28 CP kW, 1.47 NCP kW, and 0.25 4CP kW.

Deemed savings are presented as a function of the CFM_{50} reduction achieved, as demonstrated by blower door testing. The *CPS Energy Guidebook* restricts base and post CFM_{50} readings to reasonable

values that do not exceed building tightness limits. Where necessary to meet those requirements, pre- and post-CFM_{50} limits were applied to the documented CFM_{50} at each project site.

Floor Insulation

As part of the Weatherization program, Franklin Energy installed floor insulation in 698 homes during FY 2019. Average gross impacts per home for floor insulation are 622 kWh, 0.15 CP kW, 1.32 NCP kW, and 0.13 4CP kW.

The baseline is assumed to be a site-built house with pier and beam construction and no floor insulation against the floor of the conditioned area. Savings are determined per square foot of floor insulation installed and vary by heating and cooling. Adjustments to claimed savings were made as necessary to apply the appropriate savings factors for each project site.

Solar Screens

As part of the Weatherization program, Franklin Energy installed solar screens on 3,056 homes during FY 2019. Average gross impacts per home for solar screens are 503 kWh, 0.22 CP kW, 0.68 NCP kW, and 0.22 4CP kW.

The baseline is a single pane, clear glass, unshaded, east-, west-, or south-facing window with a solar heat gain coefficient of 0.75. Savings vary by window orientation and HVAC system type. Note that for this measure, the Guidebook applies a heating penalty to account for the reduction in solar heat gain during the heating season.

3.1.2.2 LED Light Bulbs

As part of the Weatherization program, Franklin Energy installed LED lighting in 3,490 homes during FY 2019. Average gross impacts per home for LED lighting are 531 kWh, 0.06 CP kW, 0.26 NCP kW, and 0.09 4CP kW. However, savings vary significantly based on installed lamp type because of the various baselines in effect for this measure.

The *CPS Energy Guidebook* includes separate calculation methodologies for omni-directional EISA-compliant and specialty EISA-exempt LED lighting. EISA-affected bulbs have savings that are determined using a two-tiered weighting approach due to the baseline change that is scheduled to occur in 2020. The savings for EISA-exempt bulbs were determined over the entire lifetime of the bulb using the equivalent wattages. The savings calculation also incorporates an interactive effects factor to account for the impacts on cooling and heating loads.

EISA-compliant lighting uses a dual baseline that is affected by several factors. Frontier applied updated CPS discount rate, avoided capacity cost, and avoided energy cost inputs specific to FY 2019. These factors are used to weight savings over the dual baselines to provide a single annualized savings value. These inputs are not known to the implementation vendor at the beginning of the fiscal year, which means that final measure realization rates are marginally impacted by factors outside of implementer control.

3.1.2.1 Duct System Improvement

As part of the Weatherization program, Franklin Energy performed duct sealing on 465 homes during FY 2019. Average gross impacts per home for duct sealing improvements are 848 kWh, 0.36 CP kW, 0.63 NCP kW, and 0.39 4CP kW.

Savings for all projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. In place of site-specific leakage testing results for each project, deemed savings are now provided for duct systems that are categorized as having high, average, or low levels of assessed leakiness. These ranges are determined by the contractor based on several factors, including a visual inspection, the amount of treated duct, and the severity of repaired leaks.

3.1.2.2 Domestic Hot Water

As part of the Weatherization program, Franklin Energy installed domestic hot water (DHW) measures in 676 homes during FY 2019. Average gross impacts per home for DHW measures are 347 kWh, 0.02 CP kW, 0.10 NCP kW, and 0.02 4CP kW.

Savings for all projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. Showerhead and aerator coincident, non-coincident, and 4CP peak demand factors were calculated using a DHW load profile developed from the Building America Analysis spreadsheet for existing homes. Pipe and water heater insulation coincident, non-coincident, and 4CP peak demand factors were calculated using an assumption that the load shape for this measure is evenly distributed across all hours of the year.

During the previous FY 2018 evaluation, DHW measures saw a change in methodology between the first and second half of the fiscal year. The change resulted in generally lower impacts for faucet aerator measures during the second half of the year. For FY 2019, the lower savings were used for the entire fiscal year, resulting in lower evaluated savings compared to the previous fiscal year evaluation.

Water Heater Pipe Insulation

Savings for this measure are based on an assumed baseline of a typical electric water heater without insulation on the water heater pipes with a maximum allowable insulation length of 6 feet of piping per installation. For any installation of water heater pipe insulation over six feet, the savings were capped at this maximum allowable length. The R-value of the installed insulation is reported by Franklin at R-3. Savings vary based on the location of the water heater, in conditioned or unconditioned space. Savings inputs based on the location of the water heater were applied based on project-specific documentation. If not provided, the more conservative inputs assumptions were used to estimate impacts.

Water Heater Tank Insulation

Savings for this measure are determined using an assumption of a 30-gallon water heater of standard height and diameter, providing a tank surface area of 17.45 square feet. The R-value of the installed insulation is reported by Franklin at R-5. Savings vary based on the location of the water heater, in conditioned or unconditioned space. Savings inputs based on the location of the water heater were

applied based on project-specific documentation. If not provided, the more conservative inputs assumptions were used to estimate impacts. The *CPS Energy Guidebook* requires water heaters to be manufactured after 1991 to be eligible for this measure. Claimed savings were adjusted accordingly based on project documentation. This requirement was not enforced by Franklin, resulting in very low realization rates for this measure.

Low-Flow Showerheads

Savings for this measure are determined using a baseline assumption of a 2.5 gallon per minute (GPM) flowrate for the existing showerhead, a 1.5 GPM flowrate for the replacement showerhead, and an average shower water temperature setpoint of 101°F.

Faucet Aerators

Savings for this measure are determined using a baseline assumption of a 2.2 gallon per minute (GPM) flowrate for the existing faucets, a 1.5 GPM flowrate for kitchen faucet aerators, a 1.0 GPM flowrate for the bathroom faucet aerators, and an average faucet water temperature setpoint of 88°F.

3.1.3 Results

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population. The following are the gross energy and demand savings for the Weatherization program, by measure.

Table 3-1: Weatherization Gross Energy and Demand Savings

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Attic Insulation	3,605,489	2,001	3,258	1,808
Air Infiltration Reduction	2,916,405	1,004	5,257	903
Lighting	1,851,619	210	920	329
Wall Insulation	1,809,255	898	2,151	845
Solar Screens	1,536,668	671	2,078	666
Floor Insulation	434,499	101	924	93
Duct	394,151	168	293	180
Domestic Hot Water	234,406	12	68	12
Total[6]	12,782,493	5,066	14,950	4,835

Rows may not sum to total due to rounding.

[6] The sum of the individual measures may not match the total due to the individual measure savings having been rounded to the nearest whole number.

3.2 WEATHERIZATION PROGRAM RECOMMENDATIONS

The following summarizes recommendations for the Weatherization program:

Envelope Measures

- Evaluation of envelope measures requires confirmation of heating and cooling system types at the individual home-level, as well as other home-specific characteristics such as square footage and number of stories. We recommend mapping database IDs for these inputs to each project and ensuring that there is only one of each input field mapped for each measure. Where the same inputs are required across measures, the same input field may be mapped to multiple measures.

LED Light Bulbs

Frontier recommends updating savings calculators to comply with the following key changes (and any other revisions not specifically listed below) to the *CPS Energy Guidebook* applicable to future fiscal year evaluations:

- First tier EISA baselines have been incremented down to a period of 1.5 years for FY 2020.
- Updated interactive effects factors have been provided for upstream programs or for instances where the cooling/heating types are unknown.

Duct Sealing

Frontier recommends updating savings calculators to comply with the following key changes (and any other revisions not specifically listed below) to the *CPS Energy Guidebook* applicable to future fiscal year evaluations:

- Updated claimed savings to use new deemed savings values for duct sealing projects performed without leakage testing.

4. RESIDENTIAL PROGRAMS

4.1 SUMMARY OF RESIDENTIAL IMPACTS

CPS Energy's portfolio of residential programs addresses all markets and major residential end uses. Residential demand response programs are included in Section 6. CPS Energy offered the following energy efficiency programs for the residential sector in FY 2019:

Home Efficiency - targets a wide range of energy efficiency measures that save cooling and heating energy in existing homes.

Residential HVAC - incentives for eligible high efficiency central AC, HP and room AC.

New Homes Construction - incentives for developers to build at least 15% more energy efficient than current CoSA building codes.

Home Energy Assessment - a free home assessment to identify energy saving opportunities, which may include directly installed LED lighting.

Multifamily Energy Efficiency - multiple direct install measures to help save energy through LED lights and other energy saving opportunities.

Energy Savings Through Schools - equips teachers, students and parents with in-class curriculum and take-home kits full of energy efficient products.

Residential Retail Partners - point of purchase incentives on ENERGY STAR® lighting and room air conditioners at participating retailers.

Cool Roof - rebates for self- or contractor-installed reflective roofing systems or coatings.

Most programs were implemented by Franklin Energy under contract to CPS Energy. However, the Cool Roof program was fully managed and implemented internally by CPS Energy.

The FY 2019 fiscal calendar spans part of Program Year 2 (PY2) and part of Program Year 3 (PY3) for contracted programs. Due to this break across program years, projects completed between February 1, 2018 and May 31, 2018 were evaluated against the November 2017 *CPS Energy Guidebook* and projects completed between June 1, 2018 and January 31, 2019 were evaluated against the June 2018 *CPS Energy Guidebook*, except where noted otherwise.

The contributions of each program to the residential portfolio's energy, peak demand, and non-coincident peak savings are shown in the following figures. Values in Figure 4-1 through Figure 4-3 represent energy and demand savings from new FY 2019 program participants as measured at the participant or end-user level and adjusted to account for net-to-gross ratios and line losses. Program names are abbreviated in chart labels.[7]

[7] HVAC = Heating Ventilation and Air Conditioning, Wx = Weatherization, HEA = Home Energy Assessments, MF = Multifamily, HER = Home Efficiency Rebates, NHC = New Home Construction

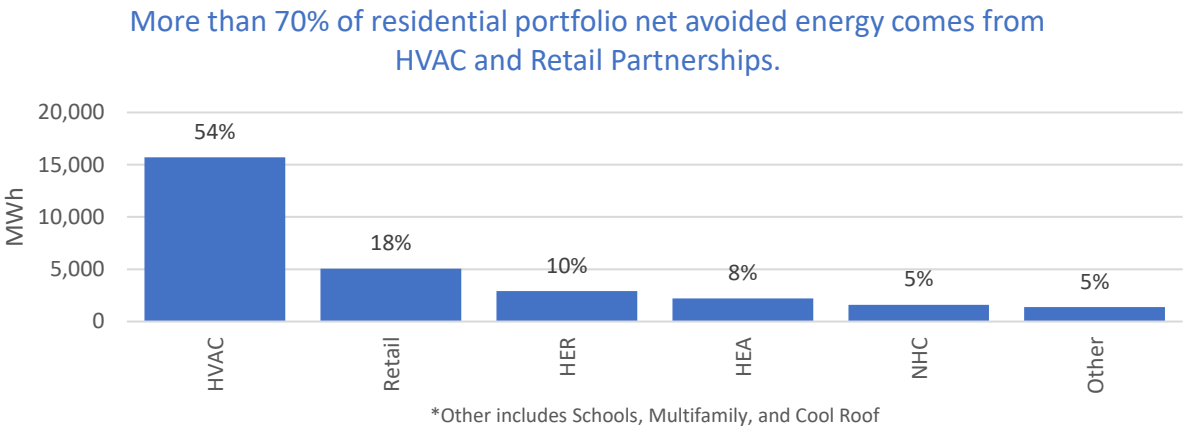


Figure 4-1: Summary of Residential Impacts – Net Avoided Energy by Program

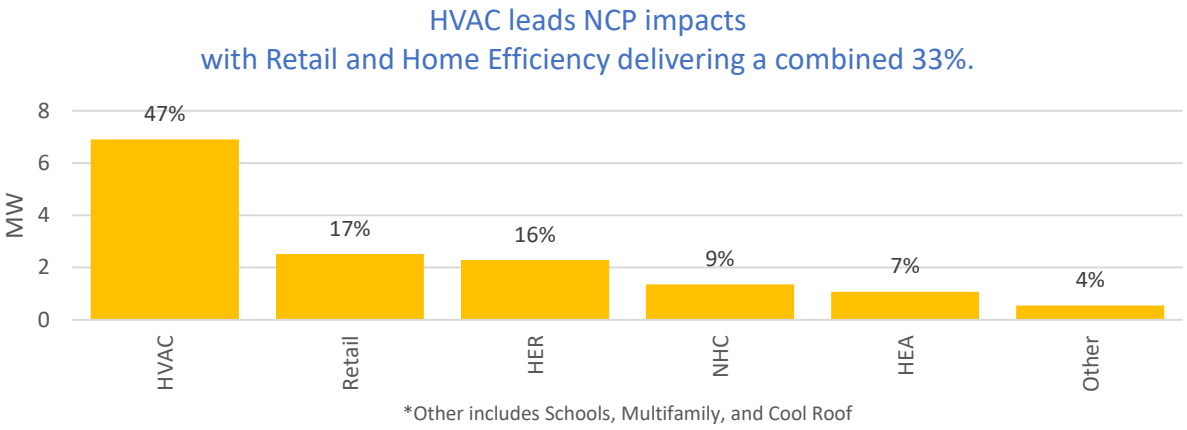


Figure 4-2: Summary of Residential Impacts – Net Avoided Non-Coincident Peak by Program

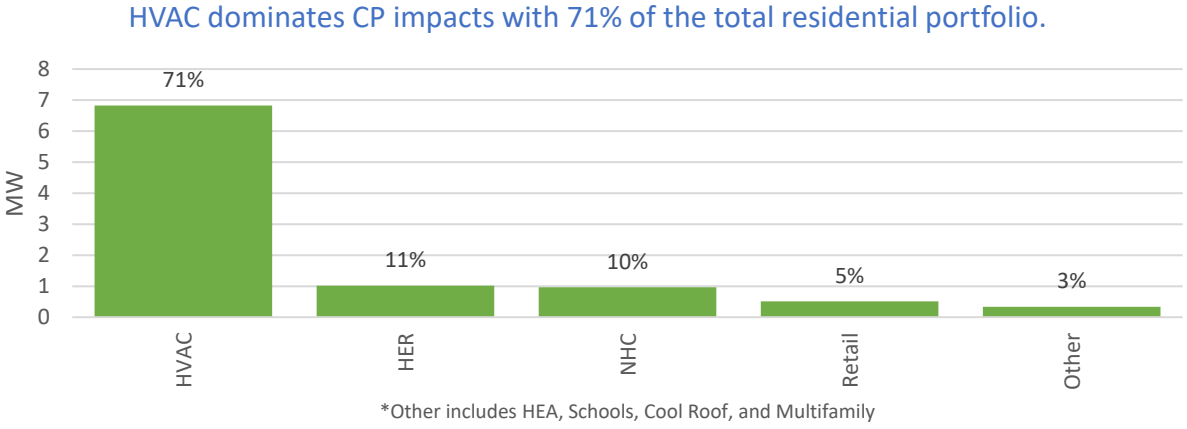


Figure 4-3: Summary of Residential Impacts – Net Avoided Coincident Peak by Program

4.2 HOME EFFICIENCY PROGRAM

4.2.1 Overview

CPS Energy's Home Efficiency program offers incentives for attic insulation and variable-speed pool pumps. Through the home efficiency program, Franklin Energy served 1,714 homes in FY 2019, compared to 1,876 in FY 2018. The proportion of total program energy and peak impacts derived from each measure type is presented in Figure 4-4.

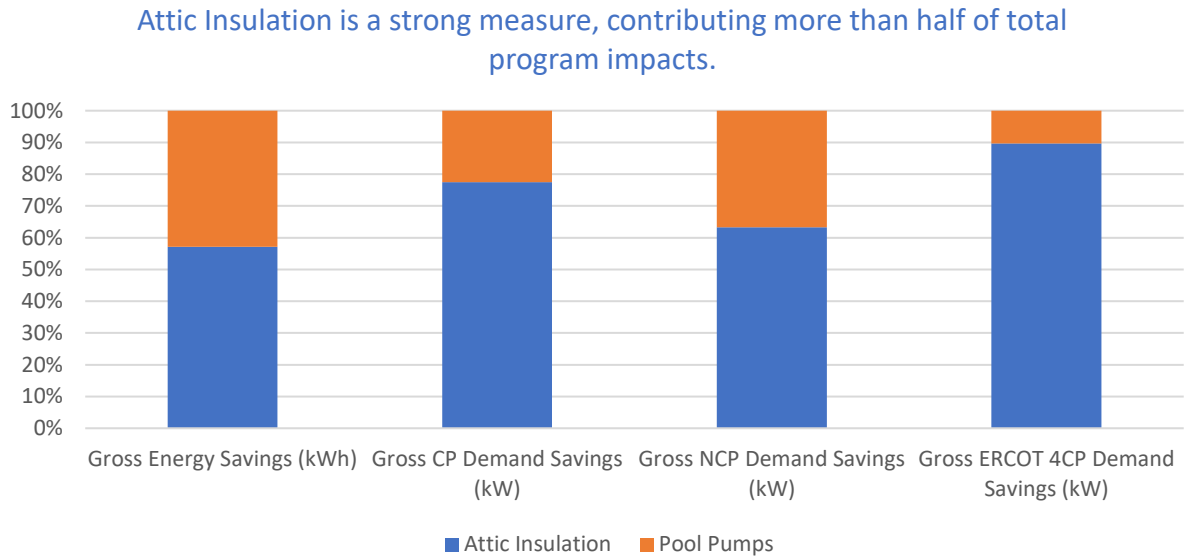


Figure 4-4: Home Efficiency – Gross Energy and Demand Impact Percentages by Measure

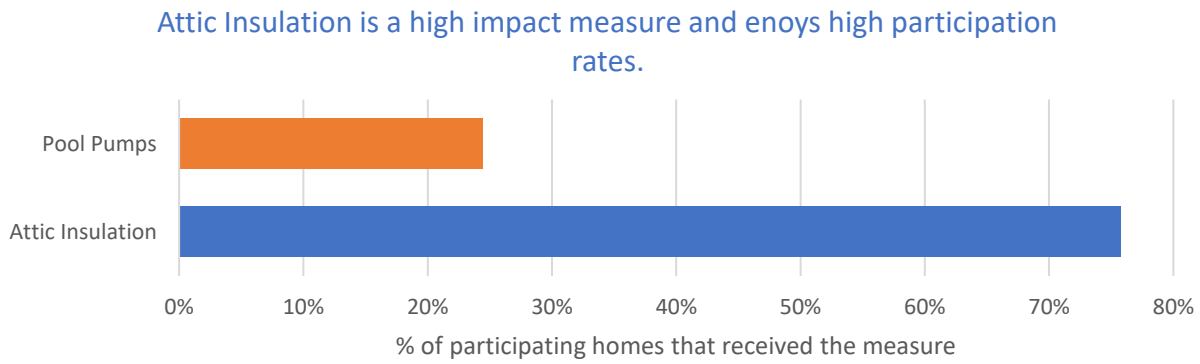


Figure 4-5: Home Efficiency – Frequency of Installation by Measure

4.2.2 Savings Calculation Method

Frontier conducted a desk review of sampled projects and found that project documentation supported the reported project data and no adjustments were made to project-level input assumptions.

For each of the measures, Frontier determined energy savings using methodology from the *CPS Energy Guidebook*. Projects completed between February 1, 2018 and May 31, 2018 (PY2) were evaluated

against the November 2017 *CPS Energy Guidebook*. Projects completed between June 1, 2018 and January 31, 2019 (PY3) were evaluated against the June 2018 *CPS Energy Guidebook*. For programs or measures where other methods were used, those are referenced in each section.

4.2.2.1 Attic Insulation

CPS Energy incentivized 1,298 attic insulation installations in FY 2019, compared with 1,434 attic insulation installations in FY 2018. Average gross impacts per home for attic insulation are 1,343 kWh, 0.75 CP kW, 1.22 NCP kW, and 0.69 4CP kW.

Savings are determined per square foot of attic insulation installed and vary by heating and cooling system type and pre- and post-insulation levels. Adjustments to claimed savings were made as necessary to apply the appropriate savings factors for each project site.

4.2.2.2 Variable-Speed Pool Pumps

Through the Home Efficiency program, CPS Energy provided incentives for the installation of 419 variable-speed pool pumps in FY 2019 compared to the 442 pool pumps installed in FY 2018.

The deemed energy and demand savings tables in the *CPS Energy Guidebook* include savings for seven pool pump horsepower sizes, ranging from 0.5 to 3.0 horsepower. For pool pumps with a horsepower not included within the deemed energy and demand savings tables, the savings were applied for the closest appropriate horsepower.

4.2.3 Results

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population.

The following are the gross energy and demand savings for the Home Efficiency program.

Table 4-1: Home Efficiency Gross Energy and Demand Savings

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Attic Insulation	1,692,632	779	1,474	877
Pool Pumps	1,270,464	227	856	101
Total[8]	2,963,096	1,006	2,330	978

Rows may not sum to total due to rounding.

[8] The sum of the individual measures may not match the total due to the individual measure savings having been rounded to the nearest whole number.

4.3 RESIDENTIAL HVAC PROGRAM

4.3.1 Overview

This program promotes the installation of energy efficient Heating, Ventilation, and Air Conditioning (HVAC) equipment. The program covers the installation of central air conditioners (ACs), central heat pumps (HPs), window air conditioners (WACs), and ground source heat pumps (GSHPs). During FY 2019, a total of 6,969 HVAC systems were incentivized through the CPS Residential HVAC program for HVAC equipment installed in 6,421 homes.

This evaluation includes both previously evaluated projects from the CPS PY2 evaluation and new PY3 projects completed during the CPS FY 2019 evaluation period. The figure below presents a percentage breakdown of kWh energy savings. Savings are presented by system type for all newly evaluated HVAC projects completed through this program.

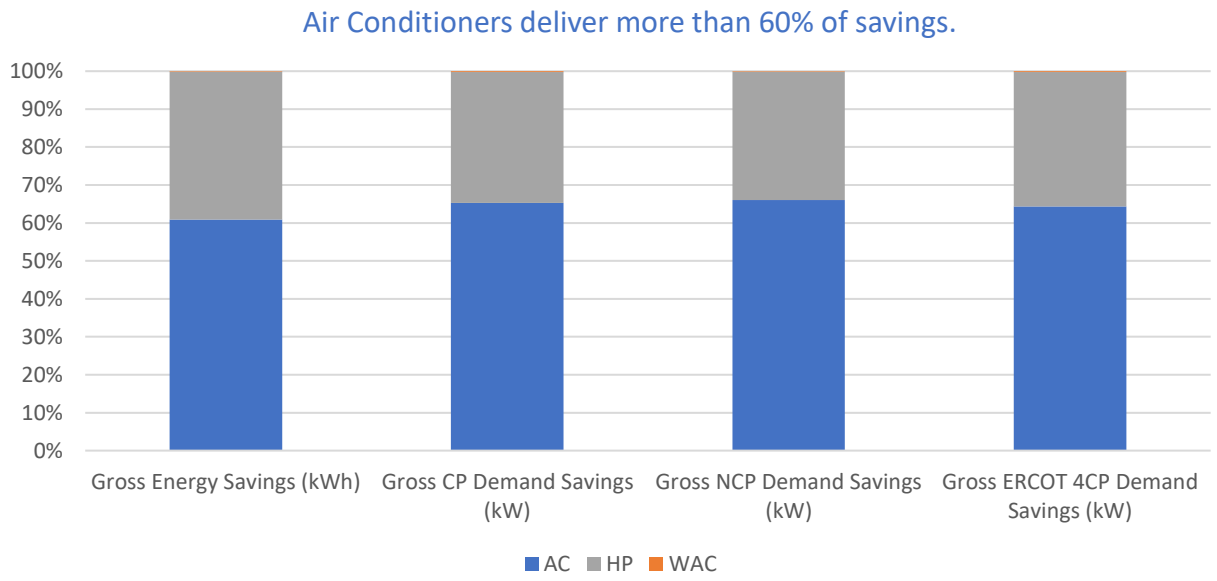


Figure 4-6: Residential HVAC – Gross Energy and Demand Impact Percentages by Measure

4.3.2 Savings Calculation Method

Projects completed between in PY2 were evaluated against the November update to the *CPS Energy Guidebook*. Projects completed in PY3 were evaluated against the June 2018 update to the *CPS Energy Guidebook*. Savings for all projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. There were no major changes to the savings calculation methodology compared to the approach used in the FY 2018 evaluation.

AC and HP were calculated using two distinct replace-on-burnout and early retirement baselines. New constructions baselines were not used because those projects were incentivized through alternate programs.

Savings were estimated using performance curves developed by the National Renewable Energy Laboratory.[9] These performance curves provide the capacity and efficiency of the heat pump operating in cooling mode across a wide range of outside air temperatures. Unit loading was estimated as a function of outside air temperature, and hours of cooling mode operation under different loadings were estimated using bin weather data for each weather zone. The model uses a set of normalized performance curves to scale the rated performance values as a function of outdoor dry-bulb temperature ranging from 65 to 115 degrees Fahrenheit. The total capacity and Energy Input Ratio (EIR = 1/COP) curves are a function of entering wet-bulb temperature (EWB) and outdoor dry-bulb temperature (ODB) with quadratic curve fittings.

In heating mode, predicted HVAC operation was limited to meeting 77% of load, using a factor applied in Manual J to correlate design load hours to equivalent full load hours under actual operating conditions, taking into account that heating systems are not always operated even when outdoor conditions indicate they should be in operation. It was assumed that typical HVAC systems are sized to 115% of their design cooling load (oversized by 15%). Heating mode capacity was related to rated cooling capacity using rated capacity in cooling and heating mode according to data exported from the AHRI Directory.[10]

For early retirement projects, remaining useful life assumptions were incremented by a year to account for bulk installation during the 2018 calendar year. Frontier also applied updated CPS discount rate, avoided capacity cost, and avoided energy cost factors specific to FY 2019. These factors are used to weight savings over the dual baselines used for early retirement projects. These factors are also not known to the implementation vendor at the beginning of the fiscal year, which means that final measure realization rates are marginally impacted by factors outside of implementer control.

WAC savings were calculated using a replace-on-burnout baseline by multiplying the installed capacity by the change in system efficiency using the engineering algorithms described in the *CPS Energy Guidebook*. No GSHP projects were installed in FY 2019.

4.3.3 Equipment Verification

To verify the accuracy of the reported equipment specifications, reported system capacities and efficiencies were validated against the AHRI Directory for the single AC project and against the ENERGY STAR certified product listing[11] for the WAC projects. Minimal discrepancies were identified for the AC and HP projects. WACs were not ENERGY STAR listed. For those systems, reported system efficiencies did not meet the minimum ENERGY STAR room air conditioner efficiency requirement.

Early retirement projects use an alternate dual baseline that requires confirmation of several additional measure inputs. Frontier validated reported existing system type, condition, model numbers, and age

[9] D. Cutler et al., Improved Modeling of Residential Air Conditioners and Heat Pumps for Energy Calculations. National Renewable Energy Laboratory. NREL/TP-5500-56354. January 2013. Tables 12 and 13. http://www.nrel.gov/docs/fy13osti/56354.pdf.
[10] AHRI Certification Directory: https://www.ahridirectory.org/ahridirectory/pages/home.aspx.
[11] ENERGY STAR Certified Room Air Conditioners: https://www.energystar.gov/productfinder/product/certified-room-air-conditioners/.

against available project documentation. Savings were calculated against an adjusted replace-on-burnout baseline for projects where this documentation was not available.

For heat pump projects replacing air conditioners with an electric furnace, heating energy savings were calculated against an electric resistance baseline. Frontier validated the reported baseline against available project documentation. Savings were calculated against an adjusted heat pump baseline for projects where this documentation was not available.

4.3.4 Results

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population.

Overall, the Franklin Residential HVAC program achieved realization rates of 104% for NCP kW demand savings and 86% for kWh energy savings.

Table 4-2: Residential HVAC Gross Energy and Demand Savings

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Central Air Conditioners	9,551,917	4,308	4,454	3,610
Central Heat Pumps	6,114,371	2,280	2,280	1,986
Window Air Conditioners	17,665	12	12	12
Total[12]	15,683,954	6,600	6,745	5,608

Rows may not sum to total due to rounding.

[12] The sum of the individual measures may not match the total due to the individual measure savings having been rounded to the nearest whole number.

4.4 NEW HOMES CONSTRUCTION PROGRAM

4.4.1 Overview

CPS Energy's FY 2019 new residential construction program provided incentives for 1,401 new homes. Eight builders participated in the program. CPS Energy used a two-tiered incentive structure in FY 2019. and paid incentives based on whether a certification could be obtained to confirm the construction of a home was expected to consume at least 15% less total source energy (electricity and gas) than a home built to the requirements of IECC 2015.

Participants could qualify for higher incentives by obtaining certification through the Build San Antonio Green (BSAG) program. The BSAG single family new construction program incorporates other elements in addition to energy consumption to achieve its certification including water, site, and health requirements. BSAG also requires a HERS rating and meeting of all the requirements of the Energy Star New Homes program.

Table 4-3: New Residential Construction – FY 2019 Incentive Levels

Requirement	FY 2019 Starting Incentive Amount ($)	FY 2019 Ending Incentive Amount ($)
15% better than IECC 2015 – no Certification	$1,100	$800
15% better than IECC 2015 – with BSAG Certification	$1,300	$1,000

4.4.1 Participation Trends

In the FY 2019 program there were 1,211 homes certified by BSAG, or 86% of the total 1,401 homes. Two main builders, Lennar and Meritage, built 80% of all the homes in the program.

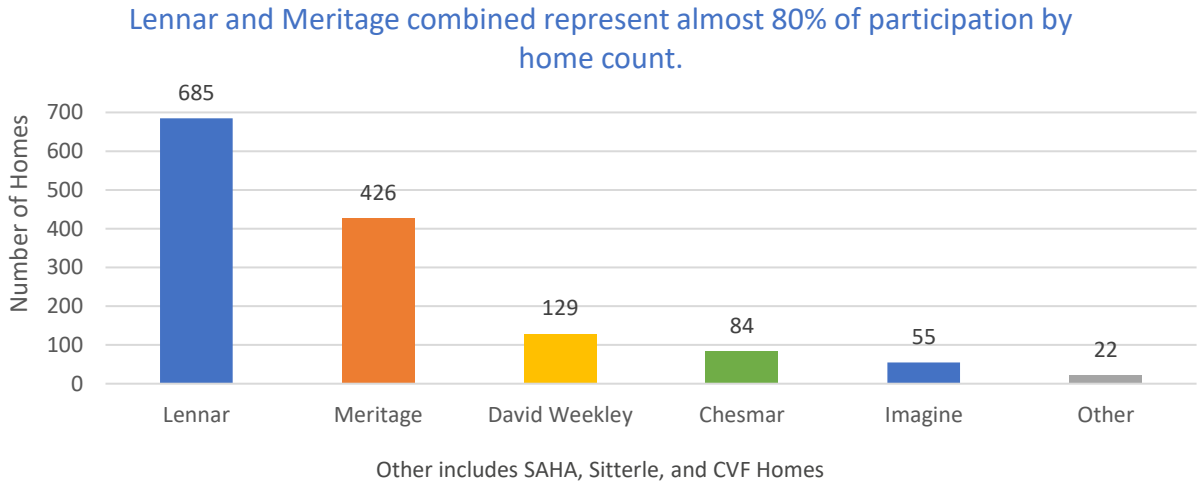


Figure 4-7: New Home Construction Program – Participation by Builder

4.4.2 Savings Calculation Methods

San Antonio adopted IECC 2018 in June 2018 with an effective date of October 1, 2018. For this evaluation, we estimated savings based on the previous code, IECC 2015, to accommodate any lag in enforcement of the new code.

Homes are accepted to the program based on ratings developed using the Energy Systems Lab's (ESL) International Code Compliance Calculator (IC3) and Architectural Energy Corporation's REM/Rate, the software used to establish Energy Star program compliance. Both tools provide site and source energy savings estimates based on a comparison of the predicted energy use in the as-built home to the energy use the models predict for a reference model, which incorporates the features of a home built to the reference code (IECC 2015) and equipped to relevant standards (e.g. federal equipment efficiency standards for HVAC units, water heaters, etc.). Source energy savings estimates are the basic requirement for establishing whether program guidelines have been met and the incentive tier for a given project. However, neither tool provides the coincident peak (CP), ERCOT 4 CP (4CP) or non-coincident peak (NCP) demand savings needed for benefit-cost analysis of the residential new construction program.

Frontier employed BEopt residential building energy use simulation software to develop models representing the general suites of measures incorporated in participating homes by different builders. With these models Frontier is able to verify the energy savings estimates from the rating tools and estimate CP, 4CP and NCP demand savings. The base Frontier model is a simple single-story square home with an unfinished attic, built on a slab. The reference model is populated in accordance with the requirements for creating a standard reference model in Section R405 of the IECC 2015.

Builders are using a wide array of measures to meet program requirements: some have gone to 2x6 walls with R-19 insulation, while others are also adding continuous rigid insulation around the exterior of the homes. A majority of homes have 16 SEER air conditioners (or 16 SEER/8.5 and higher HSPF heat pumps), and some have tankless water heaters. Many are bringing the attics inside the envelope, insulating at the roof deck and completely sealing the attic; almost all are installing radiant barriers.

Perhaps the most important feature in determining by how much participating homes beat code is in reducing air infiltration. Code requires that homes not allow more than 5 air changes per hour (ACH) during blower door testing (pressurized to 50 pascals): reported air infiltration rates from post-construction blower door tests were between 2 and 5 ACH_{50}.

After reviewing the data from the IC3 reports and supplemental information requested (as listed in the *CPS Energy Guidebook* section for this program), Frontier developed simulation models reflecting the basic packages implemented by each of the builders. Frontier then ran simulations on variations of these models reflecting important differences such as the size (conditioned floor area) and achieved air infiltration rate. The result of this calibrated modeling approach is a deemed savings value per home as shown in Table 4-4.

Table 4-4: New Residential Construction – Deemed Savings per Home

kWh/home	CP kW/home	NCP kW/home	4CP kW/home
1,072	0.603	0.923	0.724

4.4.3 Results

Coincident, non-coincident, and 4CP peak demand factors were calculated using an assumption that the load shape for this measure is evenly distributed across all hours of the year.

The estimated energy savings and coincident peak, non-coincident peak, and ERCOT 4CP demand savings for the FY 2019 residential new construction program are presented in Table 4-5.

Table 4-5: New Residential Construction Gross Energy and Demand Savings

Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
1,504,416	888	1,292	1,020

4.5 HOME ENERGY ASSESSMENT

4.5.1 Overview

The Home Energy Assessment (HEA) Program provides energy-saving products to CPS Energy customers by means of an in-person home energy assessment or through home energy assessment direct installation kits. The HEA Program served 4,231 homes in FY 2019.

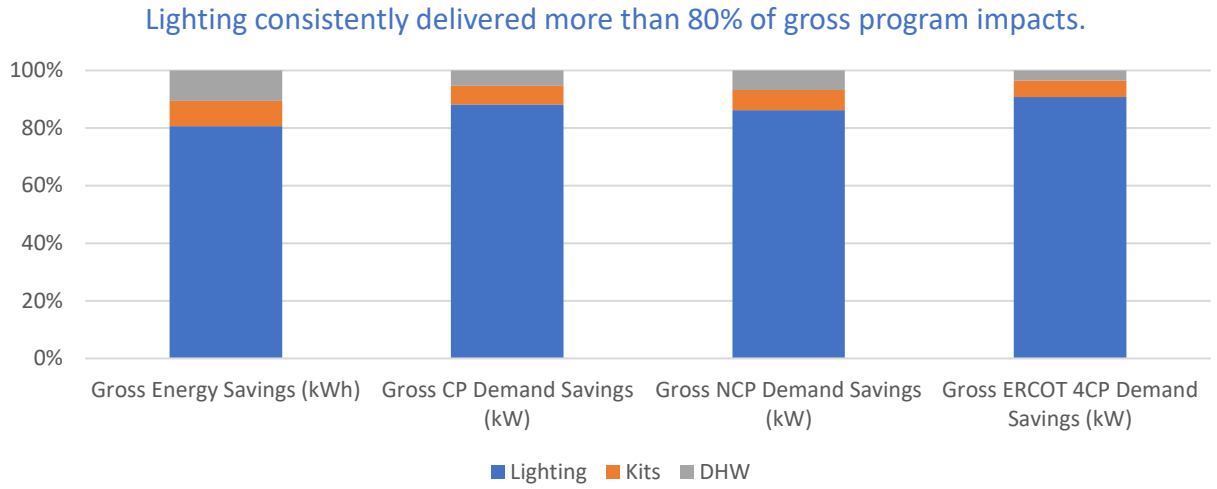


Figure 4-8: Home Energy Assessment Program – Gross Energy and Demand Impact Percentages by Measure

4.5.2 Savings Calculation Method

The energy and demand savings for the HEA Program were determined using the methodologies outlined in the *CPS Energy Guidebook*. Projects completed between February 1, 2017 and May 31, 2017 were evaluated against the October 2016 *CPS Energy Guidebook*. Projects completed between June 1, 2017 and January 31, 2018 were evaluated against the November 2017 *CPS Energy Guidebook*. For programs or measures where other methods were used, those are referenced in each section.

The sections below include the savings methodologies for in-person installations for LED light bulbs, low-flow showerheads, faucet aerators, and water heater pipe insulation. The following sections also include the savings methodologies for the two HEA kits, one for electric water heater customers and one for gas water heater customers.

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population.

4.5.2.1 LED Light Bulbs

As part of the HEA program, Franklin Energy installed LED lighting in 2,504 homes during FY 2019. Average gross impacts per home for LED lighting are 831 kWh, 0.09 CP kW, 0.43 NCP kW, and 0.14 4CP

kW. However, savings vary significantly based on installed lamp type because of the various baselines in effect for this measure.

The *CPS Energy Guidebook* includes separate calculation methodologies for omni-directional EISA-compliant and specialty EISA-exempt LED lighting. EISA-affected bulbs have savings that are determined using a two-tiered weighting approach due to the baseline change that is scheduled to occur in 2020. The savings for EISA-exempt bulbs were determined over the entire lifetime of the bulb using the equivalent wattages. The savings calculation also incorporates an interactive effects factor to account for the impacts on cooling and heating loads.

EISA-compliant lighting uses a dual baseline that is affected by several factors. Frontier applied updated CPS discount rate, avoided capacity cost, and avoided energy cost inputs specific to FY 2019. These factors are used to weight savings over the dual baselines to provide a single annualized savings value. These inputs are not known to the implementation vendor at the beginning of the fiscal year, which means that final measure realization rates are marginally impacted by factors outside of implementer control.

4.5.2.2 Domestic Hot Water

As part of the HEA program, Franklin Energy installed domestic hot water (DHW) measures in 578 homes during FY 2019. Average gross impacts per home for DHW measures are 469 kWh, 0.02 CP kW, 0.15 NCP kW, and 0.02 4CP kW.

Savings for all projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. Showerhead and aerator coincident, non-coincident, and 4CP peak demand factors were calculated using a DHW load profile developed from the Building America Analysis spreadsheet for existing homes. Pipe and water heater insulation coincident, non-coincident, and 4CP peak demand factors were calculated using an assumption that the load shape for this measure is evenly distributed across all hours of the year.

During the previous FY 2018 evaluation, Domestic Hot Water (DHW) measures saw a change in methodology between the first and second half of the fiscal year. The change resulted in generally lower impacts for faucet aerator measures during the second half of the year. For FY 2019, the lower savings were used for the entire fiscal year, resulting in lower evaluated savings compared to the previous fiscal year evaluation.

Water Heater Pipe Insulation

Savings for this measure are based on an assumed baseline of a typical electric water heater without insulation on the water heater pipes with a maximum allowable insulation length of 6 feet of piping per installation. For any installation of water heater pipe insulation over six feet, the savings were capped at this maximum allowable length. The R-value of the installed insulation is reported by Franklin at R-3. Savings vary based on the location of the water heater, in conditioned or unconditioned space. Savings inputs based on the location of the water heater were applied based on project-specific documentation. If not provided, the more conservative inputs assumptions were used to estimate impacts.

Low-Flow Showerheads

Savings for this measure are determined using a baseline assumption of a 2.5 gallon per minute (GPM) flowrate for the existing showerhead, a 1.5 GPM flowrate for the replacement showerhead, and an average shower water temperature setpoint of 101°F.

Faucet Aerators

Savings for this measure are determined using a baseline assumption of a 2.2 gallon per minute (GPM) flowrate for the existing faucets, a 1.5 GPM flowrate for kitchen faucet aerators, a 1.0 GPM flowrate for the bathroom faucet aerators, and an average faucet water temperature setpoint of 88°F.

4.5.2.3 HEA Kits

Through the Home Energy Assessment program, Franklin Energy also offered the option of direct installation kits for customers. As part of the HEA program, Franklin Energy distributed kits to 1,575 homes during FY 2019. Average gross impacts per home for kit measures are 144 kWh, 0.010 CP kW, 0.055 NCP kW, and 0.014 4CP kW.

The savings methodology for each of these measures is described above. An installation rate is applied to the savings for each of these measures. These installation rates were provided by the contractor through a data analysis installation document. The installation rates for LEDs are 95% for the first LED, 90% for the second LED, 85% for the third LED, 80% for the fourth LED, and 75% for the fifth LED. The low-flow showerheads were evaluated using an installation rate of 51%. The savings for kitchen faucet aerators were determined using a 39% installation rate and savings for bathroom aerators were determined using a 38% installation rate. The savings for pipe insulation were determined using a 50% installation rate. DHW measure installation rates were determined from survey results compiled during the FY 2017 fiscal year evaluation.

Kits for Customers with Electric Water Heaters

As part of the HEA program, Franklin Energy distributed kits to 723 homes with electric water heating during FY 2019. Average gross impacts per home for electric DHW kit measures are 242 kWh, 0.015 CP kW, 0.083 NCP kW, and 0.019 4CP kW.

Electric water heater kits consist of five 9-Watt LED lightbulbs, one 1.5 GPM low-flow showerhead, one 1.5 GPM kitchen faucet aerator, one 1.0 GPM bathroom faucet aerator, and six feet of pipe insulation.

Kits for Customers with Gas Water Heaters

As part of the HEA program, Franklin Energy distributed kits to 852 homes with gas water heating during FY 2019. Average gross impacts per home for gas DHW kit measures are 61 kWh, 0.006 CP kW, 0.030 NCP kW, and 0.009 4CP kW.

Gas water heater kits consist of five 9-Watt LED lightbulbs.

4.5.3 Results

For future iterations of the Home Energy Assessment program, Frontier recommends conducting customer surveys for the electric water heater kits and gas water heater kits. Using survey data, more accurate installation rates can be applied.

The following are the gross energy and demand savings for the Home Energy Assessment program.

Table 4-6: Home Energy Assessment Gross Energy and Demand Saving

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Lighting	2,079,958	217	1,074	340
DHW	271,108	13	85	13
Kits	226,685	16	86	21
Total[13]	2,577,751	246	1,245	375

Rows may not sum to total due to rounding.

[13] The sum of the individual measures may not match the total due to the individual measure savings having been rounded to the nearest whole number.

4.6 MULTIFAMILY ENERGY EFFICIENCY

4.6.1 Overview

The Multifamily Energy Efficiency program provides energy efficient measures to multifamily properties with more than five units. The Multifamily program includes installation of LED bulbs, high-efficiency showerheads, kitchen and bathroom faucet aerators, water heater pipe insulation, and power strips (no power strips were installed in FY 2019). The Multifamily program was active only during PY2 and saw no activity in PY3. The program served 310 individual apartments in FY 2019.

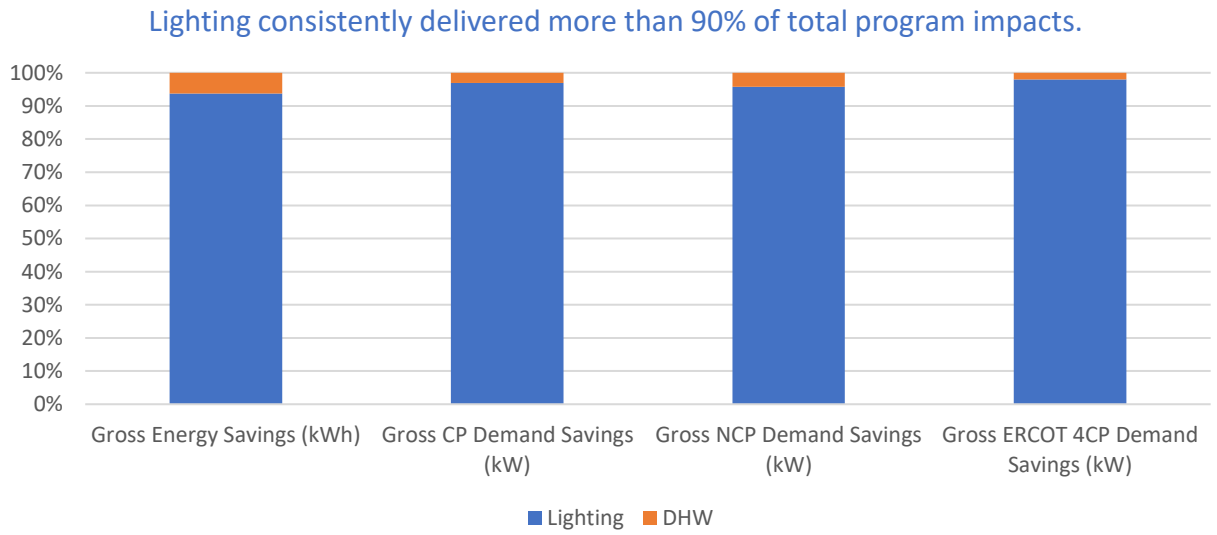


Figure 4-9: Multifamily Program – Gross Energy and Demand Impacts by Measure

4.6.2 Savings Calculation Method

Frontier conducted a desk review for a sample of projects designed to deliver 90% confidence and 10% precision. Frontier's desk review of sampled projects indicated that project documentation supported the reported project data and no adjustments were made to project-level input assumptions.

For each of the measures, Frontier determined energy savings using methodology from the *CPS Energy Guidebook*. Projects completed between February 1, 2018 and May 31, 2018 were evaluated against the November 2017 *CPS Energy Guidebook*. Projects completed between June 1, 2018 and January 31, 2019 were evaluated against the June 2018 *CPS Energy Guidebook*. For programs or measures where other methods were used, those are referenced in each section.

4.6.2.1 LED Light Bulbs

As part of the Multifamily Energy Efficiency program, Franklin Energy installed LED lighting at 89 properties in 6,357 homes and multifamily common areas during FY 2019. Average gross impacts per project for LED lighting are 400 kWh, 0.05 CP kW, 0.17 NCP kW, and 0.07 4CP kW. However, savings vary significantly based on installed lamp type because of the various baselines in effect for this measure.

The *CPS Energy Guidebook* includes separate calculation methodologies for omni-directional EISA-compliant and specialty EISA-exempt LED lighting. EISA-affected bulbs have savings that are determined using a two-tiered weighting approach due to the baseline change that is scheduled to occur in 2020. The savings for EISA-exempt bulbs were determined over the entire lifetime of the bulb using the equivalent wattages. The savings calculation also incorporates an interactive effects factor to account for the impacts on cooling and heating loads.

EISA-compliant lighting uses a dual baseline that is affected by several factors. Frontier applied updated CPS discount rate, avoided capacity cost, and avoided energy cost inputs specific to FY 2019. These factors are used to weight savings over the dual baselines to provide a single annualized savings value. These inputs are not known to the implementation vendor at the beginning of the fiscal year, which means that final measure realization rates are marginally impacted by factors outside of implementer control.

Lighting installed in multifamily common areas were verified using the methodologies described in the commercial lighting measure from the *CPS Energy Guidebook*. Realization rates were lower for these lamps because Franklin calculated savings using the methodology outlined for residential lighting.

4.6.2.2 Domestic Hot Water

Savings for all projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. Showerhead and aerator coincident, non-coincident, and 4CP peak demand factors were calculated using a DHW load profile developed from the Building America Analysis spreadsheet for existing homes. Pipe and water heater insulation coincident, non-coincident, and 4CP peak demand factors were calculated using an assumption that the load shape for this measure is evenly distributed across all hours of the year.

During the previous FY 2018 evaluation, Domestic Hot Water (DHW) measures saw a change in methodology between the first and second half of the fiscal year. The change resulted in generally lower impacts for faucet aerator measures during the second half of the year. For FY 2019, the lower savings were used for the entire fiscal year, resulting in lower evaluated savings compared to the previous fiscal year evaluation.

Low Flow Showerheads

As part of the Multifamily Energy Efficiency program, Franklin Energy installed low-flow showerheads in 33 homes during FY 2019.

Savings for this measure are determined using a baseline assumption of a 2.5 gallon per minute (GPM) flowrate for the existing showerhead, a 1.5 GPM flowrate for the replacement showerhead, and an average shower water temperature setpoint of 101°F.

Faucet Aerators

As part of the Multifamily Energy Efficiency program, Franklin Energy installed faucet aerators in five homes during FY 2019.

Savings for this measure are determined using a baseline assumption of a 2.2 gallon per minute (GPM) flowrate for the existing faucets, a 1.5 GPM flowrate for kitchen faucet aerators, a 1.0 GPM flowrate for the bathroom faucet aerators, and an average faucet water temperature setpoint of 88°F.

4.6.3 Results

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population.

The following are the gross energy and demand savings for the Multifamily Energy Efficiency program.

Table 4-7: Multifamily Gross Energy and Demand Saving

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Lighting	148,485	16	72	24
DHW	9,937	0.5	3.2	0.5
Total[14]	158,422	16	75	24

Rows may not sum to total due to rounding.

[14] The sum of the individual measures may not match the total due to the individual measure savings having been rounded to the nearest whole number.

4.7 ENERGY SAVINGS THROUGH SCHOOLS

4.7.1 Overview

The Energy Savings Through Schools Program provides students with energy efficiency kits. The kits are comprised of three 9-Watt LED light bulbs, a high-efficiency showerhead, a kitchen faucet aerator, and a bathroom faucet aerator. 10,027 kits were distributed in FY 2019 compared to 14,294 in FY 2018.

The figure below presents a percentage breakdown of kWh energy savings. Savings are presented by kit measure type for all newly evaluated kits projects completed through this program.

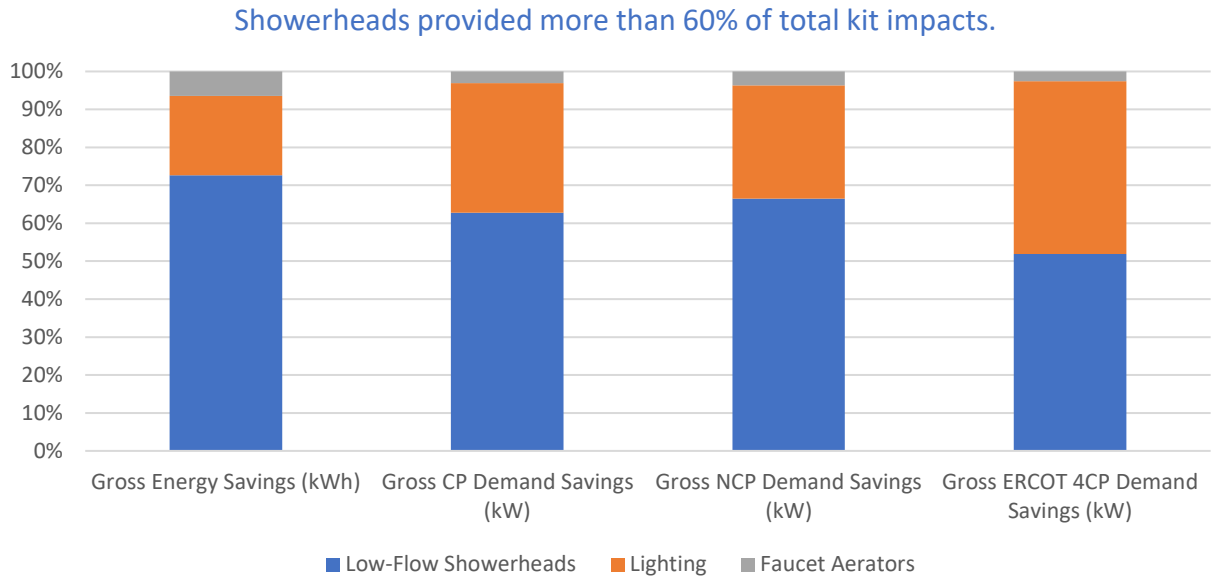


Figure 4-10: Energy Savings Through Schools – Gross Energy and Demand Impacts by Measure

4.7.2 Savings Calculation Method

Projects were evaluated against the June 2018 update to the *CPS Energy Guidebook*. As part of the Energy Savings Through Schools program, Franklin Energy distributed 10,027 kits to 49 schools during FY 2019. Kits consist of three 9-Watt LED lightbulbs, one 1.5 GPM low-flow showerhead, one 1.5 GPM kitchen faucet aerator, and one 1.0 GPM bathroom faucet aerator. Average gross impacts per home for electric DHW kit measures are 119 kWh, 0.007 CP kW, 0.042 NCP kW, and 0.008 4CP kW.

4.7.2.1 LED Light Bulbs

The *CPS Energy Guidebook* includes separate calculation methodologies for omni-directional EISA-compliant and specialty EISA-exempt LED lighting. EISA-affected bulbs have savings that are determined using a two-tiered weighting approach due to the baseline change that is scheduled to occur in 2020. The savings for EISA-exempt bulbs were determined over the entire lifetime of the bulb using the equivalent wattages. The savings calculation also incorporates an interactive effects factor to account for the impacts on cooling and heating loads.

EISA-compliant lighting uses a dual baseline that is affected by several factors. Frontier applied updated CPS discount rate, avoided capacity cost, and avoided energy cost inputs specific to FY 2019. These factors are used to weight savings over the dual baselines to provide a single annualized savings value. These inputs are not known to the implementation vendor at the beginning of the fiscal year, which means that final measure realization rates are marginally impacted by factors outside of implementer control.

Installation rates for the kits were derived from student survey data for the program. The installation rates for LEDs are 66% for the first LED, 56% for the second LED, and 49% for the third LED.

4.7.2.2 Domestic Hot Water

Savings for all projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. Showerhead and aerator coincident, non-coincident, and 4CP peak demand factors were calculated using a DHW load profile developed from the Building America Analysis spreadsheet for existing homes. Pipe and water heater insulation coincident, non-coincident, and 4CP peak demand factors were calculated using an assumption that the load shape for this measure is evenly distributed across all hours of the year.

Installation rates for the kits were derived from student survey data for the program. The low-flow showerheads were evaluated using an installation rate of 51%. The savings for kitchen faucet aerators were determined using a 39% installation rate and savings for bathroom aerators were determined using a 38% installation rate.

Low-Flow Showerheads

Savings for this measure are determined using a baseline assumption of a 2.5 gallon per minute (GPM) flowrate for the existing showerhead, a 1.5 GPM flowrate for the replacement showerhead, and an average shower water temperature setpoint of 101°F.

Faucet Aerators

Savings for this measure are determined using a baseline assumption of a 2.2 gallon per minute (GPM) flowrate for the existing faucets, a 1.5 GPM flowrate for kitchen faucet aerators, a 1.0 GPM flowrate for the bathroom faucet aerators, and an average faucet water temperature setpoint of 88°F.

The faucet aerator measure saw a change in methodology resulting in generally lower impacts compared to FY 2018.

4.7.3 Results

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population.

Overall, the Energy Savings Through Schools kit program achieved realization rates of 104% for NCP kW demand savings and 102% for kWh energy savings.

Table 4-8: Energy Savings Through Schools Gross Energy and Demand Savings

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
School Kits	1,194,782	69	418	83

4.8 RESIDENTIAL RETAIL PARTNERS

4.8.1 Overview

The Residential Retail Partners program offers in-store rebates for ENERGY STAR certified lighting. There are 54 participating retailers in this program and rebates were offered for 60 different lighting products. Average gross impacts per retail location are 115,854 kWh, 11.25 CP kW, 57.57 NCP kW, and 17.62 4CP kW. However, savings vary significantly based on installed lamp type because of the various baselines in effect for this measure.

4.8.2 Savings Calculation Method

The *CPS Energy Guidebook* includes separate calculation methodologies for omni-directional EISA-compliant and specialty EISA-exempt LED lighting. EISA-affected bulbs have savings that are determined using a two-tiered weighting approach due to the baseline change that is scheduled to occur in 2020. The savings for EISA-exempt bulbs were determined over the entire lifetime of the bulb using the equivalent wattages. The savings calculation also incorporates an interactive effects factor to account for the impacts on cooling and heating loads.

EISA-compliant lighting uses a dual baseline that is affected by several factors. Frontier applied updated CPS discount rate, avoided capacity cost, and avoided energy cost inputs specific to FY 2019. These factors are used to weight savings over the dual baselines to provide a single annualized savings value. These inputs are not known to the implementation vendor at the beginning of the fiscal year, which means that final measure realization rates are marginally impacted by factors outside of implementer control.

Lamp type, equivalent incandescent wattage, adjusted baseline wattage, rated wattage, rated lumens, and rated life were verified against reported model numbers and ENERGY STAR qualified product listings.

4.8.3 Results

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population.

Overall, the Residential Retail Partners program achieved realization rates of 101% for NCP kW demand and kWh energy savings.

Table 4-9: Residential Retail Partners Gross Energy and Demand Saving

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
LED	6,256,108	607	3,109	951

4.9 COOL ROOF

4.9.1 Overview

The Cool Roof program offers an incentive for the installation of a highly reflective roof that decreases the roofing heat transfer coefficient and reduces the solar heat transmitted to the home. During hours when cooling is required in the home, this measure decreases the cooling energy use. During hours when heating is required in the home, this measure may increase or decrease the heating energy use depending on characteristics of the site. Qualifying projects receive an incentive for using Energy Star-rated cool roofing materials. The rebate is calculated per square foot of roofing area located above conditioned space.

There were 45 applications submitted in FY 2019, but only 38 projects were determined to be eligible. The program requires a solar reflectance of greater than 40%. Projects that did not meet the minimum value were not rebated and not awarded savings.

The average installed solar reflectance was 68% and the average roof area was 2,152 square feet. There were 19 installations at gas heated homes, 11 at homes heated with electric resistance, and 8 installations at homes with heat pump heating systems.

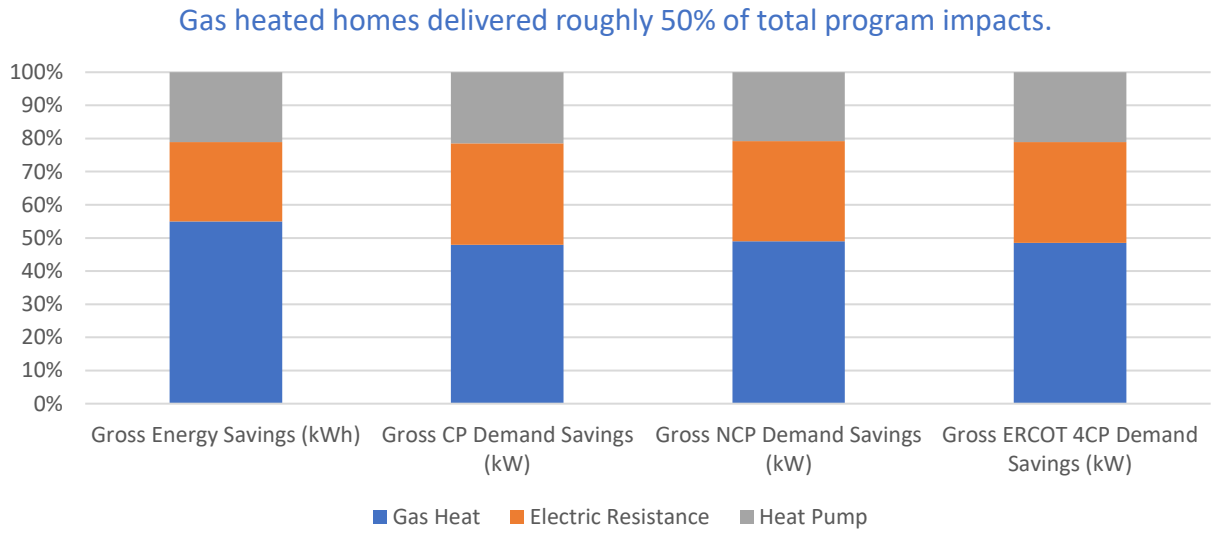


Figure 4-11: Cool Roof Program – Percent of Savings by Heating Type

4.9.2 Savings Calculation Method

Energy savings for this measure are determined using calibrated simulation models developed using NREL's BEopt 2.6 software running EnergyPlus 8.4 as the underlying simulation engine. The models were updated with the 2019-2020 *CPS Energy Guidebook* to incorporate updates adopted by the most recent Texas TRM. This resulted in higher deemed savings than were previously estimated in the pilot program in FY 2018. The simulation models used for other *CPS Energy Guidebook* envelope measures were

adapted to estimate impacts for Cool Roof. Coincident, non-coincident,[15] and 4CP peak demand savings were determined using building energy simulation models developed by subtracting the whole house energy use in each hour of the post-retrofit models from the energy use in the pre-retrofit models.

Projects completed in FY 2019 were evaluated based on a desk review of project documentation including square footage, invoices, and confirmation of roofing system reflectivity. All sampled project documentation matched reported values and no adjustments were made to claimed project inputs.

4.9.3 Results

The following are the gross energy and demand savings for the Cool Roof program.

Table 4-10: Residential Cool Roof Gross Energy and Demand Savings

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Cool Roof	29,756	25	52	33

[15] For some envelope measures installed at homes with electric heating, the non-coincident peak occurs during the non-summer months.

4.10 RESIDENTIAL PROGRAM RECOMMENDATIONS

This section presents the evaluation team's recommendations for CPS Energy's residential programs.

4.10.1 Portfolio-Wide Recommendations

4.10.1.1 LED Light Bulbs

- EUL is no longer deemed at 20 years for all LED lamps. Instead, EUL vary between 16 and 20 years depending on the rated life of the LED lamp. This also affects the first- and second-tier savings period calculation. Where Franklin did not collect the lamp rated life, the evaluation team applied a 16 year EUL for all projects. However, the higher 20 year EUL is available for any lamps with a rated life exceeding 17,500 hours.

Frontier recommends updating savings calculators to comply with the following key changes (and any other revisions not specifically listed below) to the *CPS Energy Guidebook* applicable to future fiscal year evaluations:

- First tier EISA baselines have been incremented down to a period of 1.5 years for FY 2020.
- Updated interactive effects factors have been provided for upstream programs or for instances where the cooling/heating types are unknown.

4.10.1.2 Kits

- Consider adding a second low-flow showerhead to the kit to help offset the decreasing lighting and faucet aerator savings.

4.10.2 Program-Specific Recommendations

4.10.2.1 Residential HVAC Program

Frontier recommends updating savings calculators to comply with the following key changes (and any other revisions not specifically listed below) to the *CPS Energy Guidebook* applicable to future fiscal year evaluations:

- While not new to the latest *CPS Energy Guidebook* update, Frontier would like to reinforce that rightsizing savings are now available if specified documentation is collected.
- Cooling capacity ranges for AC/HP deemed savings tables were modified in the latest *CPS Energy Guidebook* update. However, those values have since been clarified in the Texas Technical Reference Manual and will be clarified in a forthcoming update to the *CPS Energy Guidebook*. Home Energy Assessment

Frontier recommends updating savings calculation to set percent of electric water heating assumption equal to 100%. Kits with DHW measures are only distributed to homeowners with electric water heating.

4.10.2.2 Energy Savings Through Schools

Frontier recommendations conducting additional student surveys to reinforce or improve existing installation rate assumptions for future implementation of the Energy Savings Through Schools kit program. Frontier could assist with these surveys at the direction of CPS Energy.

4.10.2.3 Residential Retail Partners

Frontier recommends including manufacturer and ENERGY STAR model number in initial evaluation data report. This will prevent the evaluation team from needing to request supplemental data during future evaluations.

5. COMMERCIAL PROGRAMS

5.1 SUMMARY OF COMMERCIAL IMPACTS

CPS Energy's portfolio of commercial programs addresses most markets and major commercial end uses. FY 2019 commercial energy efficiency programs were implemented by CLEAResult under contract to CPS Energy. Commercial demand response programs are included in Section 6. CPS Energy offered the following programs for the Commercial sector in FY 2019:

- Commercial HVAC – incentives for the installation of high efficiency unitary AC equipment, heat pumps and chillers.
- C&I Solutions – energy assessments to identify opportunities and rebates for measures including lighting, HVAC, and refrigeration.
- Schools & Institutions – helps schools and government agencies reduce energy use through benchmarking, technical assistance, energy master planning, and rebate offerings.
- Small Business Solutions – contractor-led incentive program for small business customers with less than 100 kW demand.
- Whole Building Optimization – offers contractor- led incentives for building optimization, including tools and strategies to enhance a facility's operational efficiency.

Due to the fiscal year break across program years, projects completed between February 1, 2018 and May 31, 2018 were evaluated against the November 2017 *CPS Energy Guidebook*. Projects completed between June 1, 2018 and January 31, 2019 were evaluated against the June 2018 Guidebook. For measures where other methods were used, those are referenced in each section. Except as noted, CP values were calculated using the 20-hour probability method, as outlined in Section 2.2.

Values in Figure 5-1 through Figure 5-3 represent energy and demand savings from new FY 2019 program participants as measured at the participant or end-user level and adjusted to account for net-to-gross ratios and line losses. Program names are abbreviated in chart labels.[16]

[16] C&I = Commercial and Industrial, S&I = Schools and Institutions, SBS = Small Business Solutions, WBO = Whole Building Optimization

These figures show program contributions to the commercial portfolio's energy and demand savings.

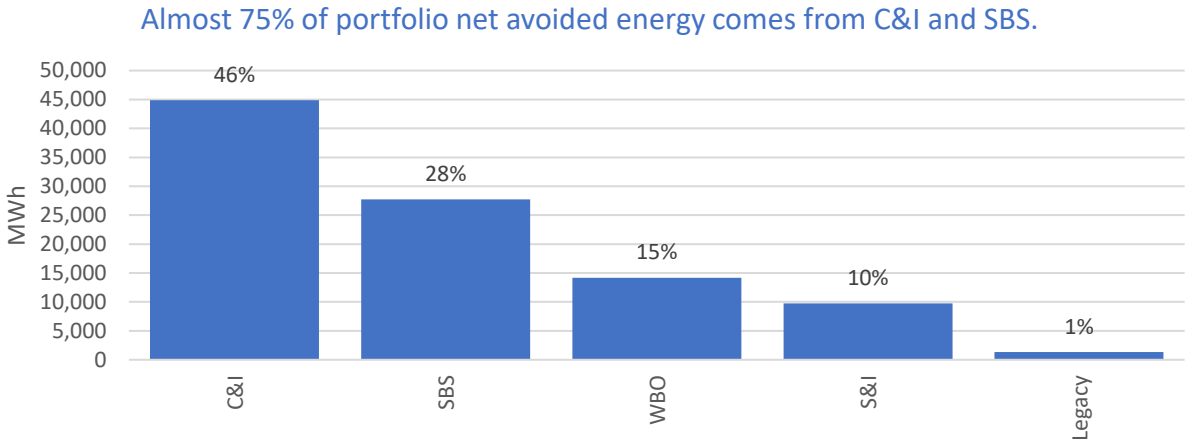


Figure 5-1: Summary of Commercial Impacts – Net Avoided Energy by Program

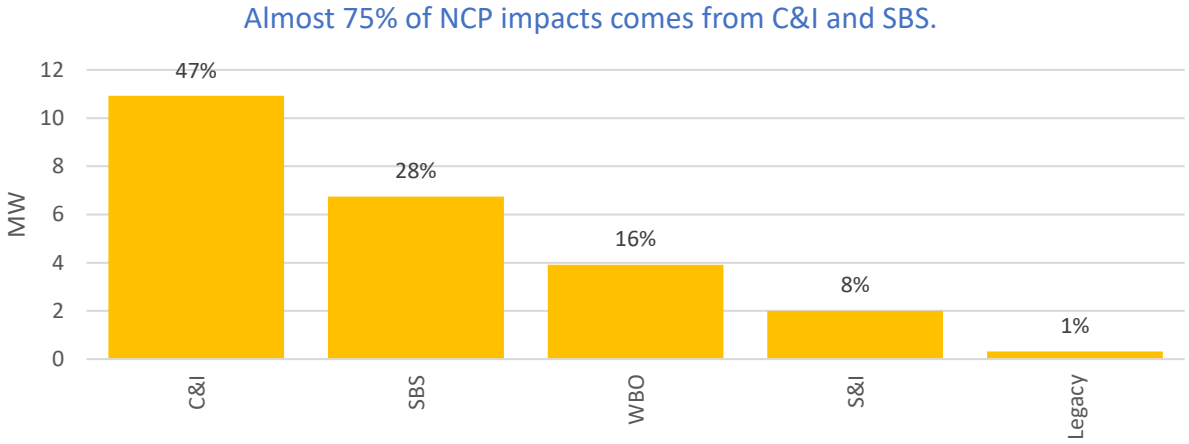


Figure 5-2: Summary of Commercial Impacts – Net Avoided NCP by Program

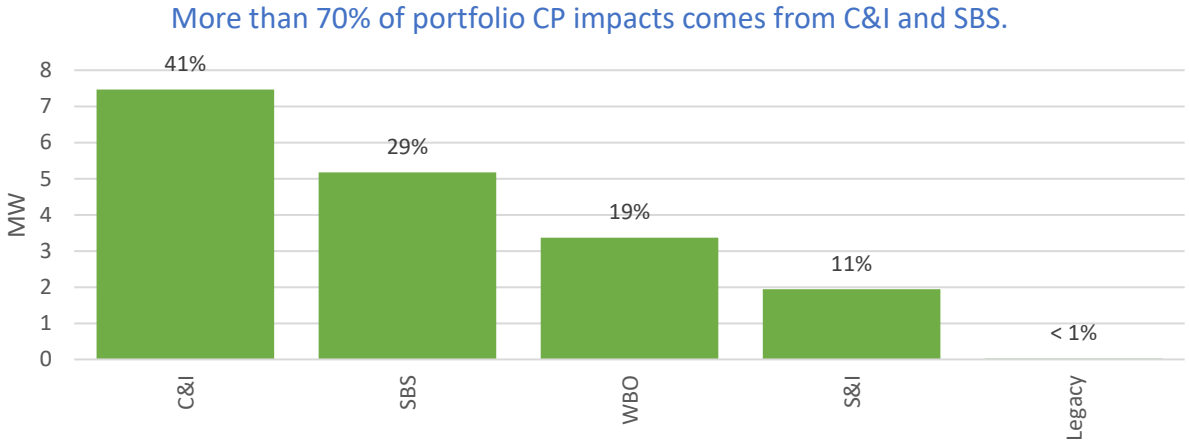


Figure 5-3: Summary of Commercial Impacts – Net Avoided CP by Program

5.2 C&I SOLUTIONS

5.2.1 Overview

This program includes the installation of the following commercial energy efficiency measures: lighting, lighting controls, HVAC, HVAC tune-up, VFD, and custom. In FY 2019, a total of 502 projects were incentivized through the C&I Solutions program, compared to 458 in FY 2018.

This evaluation includes previously evaluated projects from the CPS PY2 evaluation in addition to new PY3 projects completed during the CPS FY 2019 evaluation period. The figures below present percentage breakdowns of kWh energy savings. Figure 5-4 presents percentage breakdowns of net energy, NCP, CP and 4CP demand impacts by measure.

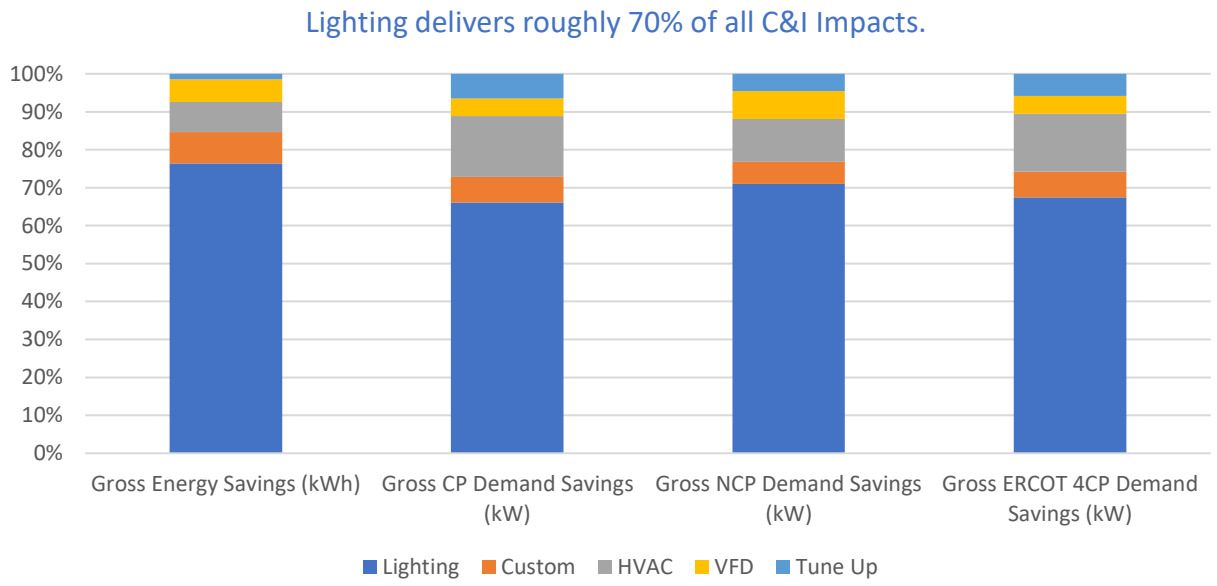


Figure 5-4: Commercial & Industrial – Gross Energy and Demand Impacts by Measure

5.2.2 Savings Calculation Method

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population.

Projects completed between February 1, 2018 and May 31, 2018 were evaluated against the November 2017 update to the *CPS Energy Guidebook*. Projects completed between June 1, 2018 and January 31, 2019 were evaluated against the June 2018 update to the *CPS Energy Guidebook*.

5.2.2.1 Lighting and Lighting Controls

Projects previously evaluated under the CPS PY2 evaluation were not adjusted for the FY 2019 evaluation. For the new PY3 projects completed during the CPS FY 2019 evaluation period, Frontier randomly selected projects for desk review based on the overall lighting project population. Savings for all sampled projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. The only major change to the savings calculation methodology compared to the approach used in the FY 2018 evaluation was the segmenting of the "manufacturing" building type into one, two, and three shift options as well as the addition of new "data center" and "other" building types.

In addition to validating the savings calculation against the *CPS Energy Guidebook*, reported building type, fixture type, model numbers, installation location (conditioned/unconditioned space), pre/post fixture counts, pre/post wattages, and pre/post control types were verified against project documentation. Project documentation includes savings calculators, invoices, manufacturer product specification sheets, fixture eligibility certification screenshots, inspection reports, and pre/post photos. Hours of operation and demand factors were also cross-referenced against the verified building type. For lighting installed in a conditioned space, Frontier awarded additional savings to account for HVAC/refrigeration interactive effects of the projects. A reduced lighting load reduces the internal heat gain to the building, which reduces the cooling load but increases the heating load.

Outdoor delivers roughly 50% of all C&I Lighting impacts. Retail delivers roughly 25% with relatively even distribution for other building types.

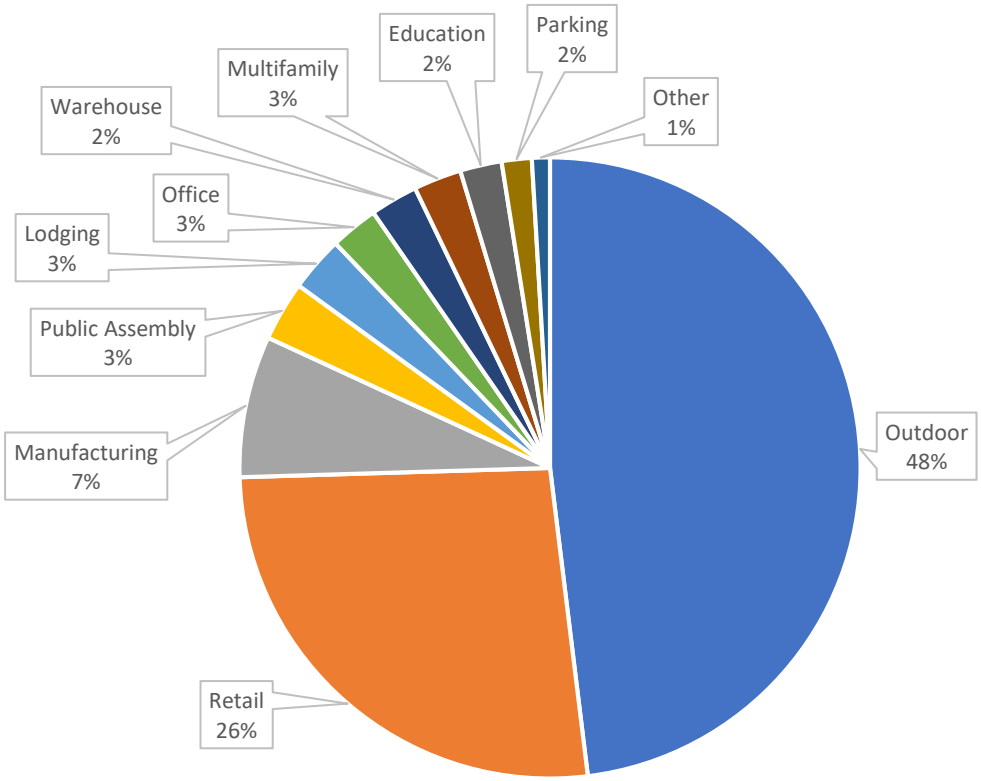


Figure 5-5: C&I Solutions – Percent of kWh Savings by Building Type for Sampled Lighting Projects

New construction projects use an alternate baseline that requires confirmation of several additional measure inputs. Frontier validated the reported IECC 2015 building or exterior space type and corresponding lighting power density (LPD) factor, IECC 2015 zone category (exterior lighting projects only) and treated interior/exterior square footage.

Where applicable, Frontier would apply the residential lighting savings calculation approaches described earlier in this report for residential end-use customers with master-metered commercial utility accounts.

Frontier identified several desk review projects for follow-up site inspections, representing 20% of the desk review sample population. For inspected sites, savings were also adjusted to match any site observations that contrasted with reported data.

After the inclusion of HVAC interactive effects, the CP or 4CP verified savings would occasionally exceed the verified NCP savings despite the higher NCP demand factor. In these instances, the CP or 4CP (higher of the two) was substituted as the verified NCP demand savings for that project.

Realization rates were calculated for NCP kW, CP kW, and kWh savings by comparing verified savings to claimed savings for each desk review project. The resulting realization rates were weighted by claimed savings then applied to each claimed savings value from the total measure population. Because CLEAResult does not calculate 4CP kW savings, verified 4CP kW was compared to verified CP kW savings to create a CP to 4CP adjustment factor for each desk review project. A weighted average adjustment factor was then applied to the verified CP kW savings for the total measure population, yielding verified 4CP kW savings.

5.2.2.2 HVAC

Projects previously evaluated under the CPS PY2 evaluation were not adjusted for the FY 2019 evaluation. For the new PY3 projects completed during the CPS FY 2019 evaluation period, Frontier randomly selected projects for desk review based on the overall HVAC project population. VFD projects reported with HVAC projects were extracted from the total measure population and were evaluated separately. Savings for all sampled projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. There were no major changes to the savings calculation methodology compared to the approach used in the FY 2018 evaluation. For chiller projects, savings are calculated against both Path A and Path B baselines from IECC 2015, with the higher of the two paths being awarded as verified savings.

In addition to validating the savings calculation against the *CPS Energy Guidebook*, reported building type, baseline type (early retirement, replace-on-burnout, or new construction), and installed system type, model numbers, cooling/heating capacities, and cooling/heating efficiencies (part and full-load) were verified against project documentation, including savings calculators, invoices, manufacturer product specification sheets, Air Conditioning, Heating & Refrigeration Institute (AHRI) certificates,

inspection reports, and pre/post photos. Equivalent full-load cooling and heating hours and demand factors were also cross-referenced against the verified building type.

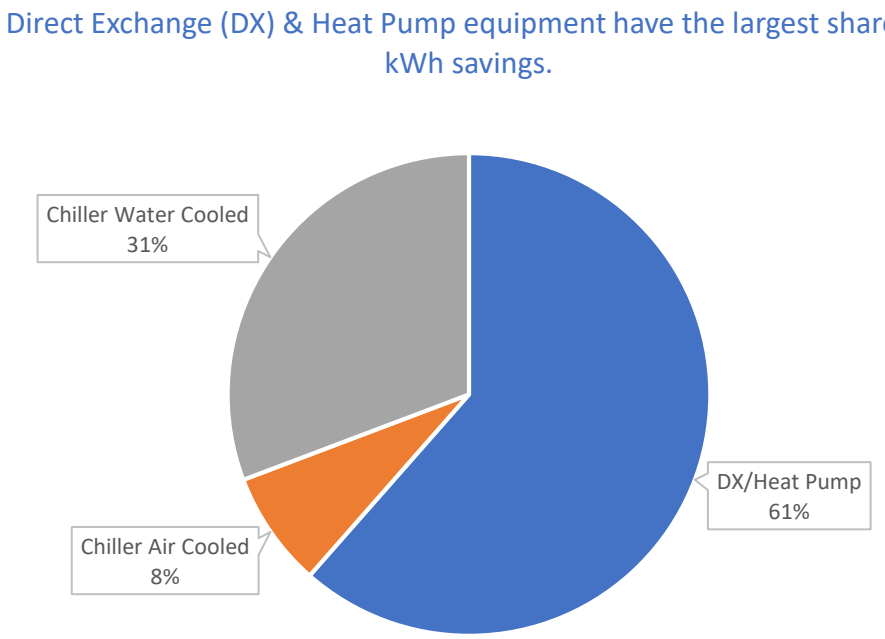


Figure 5-6: C&I Solutions – Percent of kWh Savings by System Type for HVAC Projects

Early retirement projects use an alternate dual baseline that requires confirmation of several additional measure inputs. Frontier validated reported existing system type, condition, model numbers, age, cooling/heating capacities, and cooling/heating baseline efficiency values (part and full-load). For early retirement projects, remaining useful life assumptions were incremented by a year to account for bulk installation during the 2018 calendar year. Frontier also applied updated CPS discount rate, avoided capacity cost, and avoided energy cost factors specific to FY 2019. These factors are used to weight savings over the dual baselines used for early retirement projects. These factors are also not known to the implementation vendor at the beginning of the fiscal year, which means that final measure realization rates are marginally impacted by factors outside of implementer control.

Where applicable, Frontier would apply the residential HVAC savings calculation approaches described earlier in this report for residential end-use customers with master-metered commercial utility accounts.

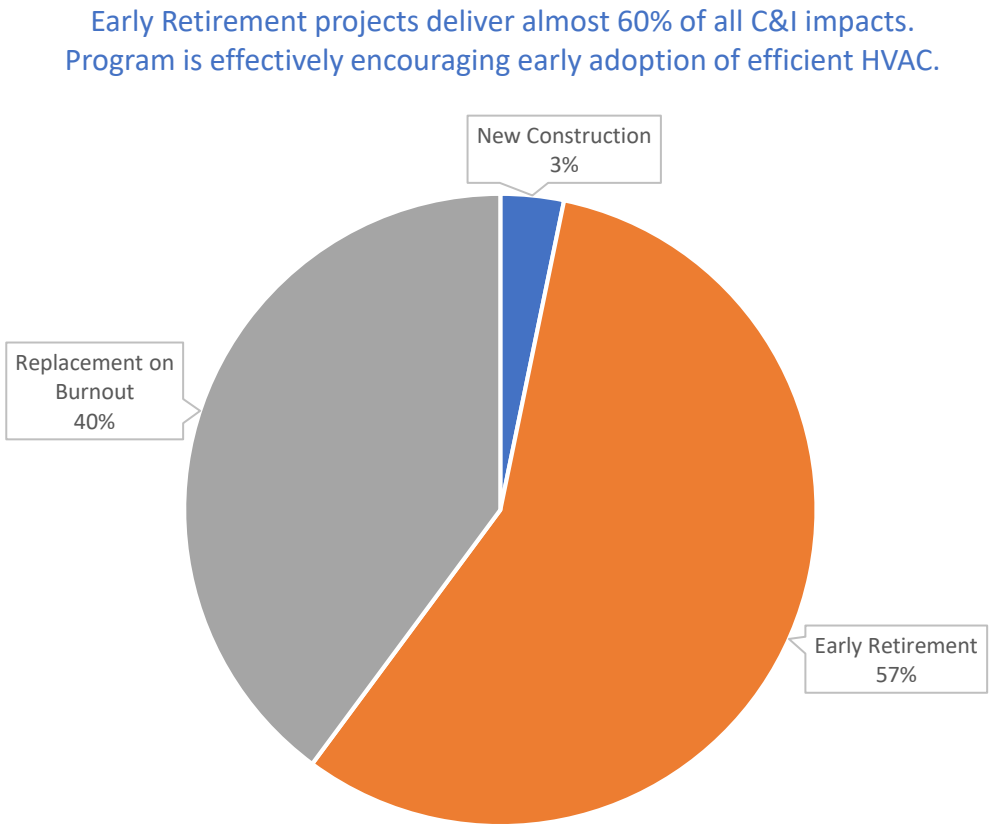


Figure 5-7: C&I Solutions – Percent of kWh Savings by Baseline Type for HVAC Projects

Frontier identified several desk review projects for follow-up site inspections, representing 20% of the desk review sample population. For inspected sites, savings were also adjusted to match any site observations that contrasted with reported data.

Realization rates were calculated for NCP kW, CP kW, and kWh savings by comparing verified savings to claimed savings for each desk review project. Resulting realization rates were weighted by claimed savings then applied to each claimed savings value from the total measure population. Because CLEAResult does not calculate 4CP kW savings, verified 4CP kW was compared to verified CP kW savings to create a CP to 4CP adjustment factor for each desk review project. A weighted average adjustment factor was then applied to the verified CP kW savings for the total measure population, yielding verified 4CP kW savings.

5.2.2.3 HVAC Tune-up

The evaluation of these measures was conducted along with inspections for Tune-ups in the Schools & Institutions program because the administration of the measure is structured similarly in both programs. Frontier sampled 52 sites for onsite inspection and conducted desk reviews for HVAC systems that received tune-ups in FY 2019. Some systems were not able to be located at the designated projects site. Generally, the missing systems were larger units of 15 or 20 tons. This measure includes service items on HVAC systems that are difficult to observe after the completion, but we were able to check coil condition and for the most part the coils appeared clean and in good condition.

Project documentation did not include customer-signed applications, photos, or other documentation types that could support the claimed system counts and sizes, therefore the evaluation team could not verify project details for sites selected for desk review. Realization rates from the site inspections were applied to the total claimed impacts for the tune-up measure.

5.2.2.4 VFD

VFD projects for FY 2019 were allowed to use a new baseline condition of no existing fan control as defined in the June 2018 *CPS Energy Guidebook*. This was agreed upon between Frontier and CLEAResult based on the type of projects that were to be installed. Percent power was set to 100% for each hour of operation during all baseline conditions when determining initial kW calculations. This differs from the other options available in the measure that follow specific power curves for each control type (Outlet Damper, Inlet Damper, Inlet Guide Vane).

Retail building sites are the predominant participants receiving the VFD measure. The results of site inspections and desk reviews confirmed reported data. Facility operators and other customers report high levels of satisfaction with this measure.

5.2.2.5 Custom/Other

There were 16 other projects completed in FY 2019, targeting a variety of end uses included HVAC, refrigeration, envelope, and process loads. Certain measures like insulation and ECM evaporator fans follow savings methodologies as described in the CPS Energy Guidebook. Custom projects were validated individually during implementation by reviewing submitted M&V plans and confirming procedures aligned with claimed savings as described in the calculation methodology. All procedures were confirmed to have been followed as planned.

5.2.3 Results

A weighted average realization rate (weighted by claimed NCP kW, CP kW, and kWh savings) was calculated for the projects sampled for a desk review. The weighted average realization rates were applied to the entire project population (both sampled and un-sampled).

Overall, the C&I program achieved realization rates of 97% for NCP kW demand savings, 98% for CP kW demand savings, and 96% for kWh energy savings.

Table 5-1: C&I Solutions Gross Energy and Demand Savings

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Lighting	33,758,040	4,712	7,651	4,695
Custom	3,649,677	475	619	470
HVAC	3,519,614	1,146	1,223	1,065
VFD	2,643,101	331	785	324
Tune Up	643,044	461	494	408
Lighting	33,758,040	4,712	7,651	4,695
Total[17]	44,213,477	7,125	10,773	6,962

Rows may not sum to total due to rounding.

[17] The sum of the individual measures may not match the total due to the individual measure savings having been rounded to the nearest whole number.

5.3 SCHOOLS & INSTITUTIONS

5.3.1 Overview

The Schools & Institutions (S&I) program includes the installation of the following commercial energy efficiency measures: lighting, lighting controls, HVAC, HVAC tune-up, VFD, and custom. In FY 2019, a total of 399 projects were incentivized through the Schools & Institutions program, compared with 122 in FY 2018. CPS Energy initiated two of those projects before contracting with CLEAResult to implement the program. Those projects are not reflected in this section but are accounted for in section 1.2 of this report.

This evaluation includes both previously evaluated projects from the CPS PY2 evaluation and new PY3 projects completed during the CPS FY 2019 evaluation period. Figure 5-8 presents percentage breakdowns of net energy, NCP, CP and 4CP demand impacts by measure.

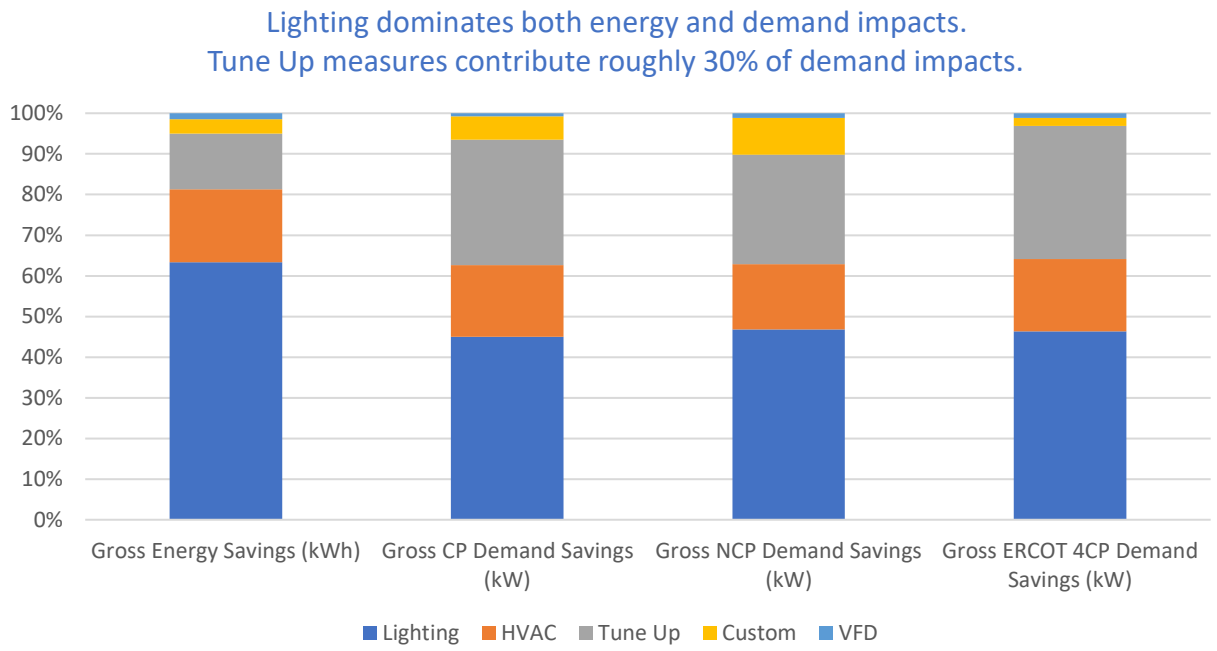


Figure 5-8: Schools & Institutions – Gross Energy and Demand Impacts by Measure

5.3.2 Savings Calculation Method

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population.

Projects completed between February 1, 2018 and May 31, 2018 were evaluated against the November 2017 update to the *CPS Energy Guidebook*. Projects completed between June 1, 2018 and January 31, 2019 were evaluated against the June 2018 update to the *CPS Energy Guidebook*.

5.3.2.1 Lighting and Lighting Controls

Projects previously evaluated under the CPS PY2 evaluation were not adjusted for the FY 2019 evaluation. For the new PY3 projects completed during the CPS FY 2019 evaluation period, Frontier randomly selected projects for desk review based on the overall lighting project population. Savings for all sampled projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. The only major change to the savings calculation methodology compared to the approach used in the FY 2018 evaluation was the segmenting of the "manufacturing" building type into one, two, and three shift options and the addition of new "data center" and "other" building types.

In addition to validating the savings calculation against the *CPS Energy Guidebook*, reported building type, fixture type, model numbers, installation location (conditioned/unconditioned space), pre/post fixture counts, pre/post wattages, and pre/post control types were verified against project documentation, including savings calculators, invoices, manufacturer product specification sheets, fixture eligibility certification screenshots, inspection reports, and pre/post photos. Hours of operation and demand factors were also cross-referenced against the verified building type. For lighting installed in a conditioned space, Frontier awarded additional savings to account for HVAC/refrigeration interactive effects of the projects. A reduced lighting load reduces the internal heat gain to the building, which reduces the cooling load but increases the heating load.

Education delivers roughly 70% of all S&I lighting impacts. However, this is a product of program design to target that particular customer base.

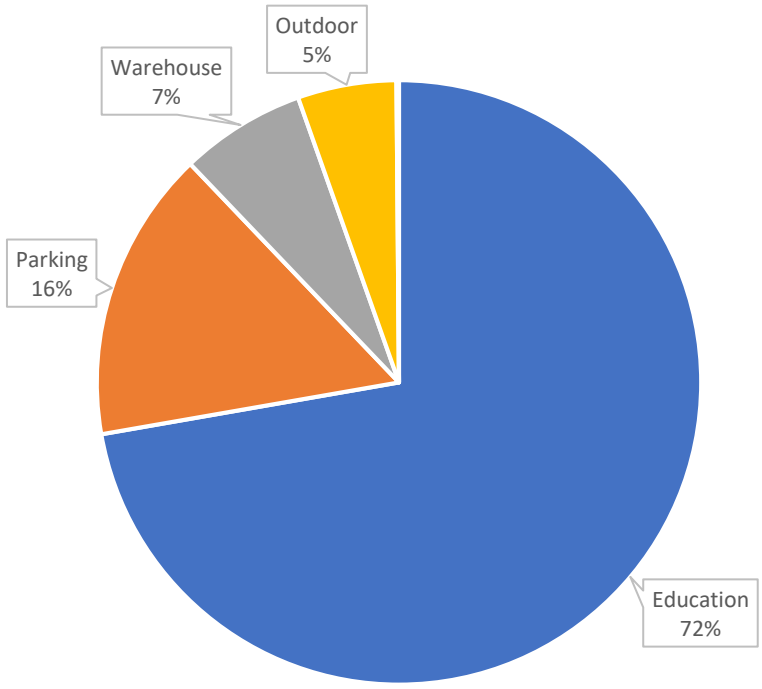


Figure 5-9: Schools & Institutions – Percent of kWh Savings by Building Type for Sampled Lighting Projects

New construction projects use an alternate baseline that requires confirmation of several additional measure inputs. Frontier validated reported IECC 2015 building or exterior space type and corresponding lighting power density (LPD) factor, IECC 2015 zone category (exterior lighting projects only), and treated interior/exterior square footage.

Where applicable, Frontier would apply the residential lighting savings calculation approaches described earlier in this report for residential end-use customers with master-metered commercial utility accounts.

Frontier identified several desk review projects for follow-up site inspections, representing 20% of the desk review sample population. For inspected sites, savings were also adjusted to match any site observations that contrasted with reported data.

After the inclusion of HVAC interactive effects, the CP or 4CP verified savings would occasionally exceed the verified NCP savings despite the higher NCP demand factor. In these instances, the CP or 4CP (higher of the two) was substituted as the verified NCP demand savings for that project.

Realization rates were calculated for NCP kW, CP kW, and kWh savings by comparing verified savings to claimed savings for each desk review project. Resulting realization rates were weighted by claimed savings then applied to each claimed savings value from the total measure population. Because CLEAResult does not calculate 4CP kW savings, verified 4CP kW was compared to verified CP kW savings to create a CP to 4CP adjustment factor for each desk review project. A weighted average adjustment factor was then applied to the verified CP kW savings for the total measure population, yielding verified 4CP kW savings.

5.3.2.2 HVAC

Projects previously evaluated under the CPS PY2 evaluation were not adjusted for the FY 2019 evaluation. For the new PY3 projects completed during the CPS FY 2019 evaluation period, Frontier randomly selected projects for desk review based on the overall HVAC project population. VFD projects reported with HVAC projects were extracted from the total measure population and were evaluated separately. Savings for all sampled projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. There were no major changes to the savings calculation methodology compared to the approach used in the FY 2018 evaluation. For chiller projects, savings are calculated against both Path A and Path B baselines from IECC 2015, with the higher of the two paths being awarded as verified savings.

In addition to validating the savings calculation against the *CPS Energy Guidebook*, reported building type, baseline type (early retirement, replace-on-burnout, or new construction), and installed system type, model numbers, cooling/heating capacities, and cooling/heating efficiencies (part and full-load) were verified against project documentation, including savings calculators, invoices, manufacturer product specification sheets, Air Conditioning, Heating & Refrigeration Institute (AHRI) certificates,

inspection reports, and pre/post photos. Equivalent full-load cooling and heating hours and demand factors were also cross-referenced against the verified building type.

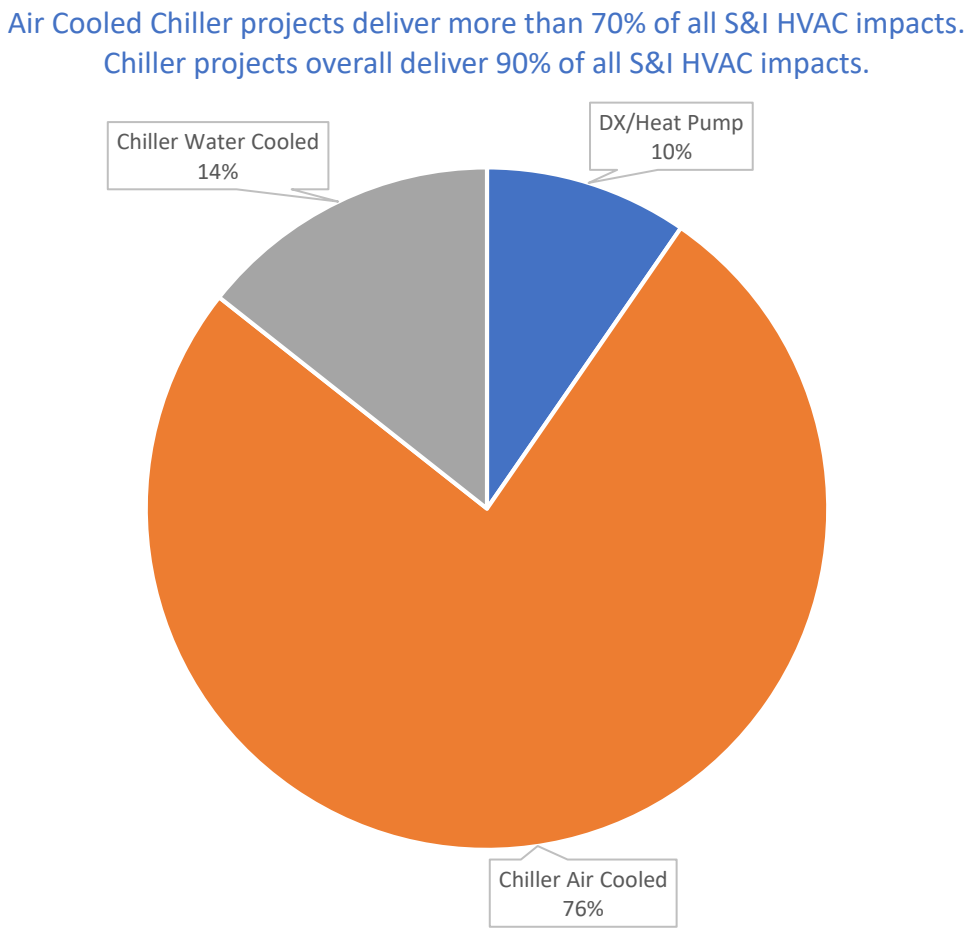


Figure 5-10: Schools & Institutions – Percent of kWh Savings by System Type for HVAC Projects

Early retirement projects use an alternate dual baseline that requires confirmation of several additional measure inputs. Frontier validated reported existing system type, condition, model numbers, age, cooling/heating capacities, and cooling/heating baseline efficiency values (part and full-load). For early retirement projects, remaining useful life assumptions were incremented by a year to account for bulk installation during the 2018 calendar year. Frontier also applied updated CPS discount rate, avoided capacity cost, and avoided energy cost factors specific to FY 2019. These factors are used to weight savings over the dual baselines used for early retirement projects. These factors are also not known to the implementation vendor at the beginning of the fiscal year, which means that final measure realization rates are marginally impacted by factors outside of implementer control.

Where applicable, Frontier would apply the residential HVAC savings calculation approaches described earlier in this report for residential end-use customers with master-metered commercial utility accounts.

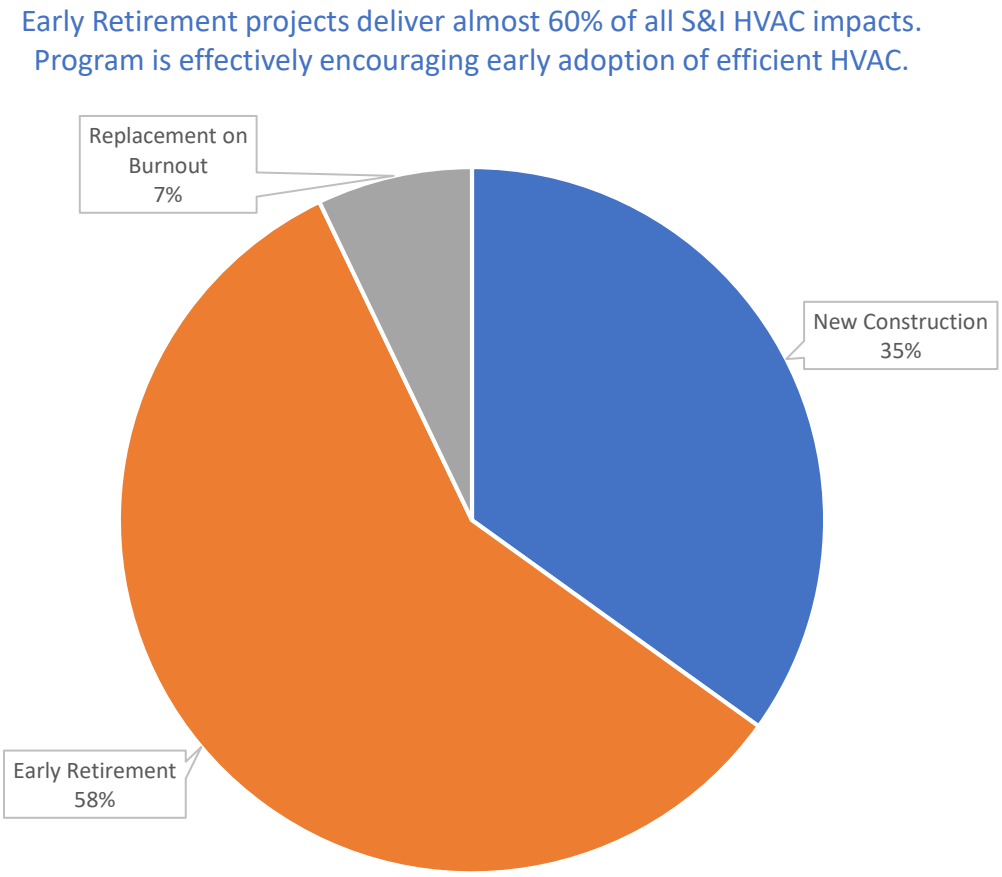


Figure 5-11: Schools & Institutions – Percent of kWh Savings by Baseline Type for HVAC Projects

Frontier identified several desk review projects for follow-up site inspections, representing 20% of the desk review sample population. For inspected sites, savings were also adjusted to match any site observations that contrasted with reported data.

Realization rates were calculated for NCP kW, CP kW, and kWh savings by comparing verified savings to claimed savings for each desk review project. Resulting realization rates were weighted by claimed savings then applied to each claimed savings value from the total measure population. Because CLEAResult does not calculate 4CP kW savings, verified 4CP kW was compared to verified CP kW savings to create a CP to 4CP adjustment factor for each desk review project. A weighted average adjustment factor was then applied to the verified CP kW savings for the total measure population, yielding verified 4CP kW savings.

5.3.2.3 HVAC Tune-up

Frontier conducted site visits for 52 HVAC systems that received Tune-Ups in FY 2019. Some systems were not able to be located at the designated projects site. Generally, the missing systems were larger units of 15 or 20 tons. This measure includes service items on HVAC systems that are difficult to observe after the completion, but we were able to check coil condition and for the most part the coils appeared clean and in good condition.

Project documentation did not include customer-signed applications, photos, or other documentation types that could support the claimed system counts and sizes, therefore the evaluation team could not verify project details for sites selected for desk review. Because documentation was not available from desk reviews, impacts were verified using the results of site inspections. Realization rates from the site inspections were applied to the total claimed impacts for the Tune-Up measure.

5.3.2.4 VFD

VFD projects for FY 2019 were allowed to use a new baseline condition of no existing fan control as defined in the June 2018 *CPS Energy Guidebook*. This was agreed upon between Frontier and CLEAResult based on the type of projects that were to be installed. Percent power was set to 100% for each hour of operation during all baseline conditions when determining initial kW calculations. This differs from the other options available in the measure that follow specific power curves for each control type (Outlet Damper, Inlet Damper, Inlet Guide Vane).

The results of site inspections and desk reviews confirmed reported data. Facility operators and other customers report high levels of satisfaction with this measure.

5.3.2.5 Custom/Other

There were five custom projects completed in FY 2019, one HVAC fan project, one thermal ice storage project, and behavior-based projects implemented across three school districts. Custom projects were validated by reviewing submitted M&V plans and confirming procedures aligned with claimed savings as described in the calculation methodology. All procedures were confirmed to have been followed as planned.

5.3.3 Results

A weighted average realization rate (weighted by claimed NCP kW and kWh savings) was calculated for the projects sampled for a desk review. The weighted average realization rates were applied to the entire project population (both sampled and un-sampled).

Overall, the Schools & Institutions program achieved realization rates of 90% for NCP kW demand savings, 34% for CP kW demand savings, and 81% for kWh energy savings.

Table 5-2: Schools & Institutions Gross Energy and Demand Savings

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Commercial Lighting	6,695,342	1,607	1,984	1,413
HVAC	1,900,018	629	680	543
HVAC Tune-Up	1,451,424	1,102	1,142	997
Custom	374,261	205	385	61
VFD	154,077	26	48	34
Total[18]	10,575,123	3,569	4,239	3,049

Rows may not sum to total due to rounding.

[18] The sum of the individual measures may not match the total due to the individual measure savings having been rounded to the nearest whole number.

5.4 SMALL BUSINESS SOLUTIONS

5.4.1 Overview

This program includes the installation of the following commercial energy efficiency measures: lighting, lighting controls, envelope, HVAC, HVAC tune-up, and custom. In FY 2019, a total of 455 projects were incentivized through the Small Business Solutions program compared to 223 projects in FY 2018.

This evaluation includes both previously evaluated projects from the CPS PY2 evaluation and new PY3 projects completed during the CPS FY 2019 evaluation period. Figure 5-12 presents percentage breakdowns of net energy, NCP, CP and 4CP demand impacts by measure.

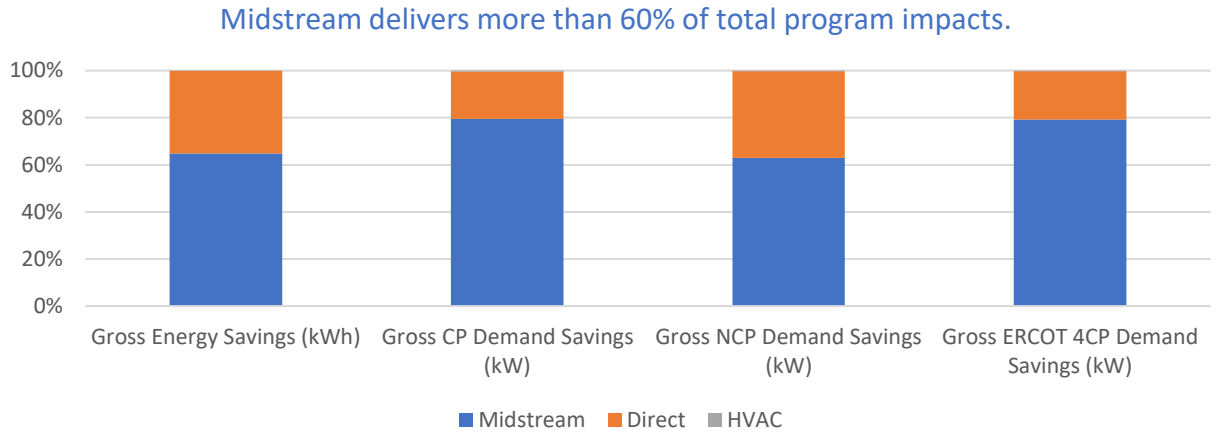


Figure 5-12: Small Business Solutions – Gross Energy and Demand Impacts by Measure

5.4.2 Savings Calculation Method

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population.

Projects completed between February 1, 2018 and May 31, 2018 were evaluated against the November 2017 update to the *CPS Energy Guidebook*. Projects completed between June 1, 2018 and January 31, 2019 were evaluated against the June 2018 update to the *CPS Energy Guidebook*.

5.4.2.1 Direct Program – Lighting Measures

Projects previously evaluated under the CPS PY2 evaluation were not adjusted for the FY 2019 evaluation. For the new PY3 projects completed during the CPS FY 2019 evaluation period, Frontier randomly selected projects for desk review based on the overall lighting project population. Savings for all sampled projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. The only major change to the savings calculation methodology compared to the approach used in the FY 2018 evaluation was the segmenting of the "manufacturing" building type into one, two, and three shift options as well as the addition of new "data center" and "other" building types.

In addition to validating the savings calculation against the *CPS Energy Guidebook*, reported building type, fixture type, model numbers, installation location (conditioned/unconditioned space), pre/post fixture counts, pre/post wattages, and pre/post control types were verified against project documentation, including savings proposals, invoices, manufacturer product specification sheets, fixture eligibility certification screenshots, inspection reports, and pre/post photos. Hours of operation and demand factors were also cross-referenced against the verified building type. For lighting installed in a conditioned space, Frontier awarded additional savings to account for HVAC/refrigeration interactive effects of the projects. A reduced lighting load reduces the internal heat gain to the building, which reduces the cooling load but increases the heating load.

New construction projects use an alternate baseline that requires confirmation of several additional measure inputs. Frontier validated reported IECC 2015 building or exterior space type and corresponding lighting power density (LPD) factor, IECC 2015 zone category (exterior lighting projects only), and treated interior/exterior square footage.

Where applicable, Frontier would apply the residential lighting savings calculation approaches described earlier in this report for residential end-use customers with master-metered commercial utility accounts.

Frontier identified several desk review projects for follow-up site inspections, representing 20% of the desk review sample population. For inspected sites, savings were also adjusted to match any site observations that contrasted with reported data.

After the inclusion of HVAC interactive effects, the CP or 4CP verified savings would occasionally exceed the verified NCP savings despite the higher NCP demand factor. In these instances, the CP or 4CP (higher of the two) was substituted as the verified NCP demand savings for that project.

Realization rates were calculated at the program level for NCP kW, CP kW, and kWh savings by comparing verified savings to claimed savings for each desk review project. Resulting realization rates were weighted by claimed savings then applied to each claimed savings value from the total measure population. Because CLEAResult does not calculate 4CP kW savings, verified 4CP kW was compared to verified CP kW savings to create a CP to 4CP adjustment factor for each desk review project. A weighted average adjustment factor was then applied to the verified CP kW savings for the total measure population, yielding verified 4CP kW savings.

5.4.2.1 Direct Program – HVAC Measures

Projects previously evaluated under the CPS PY2 evaluation were not adjusted for the FY 2019 evaluation. For the new PY3 projects completed during the CPS FY 2019 evaluation period, Frontier randomly selected projects for desk review based on the overall HVAC project population. Savings for all sampled projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. There were no major changes to the savings calculation methodology compared to the approach used in the FY 2018 evaluation. No chiller projects are expected for this market sector.

In addition to validating the savings calculation against the *CPS Energy Guidebook*, reported building type, baseline type (early retirement, replace-on-burnout, or new construction), and installed system type, model numbers, cooling/heating capacities, and cooling/heating efficiencies (part and full-load) were verified against project documentation, including savings proposals, invoices, manufacturer product specification sheets, Air Conditioning, Heating & Refrigeration Institute (AHRI) certificates, inspection reports, and pre/post photos. Equivalent full-load cooling and heating hours and demand factors were also cross-referenced against the verified building type.

Early retirement projects use an alternate dual baseline that requires confirmation of several additional measure inputs. Frontier validated reported existing system type, condition, model numbers, age, cooling/heating capacities, and cooling/heating baseline efficiency values (part and full-load). For early retirement projects, remaining useful life assumptions were incremented by a year to account for bulk installation during the 2018 calendar year. Frontier also applied updated CPS discount rate, avoided capacity cost, and avoided energy cost factors specific to FY 2019. These factors are used to weight savings over the dual baselines used for early retirement projects. These factors are also not known to the implementation vendor at the beginning of the fiscal year, which means that final measure realization rates are marginally impacted by factors outside of implementer control.

Where applicable, Frontier would apply the residential HVAC savings calculation approaches described earlier in this report for residential end-use customers with master-metered commercial utility accounts.

Frontier identified several desk review projects for follow-up site inspections, representing 20% of the desk review sample population. For inspected sites, savings were also adjusted to match any site observations that contrasted with reported data.

Realization rates were calculated at the program level for NCP kW, CP kW, and kWh savings by comparing verified savings to claimed savings for each desk review project. Resulting realization rates were weighted by claimed savings then applied to each claimed savings value from the total measure population. Because CLEAResult does not calculate 4CP kW savings, verified 4CP kW was compared to verified CP kW savings to create a CP to 4CP adjustment factor for each desk review project. A weighted average adjustment factor was then applied to the verified CP kW savings for the total measure population, yielding verified 4CP kW savings.

5.4.2.2 Midstream Lighting Program

Retail batches previously evaluated under the CPS PY2 evaluation were not adjusted for the FY 2019 evaluation. For the new PY3 retail batches sold during the CPS FY 2019 evaluation period, Frontier randomly selected projects for desk review based on the overall population. Savings for all sampled batches were validated using the same general approach described in the Small Business Solutions – Direct Program. The major difference with this program is that savings are awarded based on an assumed weighting of building types. These weightings vary based on the lamp or fixture type.

In addition to validating the savings calculation against the *CPS Energy Guidebook*, fixture counts, fixture types, baseline wattages, rated wattages, and lumen ratings were verified against reported model numbers. Assumptions for select model numbers were further verified against DesignLights Consortium (DLC) or ENERGY STAR qualified product listings. No inspections were completed for this program.

After the inclusion of HVAC interactive effects, the CP or 4CP verified savings would occasionally exceed the verified NCP savings despite the higher NCP demand factor. In these instances, the CP or 4CP (higher of the two) was substituted as the verified NCP demand savings for that project.

Realization rates were calculated at the program level for NCP kW, CP kW, and kWh savings by comparing verified savings to claimed savings for each desk review project. Resulting realization rates were weighted by claimed savings then applied to each claimed savings value from the total measure population. Because CLEAResult does not calculate 4CP kW savings, verified 4CP kW was compared to verified CP kW savings to create a CP to 4CP adjustment factor for each desk review project. A weighted average adjustment factor was then applied to the verified CP kW savings for the total measure population, yielding verified 4CP kW savings.

5.4.3 Results

A weighted average realization rate (weighted by claimed NCP kW and kWh savings) was calculated for the projects sampled for a desk review. The weighted average realization rates were applied to the entire project population (both sampled and un-sampled). Similarly, a weighted average estimated useful life (EUL) from the sample review was applied to the verified savings. This EUL was based on a weighted average across the C&I Solutions, Schools & Institutions, and Small Business Solutions programs. Overall, the Small Business Solutions program achieved realization rates of 97% for NCP kW demand savings, 125% for CP kW demand savings, and 94% for kWh energy savings.

Table 5-3: Small Business Solutions Gross Energy and Demand Savings

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Midstream	19,380,276	4,352	4,562	4,346
Direct	10,474,486	1,103	2,672	1,120
HVAC	39,202	18	20	16
Total[19]	29,893,964	5,473	7,254	5,483

Rows may not sum to total due to rounding.

[19] The sum of the individual measures may not match the total due to the individual measure savings having been rounded to the nearest whole number.

5.5 WHOLE BUILDING OPTIMIZATION

5.5.1 Overview

The Whole Building Optimization (WBO) program consists of a toolbox of measures related to optimizing settings and conditions for the building's HVAC equipment. These can range from changing setpoints, schedules, and static pressures in a Building Automation System (BAS) to physical changes such as coil cleaning and valve repair.

A third-party company evaluated buildings to identify opportunities for optimization among the eligible options specified in CLEAResult's Express Building Tune-up (EBTU) Methodology. Frontier reviewed and approved the methodology prior to the beginning of the program implementation allowing for the opportunity to discuss changes if any issues were observed during initial implementation.

5.5.2 Participation Trends

Participation increased sharply in FY 2019 with 83 sites compared to 16 in the FY 2018 program. Participation by building type includes an even distribution across the commercial and public sectors.

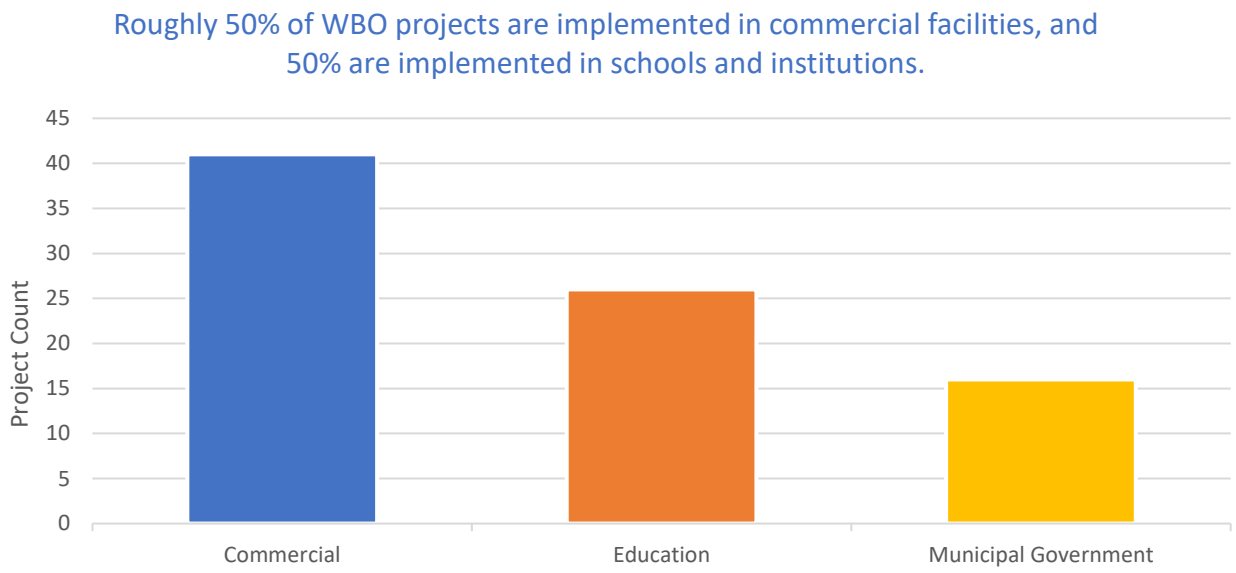


Figure 5-13: WBO Program – Participation by Sector

5.5.3 Savings Calculation Methods

Savings claims are based on the calculations and assumptions described in CLEAResult's EBTU Methodology. All variables related to building equipment and characteristics were collected by the market actors and were added as inputs into a pre-built calculator that modeled total savings based on the methodology. While many measures were available, not all were implemented for each project. Frontier reviewed all assumptions, equipment, and accompanying EBTU savings calculator for each sampled project.

During the course of site review, the evaluation team noted that some measures had been reset back to pre-implementation setpoints and operating conditions. Realized savings for those projects were adjusted by deducting savings for those individual measures from the total project savings. A weighted average realization rate (weighted by claimed NCP kW and kWh savings) was calculated for the entire sample based on validating inputs used for the EBTU calculator. The weighted average realization rates were applied to the entire program population.

5.5.4 Results

The weighted average realization rates for whole building optimization projects were 87% for NCP kW demand savings and 83% for kWh energy savings. The estimated energy savings and coincident peak, non-coincident peak, and ERCOT 4CP demand savings for the FY 2018 Whole Building Optimization program are presented in Table 5-4.

Table 5-4: Whole Building Optimization Gross Energy and Demand Savings

Participant Count	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
84	14,026,086	1,986	1,862	1,666

5.6 COMMERCIAL PROGRAM RECOMMENDATIONS

5.6.1 Portfolio-Wide Recommendations

5.6.1.1 Lighting and Lighting Controls

Frontier recommends updating savings calculators to comply with the following key changes (and any other revisions not specifically listed below) to the *CPS Energy Guidebook* applicable to future fiscal year evaluations:

- Lamps and fixtures are no longer required to be qualified by DesignLights Consortium (DLC), ENERGY STAR, or Lighting Facts. While fixtures were already allowed to be qualified through independent lab testing, test results are now required only to confirm the lamp or fixture input power (wattage) and L^{70} rated life (hours).
- Incorporate new "Less than Dusk-to-Dawn" and "Athletic Fields and Courts" outdoor space types.
- There is a new "Other" building type that is applicable to all projects that do not fit one of the deemed building types. Savings for this building type will be awarded using the most conservative assumptions from the other deemed building types in lieu of site-specific metering.
- The control adjustment factor for "multiple/combined" control types has been updated from 0.38 to 0.47.

5.6.1.2 HVAC

Frontier recommends updating savings calculators to comply with the following key changes (and any other revisions not specifically listed below) to the *CPS Energy Guidebook* applicable to future fiscal year evaluations:

- For early retirement projects:
    - If individual system components were installed in different years, savings calculations should use the condenser age as a proxy for the entire system.
    - In lieu of collecting the existing system age, a default RUL may be used exclusively if applied consistently for all projects in a given program. Otherwise, the default should only be used when a project is reported and documented as having a nameplate that is illegible.
    - Incorporate updated RUL tables with RULs capped at 75th percentile of equipment age.
    - Incorporate new documentation requirement to provide a photograph of all retired unit nameplates demonstrating model number, serial number, and manufacturer if blueprints are not provided; if photograph is unavailable or not illegible, provide a photo and/or description documenting the reason why the nameplate photo was unobtainable (alternate forms of documentation can be accepted with evaluator pre-approval).
    - For chiller projects, Frontier recommends using the early retirement baseline tables that differentiate by Path A and Path B.

- For PTAC/PTHPs, incorporate updated IECC 2018 baseline efficiencies. Baseline efficiency values for Split & Packaged ACs/HPs and chillers were not affected by the IECC 2018 code update.
- Incorporate new "Data Center" building type.
- There is a new "Other" building type that is applicable to all projects that do not fit one of the deemed building types. Savings for this building type will be awarded using the most conservative assumptions from the other deemed building types in lieu of site-specific metering.

5.6.1.3 HVAC Tune-Up

This measure has seen increased participation in the past two years and has helped to diversify the commercial measure mix. Because implementation of this measure is difficult to verify by physical inspection, we recommend making changes to increase confidence in overall effectiveness. This may include increasing the percentage of projects that are selected for pre/post-inspection, increasing project documentation requirements, or requiring customer signatures confirming the specific system counts, types, and capacities to be serviced at each project site.

5.6.1.4 HVAC VFD

We recommend increasing outreach for greater participation for this measure. Customers and facility operators and project sites consistently report satisfaction with the installed equipment and operation. Consider targeting food service and healthcare facilities with high motor operating hours as potential candidates for this measure. Additionally, VFDs are a good candidate for custom projects in industrial, agricultural, and research facilities because operation can easily be trended and measured for evaluation purposes.

5.6.2 Program-Specific Recommendations

5.6.2.1 C&I Solutions

Lodging Guest Room Occupancy Controls

Frontier recommends additional training for implementation staff and contractors to ensure that they understand all measure eligibility requirements.

5.6.2.2 Small Business Solutions

Direct Program

Frontier makes the following recommendations to enhance data reporting structure and help refine the precision of verified savings for future program years.

- Frontier recommends that projects in the Direct program require documentation of fixture/lamp DLC, ENERGY STAR, or Lighting Facts certification for all projects. Alternatively, CLEAResult could provide this review for all installed fixtures/lamps as they do for the C&I and S&I programs.

- Pre and post site photos should be required for all projects, including both photos of fixture nameplates and example installation location for each type of fixture. Most projects provided sufficient photographic evidence, but there were a few exceptions.
- Incorporate a standard customer follow-up interview with a subset of each contractor's completed projects.

Midstream Program

The data available in the CLEAResult lighting calculator aligns closely with the inputs used by the evaluation team to validate program savings claims. However, Frontier makes the following recommendations to enhance data reporting structure and help refine the precision of verified savings for future program years.

- Update manufacturing building type to differentiate by one, two, and three shift options. Frontier has proposed a straight average of all three building types to replace the previously agreed upon building type weightings. Note that the manufacturing building type is currently also a component of the "Other" building type.
- Update the coefficients for the "Other" category to use the values specified for the new "Other" building type specified in the *CPS Energy Guidebook*.

5.6.2.3 Whole Building Optimization

The conservation measures implemented in this program are largely operational and therefore require buy-in from building operators and occupants. The specific strategies selected at each site must reflect the reality of the site's needs. In order for this program to maintain effectiveness throughout the useful life of the measures implemented, we recommend ongoing training or technical support for building operators as well as outreach to occupants where necessary for effective adoption of the conservation measure strategies.

6. DEMAND RESPONSE PROGRAMS

6.1 SUMMARY OF DEMAND RESPONSE IMPACTS

CPS Energy offered the following demand response programs in FY 2019:

Commercial Demand Response

Commercial & Industrial (C&I) Demand Response –
C&I customers are incentivized to curtail during times of peak demand. DR customers lower their energy demand for a one to three hour curtailment period. Incentives are tied to performance during this period. CPS Energy offers four different demand response participation options, Options 1-4, and an Automated Demand Response (ADR) option.

Residential Demand Response

Smart Thermostat – This program provides no-cost installation of a free Honeywell thermostat in customers' homes and uses either traditional pager type thermostat or WiFi thermostat to cycle off the compressors of participating air conditioners during periods of peak summer demand.

Home Manager – Using a home energy management system designed by Landys+Gyr (formerly Consert, Inc.), load control devices are placed on a participant's AC, water heater and/or pool pump. A gateway, the brain of the Home Manager system, uses a wireless network to relay information between a CPS Energy data center and the installed system devices.

Bring Your Own Thermostat (BYOT) - CPS Energy has teamed up with Nest, Honeywell, Energy Hub, Emerson and Whisker Labs to offer customers who purchase or already own smart thermostats an opportunity to participate in CPS Energy's load management events.

Nest Direct Install (DI) – CPS Energy is helping Home Manager customers migrate to the Nest DI program by offering customers free Nest(s) and installation to replace Home Manager Consert devices.

Reduce My Use (BDR) – CPS Energy partnered with Opower to implement a Behavioral Demand Response (BDR) program for residential customers. Participants are pre-selected and must have AMI meters, and are not participating in other CPS Energy DR programs.

For benefit-cost calculations, our approach focuses only on the incremental impacts of new participants added in FY 2019, consistent with the approach used in all energy efficiency program benefit-cost calculations. ADR is the exception, using the impacts from all active participants for benefit-cost calculations. The contribution of each demand response program to energy, coincident peak (CP) demand, and non-coincident peak (NCP) demand savings are shown in Figure 6-1 through Figure 6-3. In these figures and in Table 1-1 and Table 8-1, estimated savings are reported from all active participants to most accurately represent actual program capability at the end of FY 2019. These savings are adjusted to account for net-to-gross ratios and distribution line losses.

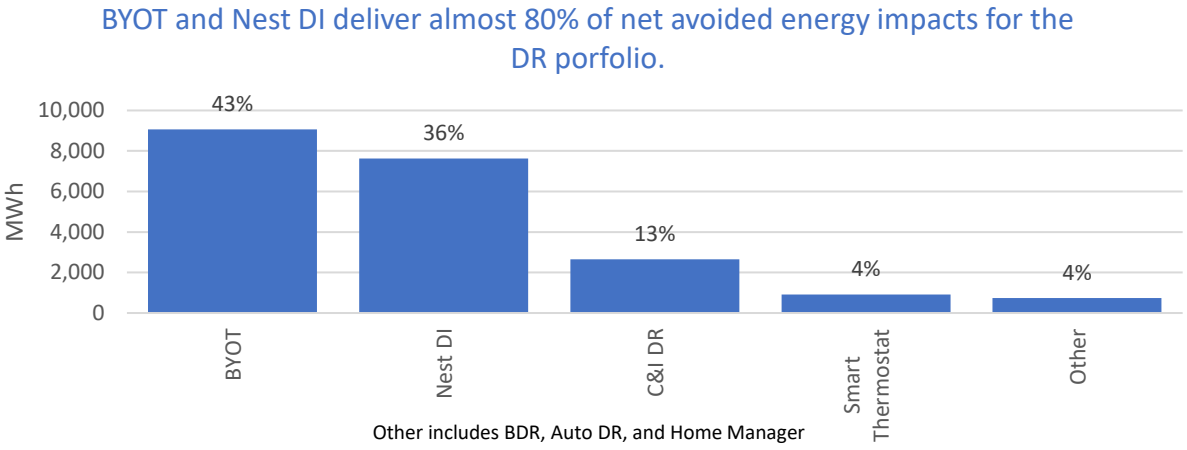


Figure 6-1: Summary of Demand Response Impacts – Energy (MWh) by Program

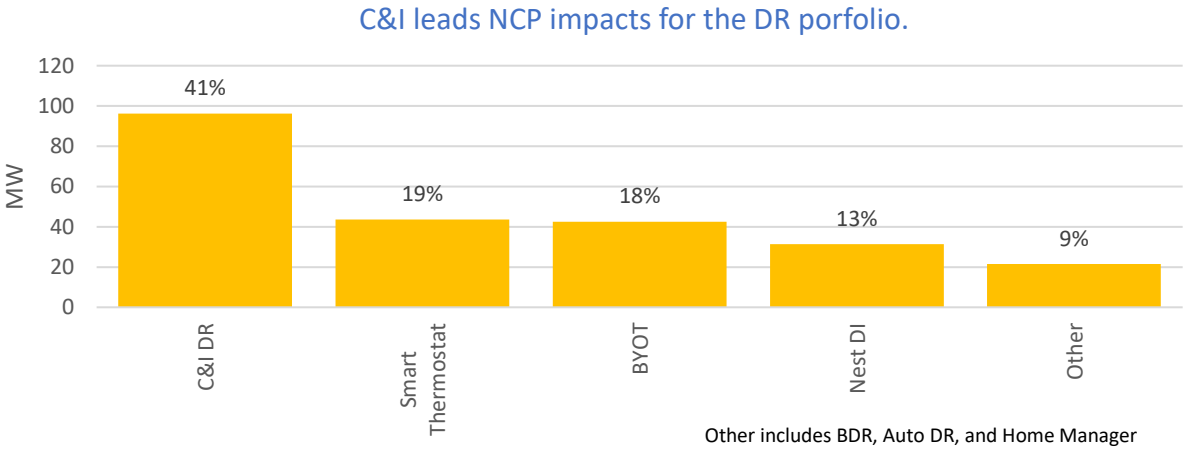


Figure 6-2: Summary of Demand Response Impacts – Non-Coincident Peak Demand (MW) by Program

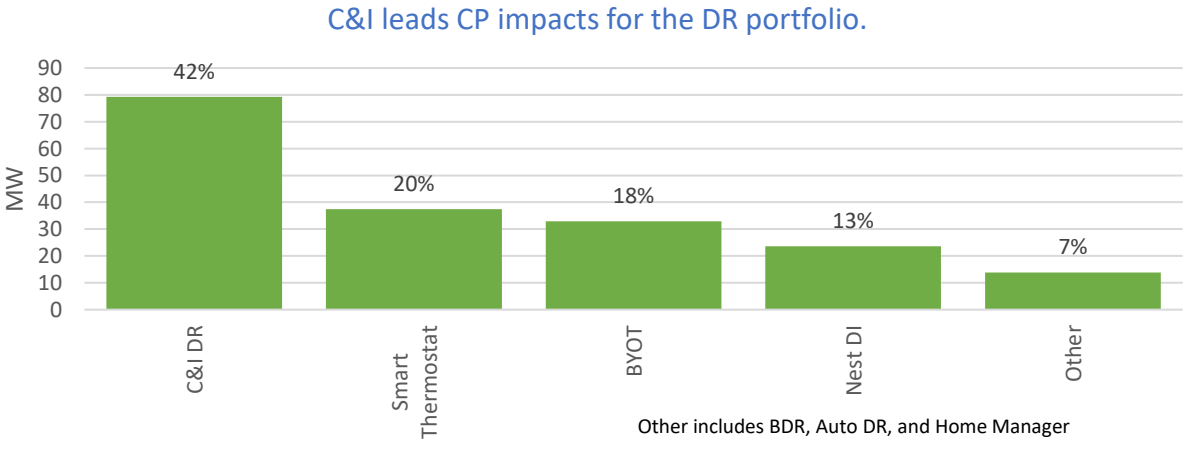


Figure 6-3: Summary of Demand Response Impacts – Coincident Peak Demand (MW) by Program

6.2 COMMERCIAL AND AUTO DEMAND RESPONSE PROGRAMS

6.2.1 Overview

CPS Energy's Commercial DR programs (C&I program) are voluntary load curtailment programs for commercial and industrial customers. They are designed to reduce peak load by incentivizing customers to shed electric loads on peak summer days. The programs run from June 1st through September 30th. Participating customers commit to be available to participate in events from 1 p.m. to 7 p.m., with events typically occurring on weekdays till 5:30 p.m.

Before FY 2019, the Commercial DR programs consisted of Options 1, 2, and 3, and ADR. In FY 2019, Option 4 was introduced to the program portfolio. Unlike Options 1, 2 and 3, customers were given notice only half an hour in advance.

CPS Energy uses each of these programs differently because they have different purposes, capabilities, and contractual stipulations. Table 6-1 summarizes these differences.

Table 6-1: Commercial DR Program Characteristics

Measure	Performance Period	Time Period	Event Days	Max Events	Total Hours Avail.	Advance Notice (hrs)
Option 1	Jul 1 - Aug 31	1300 - 1900	Weekdays	18	55	2
Option 2	Jun 1 – Sep 30	1300 - 1900	Weekdays	25	75	2
Option 3	Jun 1 – Sep 30	1300 - 1900	Weekdays	6	25	1
Option 4	Jun 1 – Sep 30	1300 - 1900	Weekdays	25	75	0.5
ADR[20]	Jun 1 – Sep 30	24/7	All Days	N/A	50	0

Programs vary by performance period, events available, total hours available, and advance notice. Option 1 is not available in June and September, while other programs operate throughout the entire summer. ADR is the most responsive, with load being curtailed immediately after calling an event. Other programs have 0.5 to 2 hours of advance notice.

6.2.2 Participation Trends

As can be seen in Figure 6-4 through Figure 6-6, the total number of sponsors (i.e., participating entities), participating sites, and contracted kW all increased in FY 2019. Compared with the previous year, the number of sponsors grew from 126 to 135[21], the number of sites went from 427 to 444, and contracted kW increased from 82.6 MW to 84.1MW. Among them, 21 sponsors, 104 sites and 21.6 contracted kW are participants in the new program – Option 4.

[20] There is also a non-summer ADR program offering that runs for the rest of the year, but its impacts are not evaluated herein.
[21] A few sponsors with multiple sites took part in more than one C&I program in FY 2019.

The total number of sponsors, sites, and contracted kW dropped slightly for Options 1, 2, and ADR due to the fact that some of customers migrated to Option 4 in FY 2019.

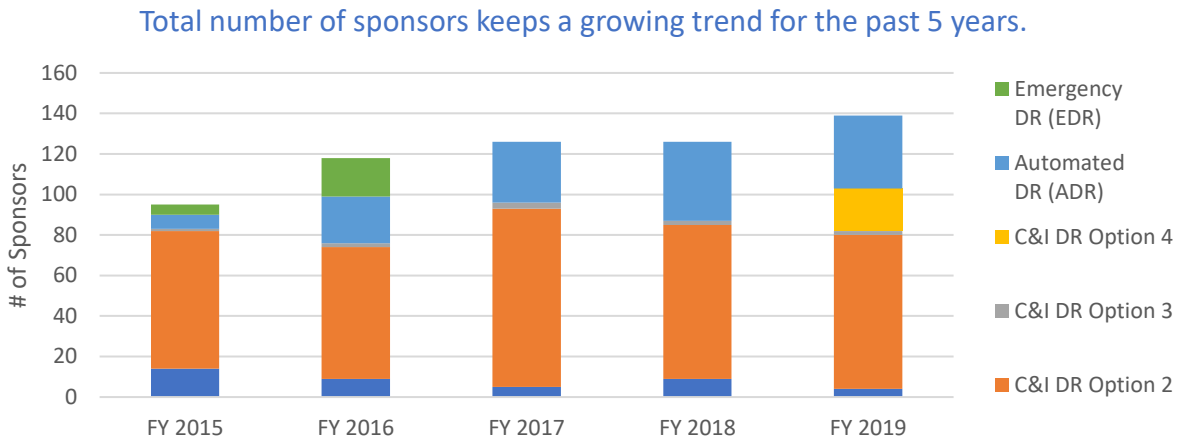


Figure 6-4: Commercial DR Sponsor Counts, FY 2015 – FY 2019

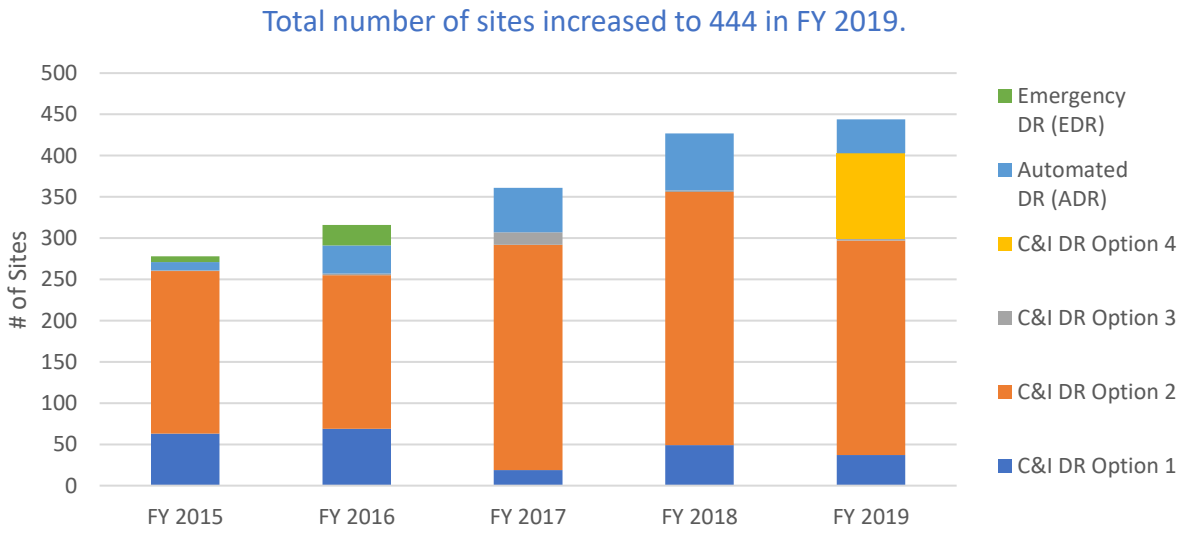


Figure 6-5: Commercial DR Site Counts, FY 2015 – FY 2019

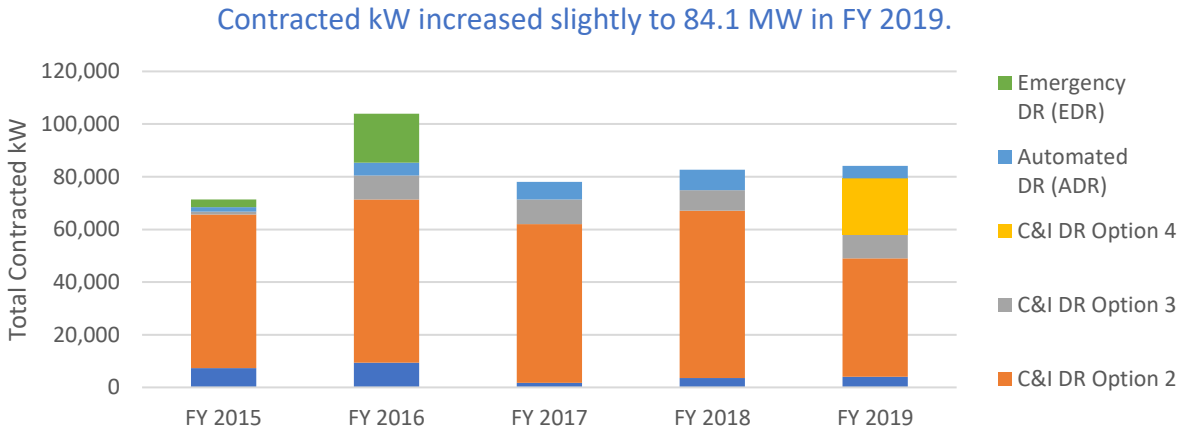


Figure 6-6: Commercial DR Contracted kW, FY 2015 – FY 2019

CPS Energy deployed its Commercial DR programs on 23 days in FY 2019. As can be seen in Table 6-2, Option 2, 4 and the ADR programs were called most frequently, while Option 3 was only called six times due to a limit on the maximum number of events that could be called under that program.

The four days highlighted in orange are 4CP days in FY 2019. On July 19th, all the C&I programs hit the 4CP event. Options 2, 4 and ADR hit all the 4CPs in FY 2019 while Option 3 hit two of the 4CPs. Option 1 hit July and August 4CPs due to the fact this program can only be implemented in July and August.

Table 6-2: Commercial DR Events and Average Duration by Program Offering

Month	June				July								August								September			Total # of Events
Day	6	22	26	27	2	3	17	18	19	20	23	24	6	7	8	15	16	17	23	24	17	18	19	
Option 1					X	X	X	X	X	X	X		X	X	X		X	X	X	X				14
Option 2	X		X	X	X	X	X	X	X	X	X		X	X			X	X	X	X	X	X	X	19
Option 3				X	X				X		X						X					X		6
Option 4	X	X		X	X	X		X	X		X	X	X	X		X	X	X	X	X	X	X	X	19
ADR	X	X		X	X	X		X	X		X	X	X	X		X	X	X	X	X	X	X	X	19

As can be seen in Table 6-3, the total number of days when events were called dropped by one compared with that in FY 2018, on which C&I events were called on 23 days.

Table 6-3: Commercial DR Total Number of Events called, FY 2016 – FY 2019

C&I DR Program/ Option	FY 2019	FY 2018	FY 2017	FY 2016
Option 1	14	12	11	10
Option 2	19	22	19	13
Option 3	6	6	6	6
Option 4	19	NA	NA	NA
ADR	19	19	18	13
EDR	NA	NA	NA	1
Total	22	23	21	17

Figure 6-7 compares the average event duration from FY 2016 to FY 2019. Apart from the newly added Option 4, event durations for all the programs are shorter in FY 2019 compared with FY 2018. The average duration for all C&I programs in FY 2018 is 1.83 hours.

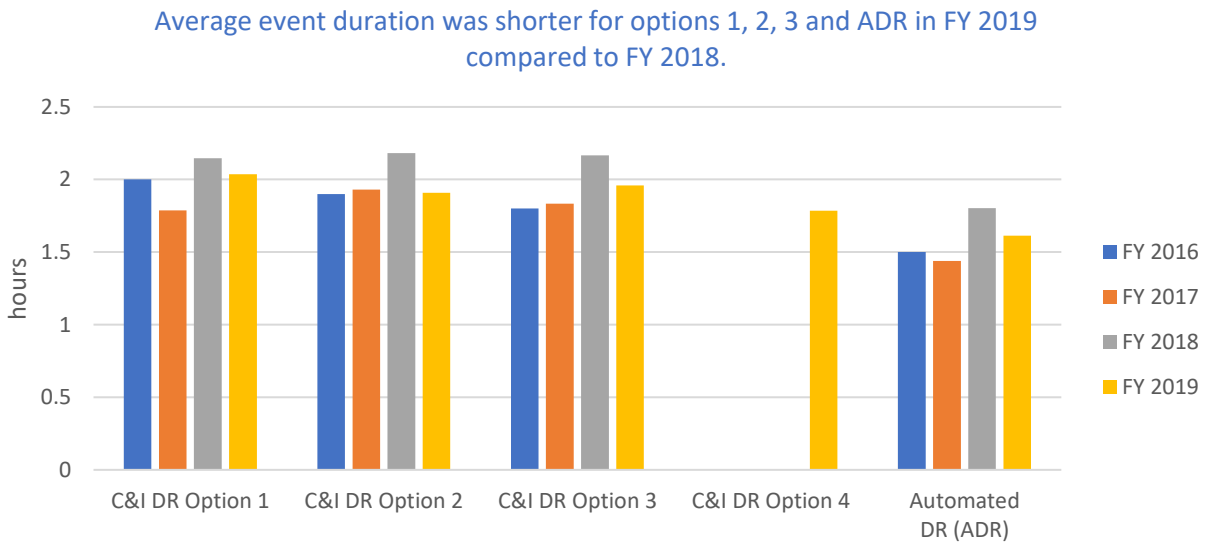


Figure 6-7: Commercial DR Average Event Duration, FY 2016 – FY 2019

6.2.3 Savings Calculation Methods

CPS Energy generally estimates delivered demand savings according to a "high 3-of-10" baseline estimation method. In cases where the high 3-of-10 baseline is not deemed to provide a reasonable baseline for a given participant for a given event, other methods may be used. This could include using a single proxy day (like-day) or applying further adjustments by evaluators.

Consistent with the methodology adopted in FY 2018, Frontier has employed a "multiple-baselining method" to verify CPS Energy's savings estimates[22] in FY 2019. This approach calculates savings using four different methods and then selects the savings generated by the most appropriate method by evaluating some statistical criteria. Specifically, the general calculation process of "multiple-baselining method" is as follows:

Step 1: Data Selection. For each event and each customer, the previous 10 eligible days and the event day are selected. These 11 days of data are used for the analysis as outlined in the following steps.

Step 2: Calculation. For each customer on each event, kW savings are calculated using four methods:

- Regression: Load is modeled as a function of *cdh* (cooling degree hours), *notify period* dummy variable indicating whether a time period is within the notification period, *event* dummy variable indicating whether a time period is within the event period, 10 day-dummy variables indicating date, and 3 *time-of-day* dummy variables indicating time of day – 0:00-6:00, 6:00-12:00, 12:00-18:00 or 18:00-24:00. The model equation can be expressed as follows:

  $$kW_t = \beta_0 + \beta_1 * cdh_t + \beta_2 * event_t + \beta_3 * notify\text{-}period_t + \sum_{i=4}^{6} \beta_i * time\text{-}of\text{-}day_t + \sum_{j=7}^{16} \beta_j * date_t$$

  $-\beta_2$ is the estimated load reduction for a certain customer during a certain event.

- CPS Energy's high 3-of-10 baseline analysis.

- Previous X hours: X = event duration + notifying period. For example, if an event duration is 2 hours, and CPS Energy notifies customers 2 hours in advance, then X = 4. If an event is from 3:30 to 5:30 p.m., then the baseline would be the average load within the period from 11:30 a.m. – 1:30 p.m.

- Average everything: this method calculates the average of all the load for the previous 10 eligible days to provide a baseline. This approach is designed for customers with rather amorphous and irregular load.

[22] Frontier made further adjustment on one customer for one event in Option 3, after running the "multiple-baselining" method, due to the fact this customer has a very irregular load profile. Instead of using "multiple-baselining" method, results with the high 3-of-10 method were adopted.

Step 3: Evaluation. For the testing data period,[23] three measures including accuracy (root mean square error, RMSE), bias (difference) and variability (standard deviation) are calculated. This step measures how fit the model results are, compared with actual results for a similar time period.

Step 4: Final Selection. For the three measures described in Step 3, a pairwise comparison is conducted using a ranking method.[24] The method with the top ranking (lowest score) is selected.

6.2.3.1 Energy Savings (kWh)

Energy savings achieved from the Commercial DR programs are estimated by multiplying the demand savings estimated for each participant for each event by that event's duration and summing these energy reductions across all events for all the programs. The calculation assumes there is no load shifting (e.g. rescheduling of industrial processes) or pre-cooling or snapback.

6.2.3.2 Coincident Peak (CP) Demand Savings (kW)

To estimate coincident peak demand kW savings, Frontier estimated per event demand savings using "multiple-baselining" analysis for each customer. For each option/program, an average kW savings of all events in summer 2018 was then calculated. This is the number used to report achieved CP savings.

6.2.3.3 Non-Coincident Peak (NCP) Demand Savings (kW)

Non-coincident peak demand savings for the Commercial DR programs represent the maximum event demand savings among all events for each option/program. The delivered NCP savings reported for each sub-program (or program option) may have occurred on different event dates. End-of-year and incremental estimates of NCP savings were estimated as the maximum event demand savings from those customers comprising the end-of-year or incremental enrollees. For the Commercial DR program as a whole, Frontier sums the maximum event demand savings from each program option.

6.2.3.4 ERCOT 4CP Demand Savings (kW)

ERCOT 4CP demand savings obtained from the Commercial DR programs are directly estimated by evaluating the average load reductions delivered when each month's 4CP event occurred, multiplied by 4CP success rate[25] for each program in FY 2019.

[23] Here "testing data period" refers to the same time period as the event period on the top three of the previous 10 eligible days, plus 09:00am – 1:00pm on the event day.

[24] General rule for "pairwise comparison using ranking": if the difference for a pair of baselines > 2% then the baseline with the higher one gets one point. Otherwise, both baselines get 0.5 point. In the end, for each method respectively, RMSE, Error and standard deviation score are added together.

[25] Success rate = # of 4CPs hit / 4. For example, in FY 2019 two of the 4CPs were hit for the Option 3 program so the success rate was 2/4 = 50%.

6.2.4 Results

For demand response programs, we present impacts in three ways:

1) Estimated program impacts during summer 2018 DR events.

2) End-of-year (EOY) program capability based on program enrollment at the end of FY 2019; this information is useful for planning purposes.

3) End-of-year (EOY) program capability based on incremental enrollment during FY 2019; this information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

For Options 1-4, there is no distinction between total EOY participation and incremental enrollment: all participants are treated as new participants each program year. As such, the analysis of incremental impacts of these programs is no different than the analysis of total impacts. For ADR program in FY 2019, there was no newly-participating customers, therefore incremental impacts are set as zero.

6.2.4.1 Estimated Impacts During Summer 2018 DR Events

During summer 2018, C&I demand response events were called on 23 days. The aggregated kW savings estimates are shown in Figure 6-8.

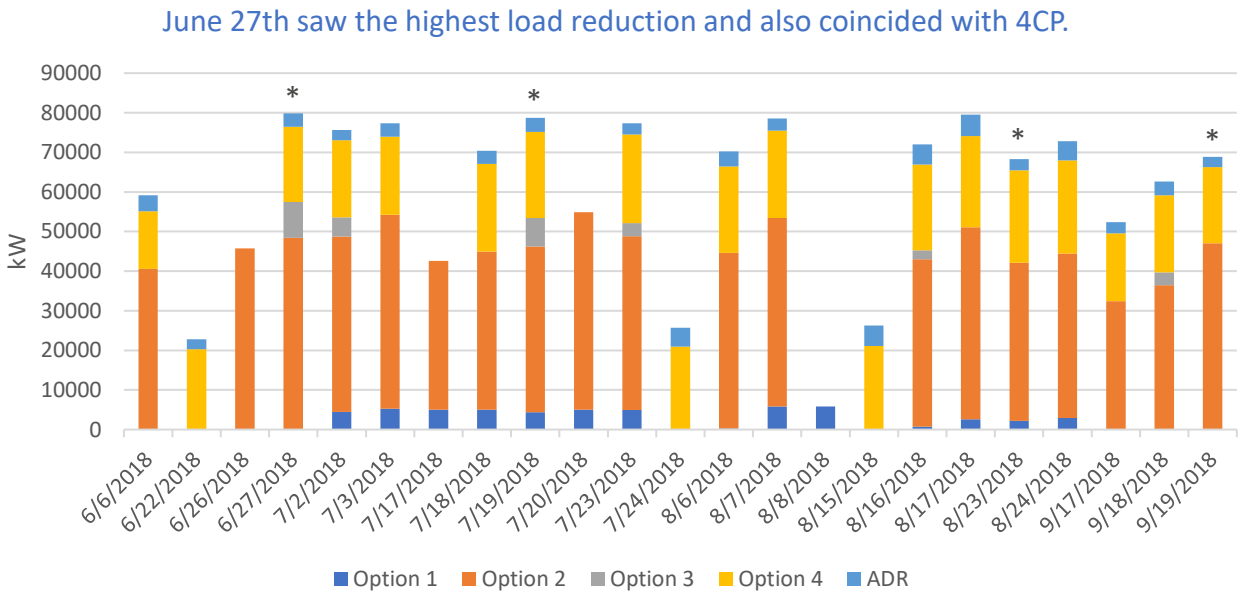


Figure 6-8: Commercial DR Delivered Demand Savings, Summer 2018

Note: Events coinciding with ERCOT 4CP intervals are designated with an asterisk (*).

Maximum total demand reduction was achieved on June 27th, which was also a 4CP day. The total demand reduction from the C&I DR programs was 80 MW on that day. Given the differences in how the individual C&I DR programs are used, Frontier estimates the demand savings delivered by each program individually. Total demand savings are presented as the sum of the demand savings delivered by each of the respective programs. The demand reduction and the number of customers participating in each option/program are shown in Figure 6-9 to Figure 6-13.

For Option 1, there was a sharp drop in savings on August 6th and August 16th due to the fact that most schools chose not to participate.

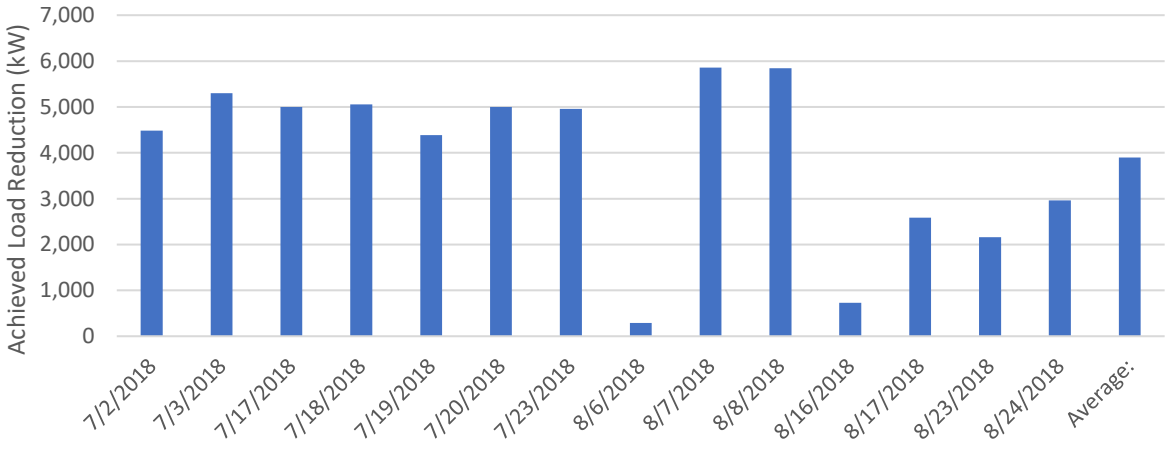


Figure 6-9: Commercial DR Option 1 Demand Savings by Event

For Option 2, load reduction remained relatively stable across all 19 events, with average savings of 43 MW.

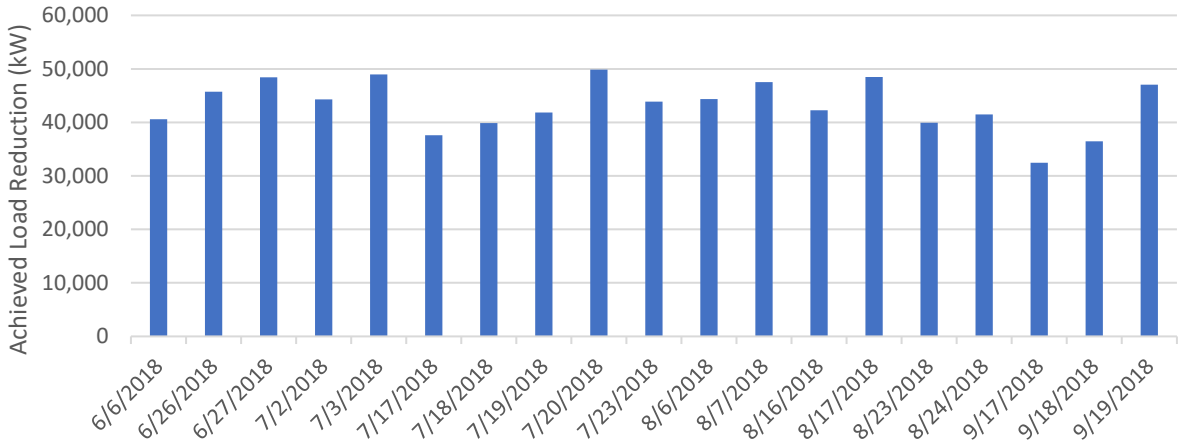


Figure 6-10: Commercial DR Option 2 Demand Savings by Event

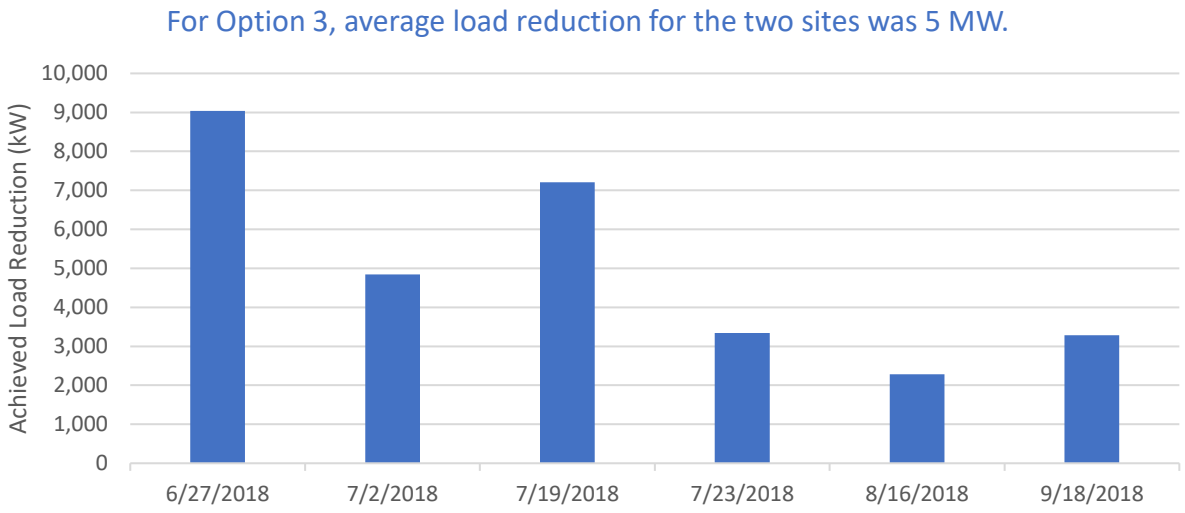


Figure 6-11: Commercial DR Option 3 Demand Savings by Event

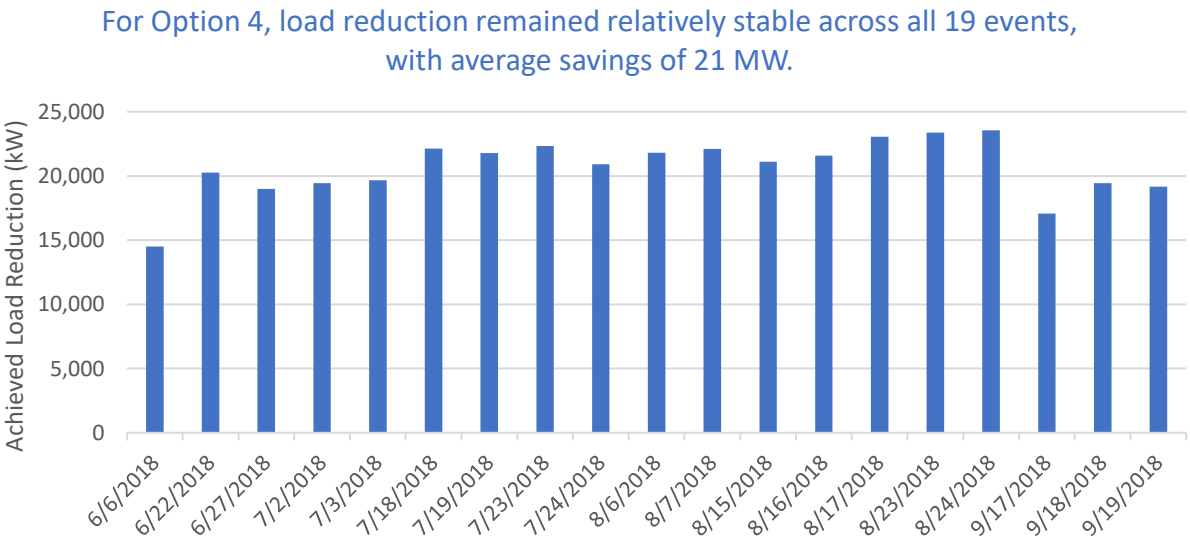


Figure 6-12: Commercial DR Option 4 Demand Savings by Event

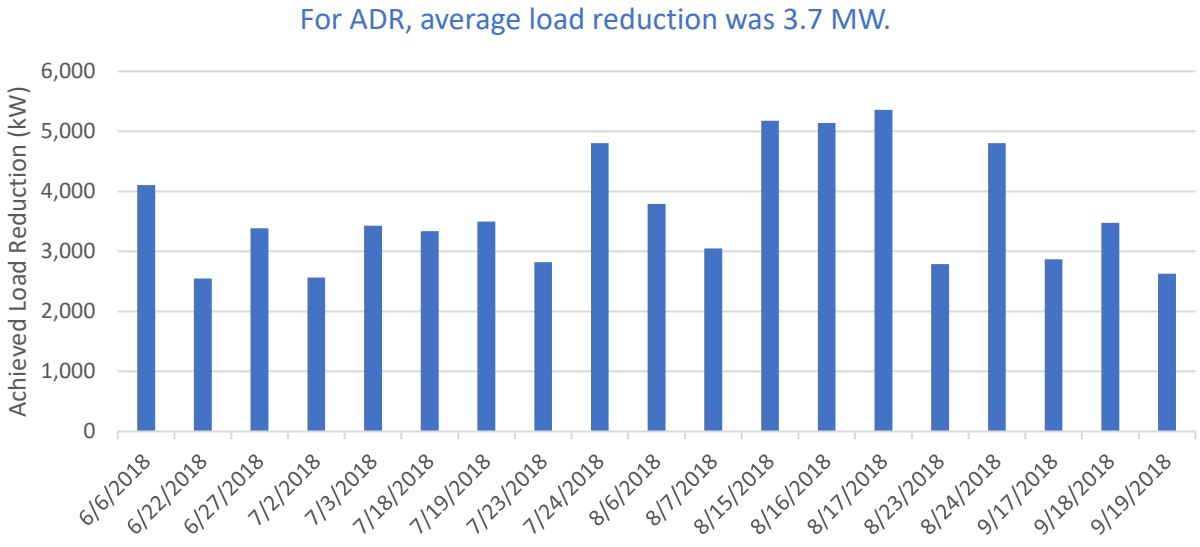


Figure 6-13: Commercial DR Automated DR Demand Savings by Event

A comparison of the estimated impacts from FY 2016 to FY 2019 is shown below:

Table 6-4: Estimated Achieved kW Impacts Comparison, FY 2016 – FY 2019

C&I DR Program/ Option	FY 2019 Average Savings (kW)	FY 2018 Average Savings (kW)	FY 2017 Average Savings (kW)	FY 2016 Average Savings (kW)
Option 1	3,900	5,373	994	11,441
Option 2	43,216	56,103	66,010	67,317
Option 3	4,998	4,265	7,860	6,609
Option 4	20,647	NA	NA	NA
ADR	3,662	7,239	5,684	3,707
EDR	NA	NA	NA	17,903
Total	76,422	72,980	80,548	106,977

Rows may not sum to total due to rounding.

FY 2019 Delivered Savings

Table 6-5 presents the estimates of savings delivered by the Commercial DR programs for FY 2018.

Table 6-5: Commercial DR Gross Energy and Demand Savings – FY 2019 Delivered

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Option 1	112,118	3,900	5,855	1,637
Option 2	1,566,646	43,216	49,872	44,314
Option 3	57,716	4,998	9,037	4,061
Option 4	705,164	20,647	23,552	20,830
Automated DR	112,462	3,662	5,359	3,074
Total	2,554,107	76,422	93,675	73,916

Rows may not sum to total due to rounding.

6.2.4.2 End-of-year Program Capability

Unlike residential DR programs which see recurring annual participation, most C&I DR programs are short and contract-based, lasting only 1-2 years—except for the ADR program. For energy savings (kWh), coincident peak savings (kW) and non-coincident peak savings (kW), Frontier uses the savings achieved in summer 2018 as an end-of-year result. Because 4CP chasing has a certain success rate, Frontier considers it reasonable to use the average success rate of the past five fiscal years to estimate end-of-year program capability for ERCOT 4CP demand savings.

Table 6-6: Commercial DR ERCOT 4CP Demand Savings – End-of-Year

Measure	Success Rate					Average Success Rate	Achieved FY 2019 ERCOT 4CP Demand Savings (kW)	EOY FY 2019 ERCOT 4CP Demand Savings (kW)
	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019			
Option 1	25%	50%	50%	25%	50%	40%	1,637	1,309
Option 2	75%	75%	100%	75%	100%	85%	44,314	37,666
Option 3	50%	75%	25%	75%	50%	55%	4,061	4,467
Option 4	NA	NA	NA	NA	100%	100%	20,830	20,830
Automated DR	75%	100%	100%	100%	100%	95%	3,074	2,921
						Total:	73,916	67,194

Rows may not sum to total due to rounding.

Option 1 participants are not available in June or September, meaning at least two 4CP events will always be missed with that program option. Option 3 participants are available for a maximum of six events, limiting CPS Energy's ability to use these program options for 4CP avoidance. Therefore, the end-of-year program capability is summarized as follows:

Table 6-7: Commercial DR Gross Energy and Demand Savings – End-of-year Capability

Measure	Energy Savings (kWh)	Coinc. Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	ERCOT 4CP Demand Savings (kW)
Option 1	112,118	3,900	5,855	1,309
Option 2	1,566,646	43,216	49,872	37,666
Option 3	57,716	4,998	9,037	4,467
Option 4	705,164	20,647	23,552	20,830
Automated DR	112,462	3,662	5,359	2,921
Total	2,554,107	76,422	93,675	67,194

Rows may not sum to total due to rounding.

6.2.4.3 Incremental Impacts

For Options 1-4, there is no distinction between total participation and incremental participation: all participants are treated as new each program year. As such, the analysis of incremental impacts of these programs is no different from the analysis of total impacts.

The ADR program is a vendor-implemented program involving the installation of hardware, and ADR participants sign longer-term contracts. Frontier has assigned the ADR program a 10-year measure life. For this program, incremental impacts differ from total impacts. In FY 2019 no new sites were added to ADR program. Therefore, incremental impacts are zero for ADR program in FY 2019.

6.3 SMART THERMOSTAT PROGRAM

6.3.1 Overview

The Smart Thermostat direct load control program has been available to residential sector participants in single-family homes since 2003. It was expanded to include multifamily and small commercial customers in 2010. Through the program, Honeywell installs a programmable, controllable thermostat (PCT) at a participant's home or place of business at no cost to the customer. In return, CPS Energy is permitted to remotely control their central air conditioning systems during demand response events. Once an event is called, CPS Energy can cycle the air conditioner compressor on and off for short periods of time on event days. Cycling events occur during the summer months of May through September, between the hours of 3 p.m. and 7 p.m. on weekdays.

Single-family, multifamily and small commercial customers participate at either a 33% cycling rate (during which units are cycled off for 10 minutes during each half hour) or a 50% cycling rate (during which units are cycled off for 15 minutes during each half hour). Customers can choose either a pager-style thermostat or a WiFi-enabled thermostat. Pager thermostats are available on either a 33% or 50% cycling rate, while WiFi Thermostats are only available for a 50% cycling rate.

In FY 2018, a small portion of single family WiFi-enabled thermostats were selected as a pilot trial for a new cycling strategy – a unique cycling pattern designed by Whisker Labs. The pilot trial showed that savings under the Whisker Labs platform were higher than that of traditional cycling. In response to pilot trial results, all Smart Thermostat WiFi thermostats in commercial and single family migrated to the Whisker Labs platform in FY 2019 while Multifamily WiFi thermostats are still run under traditional 50% cycling. For convenience, thermostats that are not on Whisker Labs cycling are referred to as "traditional cycling thermostats."

6.3.2 Participation Trends

Figure 6-14 shows overall participation in the Smart Thermostat program at the beginning and end of FY 2019 and at the time of DR events during June through September 2018.

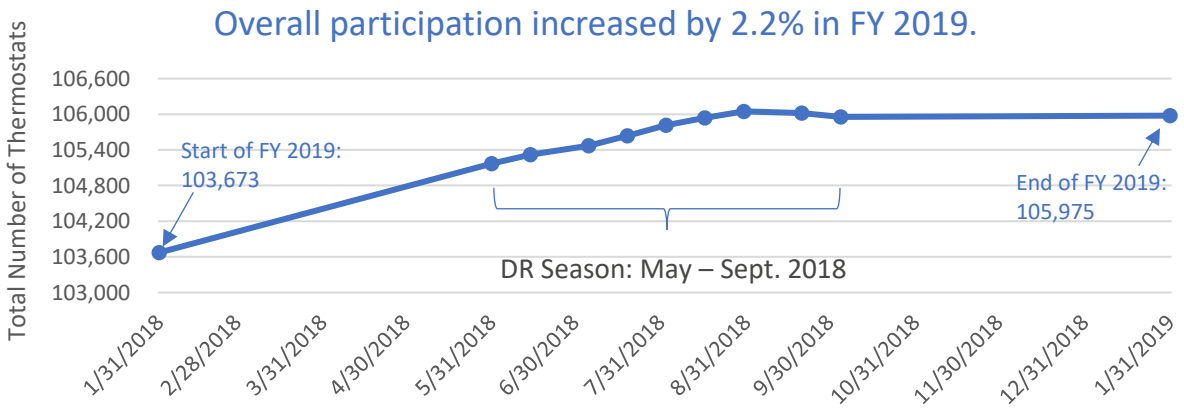


Figure 6-14: Smart Thermostat Participation Trend (FY 2019) – Total Thermostat Count

Two obvious participation drops during the event season can be observed in Figure 6-14. The first drop was from the 6/6/2018 event to the 6/22/2018 event, when total participation decreased from 120,957 to 116,124. This is caused mainly by a participation decrease in multi-family 33% cycling thermostats, from 44,065 to 38,395. The second drop was from the 7/3/2018 event to the 7/18/2018 event, with total participation decreasing from 115,790 to 105,054. The main drivers for the second drop are single family and commercial 33% cycling thermostats, from 48,073 to 38,134 for single family and 3,135 to 2,160 for the commercial dwelling type.

Figure 6-15 shows participation trends by customer dwelling type over the past six years. Device numbers in single family and commercial categories continued to increase in FY 2019, mainly driven by growing participation of WiFi thermostats.

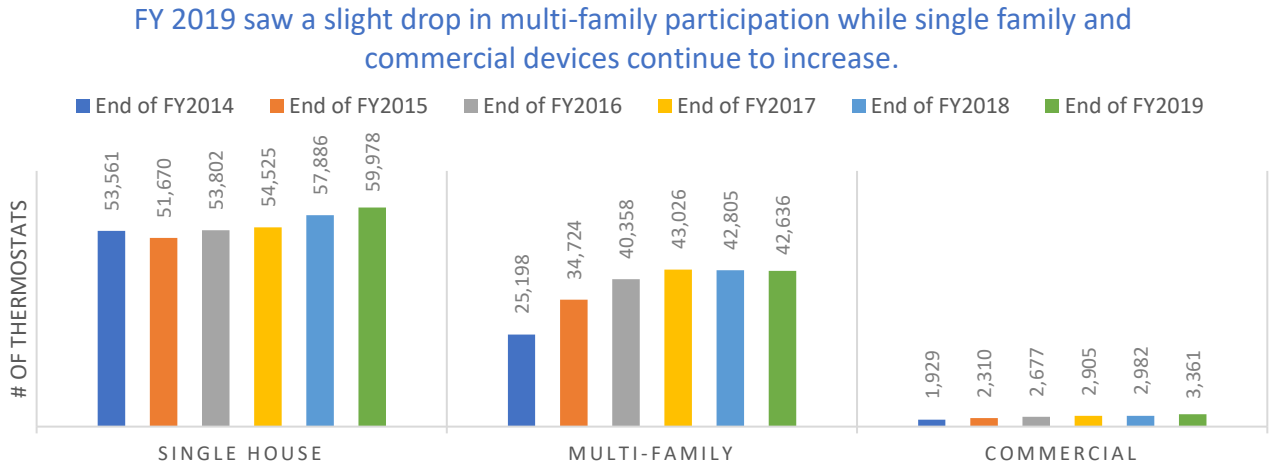


Figure 6-15: Smart Thermostat Participation Trends (FY 2014-FY 2019) by Segment

Figure 6-16 shows the participation share by dwelling type from FY 2014 to FY 2019. The majority of the Smart Thermostat program are single family customers. The share associated with commercial customers have increased slightly in FY 2019, from 2.88% to 3.17%.

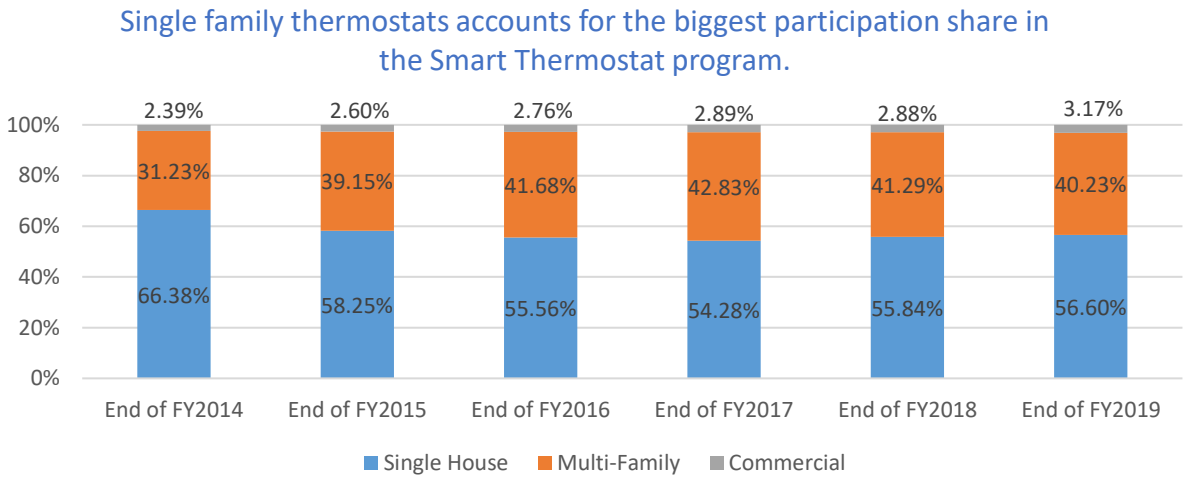


Figure 6-16: Smart Thermostat Participation Share (FY 2014-FY 2019) by Dwelling Type

Figure 6-17 shows the participation share by thermostat type (pager or WiFi) from FY 2017 to FY 2019. The percentage of WiFi thermostats increased from 8.5% to 13.6% for the past two fiscal years.

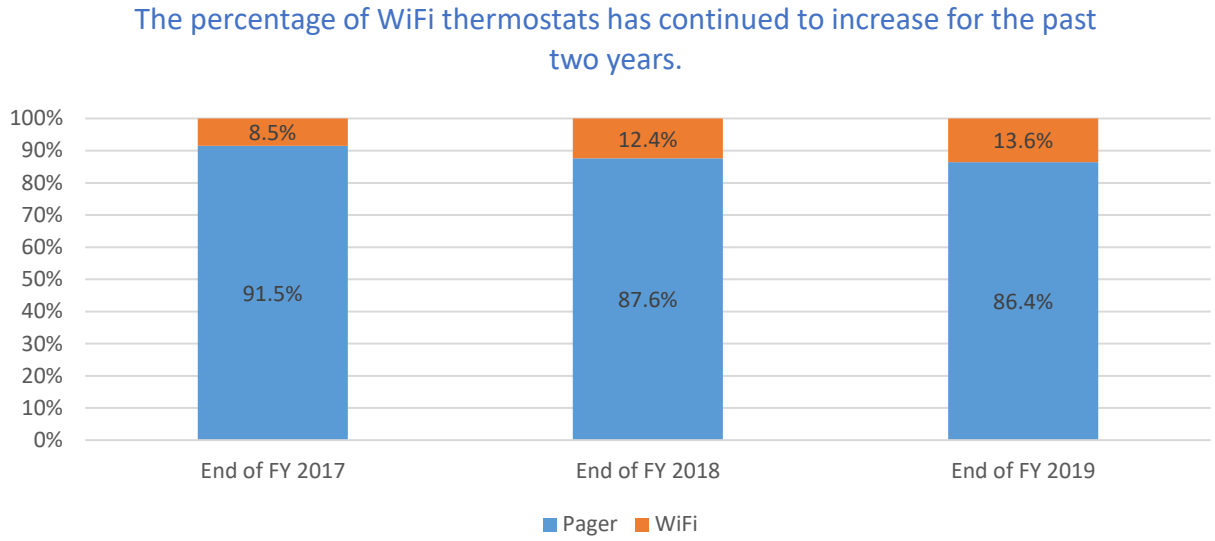


Figure 6-17: Smart Thermostat Participation Share (FY 2017 through FY 2019) by Thermostat Type

Figure 6-18 shows the breakdown by segment of all newly installed devices in FY 2019. Single family WiFi thermostats account for 3,171 of the 4,518 newly installed thermostats, i.e., 70% of all new installs. Of all new devices, 76% are WiFi thermostats, with the proportion of single family WiFi, multi-family WiFi and commercial WiFi thermostats combined in Figure 6-18.

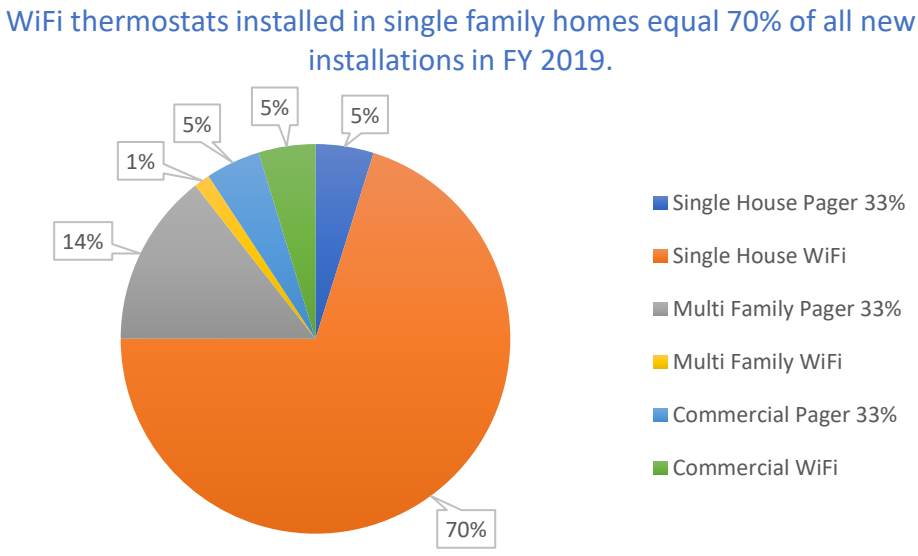


Figure 6-18: Smart Thermostat Breakdown by Thermostat Type – FY 2019 New Installs

Table 6-8 summarizes end of FY 2019 participation levels by customer segment and cycling strategy.

Table 6-8: Smart Thermostat Program Participation by Group, End of FY 2019

Thermostat Type	Dwelling Type	Cycling Strategy	Device Count Number
Pager	Single Family	33%	40,927
		50%	9,617
	Multi Family	33%	38,780
	Commercial	33%	2,275
WiFi	Single Family	Whisker Labs	9,434
	Multi Family	50%	3,856
	Commercial	Whisker Labs	1,086
		Total:	105,975

Smart thermostats are run on two different kinds of platforms, and event schedules also differ slightly in FY 2019. Table 6-9 summarizes the total number of events called and average event duration on traditional Smart Thermostat cycling and the Whisker Labs platform:

Table 6-9: Traditional Cycling vs Whisker Labs Platform: Number of Events and Average Duration

	Traditional Cycling	Whisker Labs Platform
Total Number of Events Called	21	19
Average Event Duration	1.85 hours	1.74 hours

6.3.3 Savings Calculation Methods

6.3.3.1 Per Device kW and kWh Savings

Frontier adopted temperature bins developed in FY 2017 and FY 2018 for estimating savings for non-Whisker Labs cycling thermostats and Whisker Labs cycling thermostats respectively.

Traditional Cycling (Non-Whisker Labs cycling) Thermostats

In FY 2017, Frontier conducted a full EM&V analysis for the Smart Thermostat program using sample customers' raw 15-minute interval AMI data throughout the summer of 2016. A temperature bin for some of the thermostat segments (Table 6-10) was also developed to expedite savings for future years so that raw AMI data won't be needed.

Table 6-10: Smart Thermostat Temperature Bin for Three Traditional Cycling Thermostats

Temperature (ºF)	Pager-MF-33% cycling (per device, unit: kW)	Pager-SF-33% cycling (per device, unit: kW)	Pager-SF-50% cycling (per device, unit: kW)
90	0.16	0.17	0.27
91	0.17	0.18	0.27
92	0.18	0.19	0.28
93	0.18	0.20	0.29
94	0.19	0.21	0.30
95	0.20	0.21	0.32
96	0.20	0.22	0.33
97	0.20	0.22	0.34
98	0.21	0.23	0.34
99	0.21	0.23	0.35
100	0.22	0.24	0.37
101	0.23	0.25	0.38
102	0.23	0.26	0.39
103	0.24	0.27	0.40
104	0.25	0.27	0.41
105	0.25	0.28	0.42
1-hour snapback:	0.12	0.17	0.16

Take the Multi Family 33% pager cycling thermostats during the first event (6/6/2018 16:00 – 17:30) as an example. Average temperature during the event period was 100°F[26], which corresponds to 0.22 kW per device on the temperature bin table.

To calculate net kWh savings per device per event, 1-hour post event snapback is also taken into consideration and is based on the following equation:

$$Net\ kWh\ savings\ =\ estimated\ kW\ savings\ *\ event\ duration\ -\ 1\ hour\ snapback\ kWh$$

Plugging 0.22 kW estimated kW savings, 1.5 hours event duration and 0.12 kWh snapback kWh into the equation above yields 0.21 kWh net energy savings[27] per multifamily 33% cycling device in that event.

The other two segments can be calculated in the same manner.

[26] Temperature source: NOAA, station Kelly AFB: ftp://ftp.ncdc.noaa.gov/pub/data/noaa/isd-lite/2018/
[27] Numbers may not sum due to rounding.

Due to sample size limitations, no temperature bin was developed for multifamily 50% WiFi cycling and commercial 33% pager cycling thermostats. Average kW savings and 1-hour snapback estimated in FY 2017 serve as an approximation for FY 2019 savings for these two categories.

Table 6-11: Average kW Savings and Snapback per Device for Multifamily WiFi and Commercial 33% Cycling Thermostats

	WiFi – MF – 50% Cycling	Pager – COMM – 33% Cycling
kW savings per device	0.07	0.27
1-hour snapback per device (kWh)	0.01	-0.12

Net energy savings can be calculated in the same manner as that of segments with temperature bins.

Whisker Labs Cycling Thermostats

In FY 2018, there were 917 single family households (about 1,128 WiFi devices) that participated in the Whisker Labs cycling pilot. A full EM&V analysis was conducted by Frontier and similar to other programs, a temperature bin was developed for single family WiFi thermostats with Whisker Labs cycling.

Table 6-12: Temperature Bin Savings per Device for Single Family WiFi Whisker Labs Cycling Thermostats

Temperature(°F)	kW Savings/Device	Temperature(°F)	kW Savings/Device
90	0.84	100	1.18
91	0.88	101	1.22
92	0.91	102	1.25
93	0.95	103	1.28
94	0.98	104	1.32
95	1.01	105	1.35
96	1.05	106	1.38
97	1.08	107	1.42
98	1.11	108	1.45
99	1.15	109	1.49
		110	1.52

Pre and Post Event Over-Consumption for kWh Savings Calculation (unit: kW)	
1-hour precool:	-0.01
1-hour snapback:	0.17

Evaluation results showed this type of cycling strategy yielded higher savings per device compared with that of traditional cycling. Therefore, all single family and commercial WiFi thermostats in the Smart

Thermostat program migrated to the Whisker Labs platform in FY 2019. Consequently, the temperature bin developed in FY 2018 can be applied.

We also take the first event (6/6/2018 16:00 – 17:30) as an example here. According to the temperature bin (Table 6-12), savings for single family WiFi thermostats is estimated at 1.18 kW per device. Gross energy savings during the event period is 1.18 kW * 1.5 hours = 1.77 kWh. Subtracting energy consumption change during 1-hour pre-cool period and 1-hour snapback period yields net energy savings of 1.77 kWh - (-0.01 kWh) – 0.17 kWh = 1.61 kWh.

Single family WiFi thermostats savings also served as an approximate for commercial WiFi thermostats savings, since neither raw data or temperature bin was available for this category in FY 2019.

6.3.3.2 Coincident Peak (CP) Demand Savings (kW)

To estimate coincident peak demand kW savings, we estimated total demand savings using the per device kW savings multiplied by the total number of devices by category for each event. Average kW savings across high temperature events [28] in summer 2018 was then calculated. To estimate program capability based on end-of-year and incremental enrollment, the result is scaled to the number of Smart Thermostats at the end of FY 2019 and to the number of new thermostats installed in FY 2019, respectively.

6.3.3.3 Non-Coincident Peak (NCP) Demand Savings (kW)

Delivered non-coincident peak savings represent the maximum event demand savings among FY 2019 events. End-of-year and incremental estimates of NCP savings were obtained by scaling the delivered NCP to the number of installed devices at the end of FY 2019.

6.3.3.4 ERCOT 4CP Demand Savings (kW)

During summer 2018, both traditional cycling and Whisker Labs cycling thermostats hit all four of the ERCOT 4CP events, with a success rate of 100% program wide. To estimate ERCOT 4CP demand savings, we estimated total demand savings for each event, selected the four events which coincided with ERCOT 4CP, and multiplied the result by the ERCOT 4CP success rate, which is 100%. For the year-end capability and incremental calculations, we scaled the result to the number of thermostats at the end of FY 2019 and to the number of newly installed thermostats throughout FY 2019.

[28] The high temperature threshold is set as 95^{o}F for the event period.

6.3.4 Results

For demand response programs, we present impacts in four ways:

1) Estimated per device kW and kWh savings during summer 2018 DR events.
2) Estimated program impacts during summer 2018 DR events.
3) End-of-year program capability based on program enrollment at the end of FY 2019; this information is useful for planning purposes.
4) End-of-year program capability based on incremental enrollment during FY 2019; this information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

6.3.4.1 Estimated per device kW and kWh savings during summer 2018 DR events

The table below summarizes average per device kW and kWh savings for each category across all summer 2018 DR events:

Table 6-13: Estimated per Device kW and Net kWh Savings during Summer 2018 DR Events

Category	Average kW savings per device	Average Net kWh savings per device per event
Single family pager 33% cycling	0.22	0.24
Single family pager 50% cycling	0.34	0.20
Single family WiFi Whisker Labs cycling	1.12	1.76
Multifamily pager 33% cycling	0.21	0.27
Multifamily WiFi 50% cycling	0.07	0.11
Commercial pager 33% cycling	0.27	0.50
Commercial WiFi Whisker Labs cycling	1.12	1.76

6.3.4.2 Estimated Impacts During Summer 2018 DR Events

During summer 2018, there were 21 events called for thermostats with traditional cycling and 19 events called for Whisker Labs cycling. Both traditional cycling and Whisker Labs cycling thermostats hit all four of the ERCOT 4CP events, with a success rate of 100% program wide. These demand reduction estimates are shown in Figure 6-19. For summer 2018, total kW reduction ranged from 20,822 kW (8/15/2018) to 40,004 kW (7/23/2018). Not all Whisker Labs cycling thermostats were called on 8/16/2018 and 8/17/2018 due to a platform issue.[29]

[29] Only around 40% of thermostats were successfully called on the Whisker Labs platform on 8/16/2018 and 8/17/2018, with the total number of Smart Thermostat devices estimated by the success calling rate.

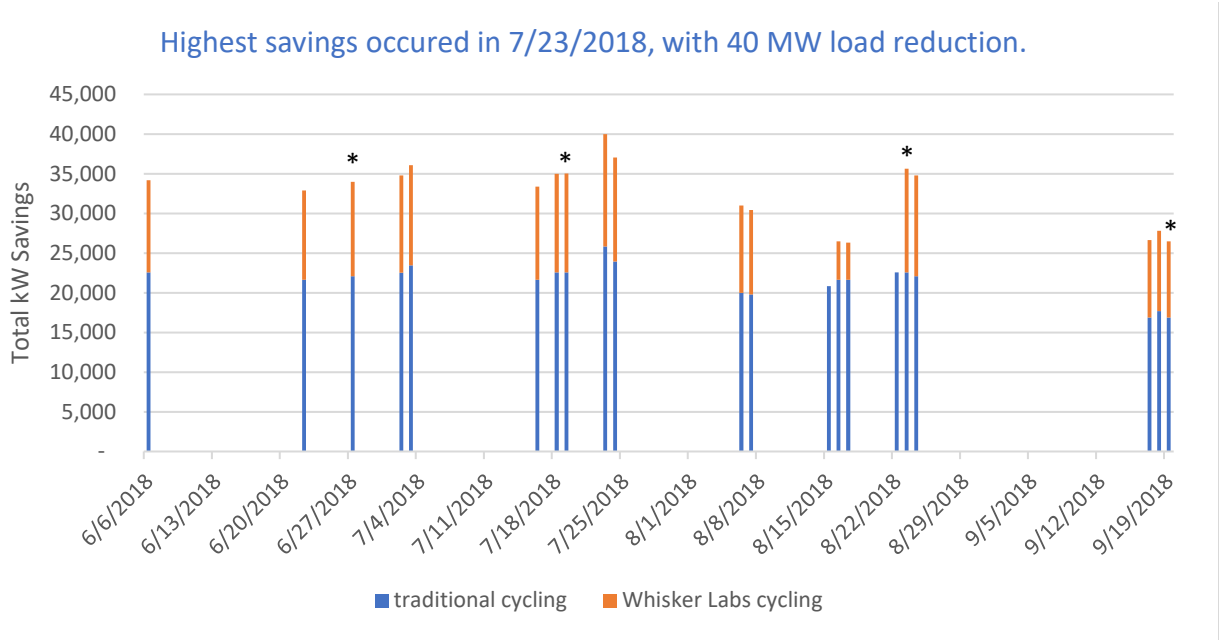


Figure 6-19: Smart Thermostat – Achieved Demand Reduction during Summer 2018 Events

Note: Events coinciding with ERCOT 4CP intervals are designated with an asterisk (*).

Table 6-14 shows estimated energy, peak demand, non-coincident peak demand, and ERCOT 4CP demand savings delivered by the program in FY 2019. Peak demand savings are the average estimated savings across high temperature events. ERCOT 4CP savings are the average estimated savings during ERCOT 4CP events. Non-coincident peak savings are the highest savings achieved during any event. Given the differences in schedule between traditional cycling and Whisker Labs cycling thermostats, Frontier estimates the demand savings delivered by each cycling type individually. Total demand savings are presented as the sum of the demand savings delivered by each type of cycling.

Table 6-14: Smart Thermostat Gross Energy and Demand Savings – FY 2019 Delivered

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Traditional Cycling	468,996	22,219	25,821	21,016
Whisker Labs Cycling	331,266	11,277	14,183	11,763
Total	800,262	33,496	40,004	32,778

6.3.4.3 End-of-year Program Capability

End-of-year program capability is based on end-of-year enrollment. Table 6-15 shows the end of FY 2019 program capability values.

Table 6-15: Smart Thermostat Gross Energy and Demand Savings – End-of-year Capability

Measure	Device Count	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Traditional Cycling	95,455	492,731	22,219	25,872	21,017
Whisker Labs Cycling	10,520	351,176	12,185	14,205	11,541
Total	105,975	843,907	34,404	40,076	32,558

6.3.4.4 Incremental Impacts

For traditional cycling thermostats, incremental impacts used for cost-effectiveness analysis are based on gross incremental enrollment. Both cycling types' results are shown Table 6-16.

Table 6-16: Smart Thermostat Gross Energy and Demand Savings – Incremental Impacts

Measure	Device Count	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Traditional Cycling	1,134	6,997	253	285	242
Whisker Labs Cycling	3,384	112,964	3,920	4,569	3,712
Total	4,518	119,961	4,173	4,855	3,955

6.4 HOME MANAGER PROGRAM

6.4.1 Overview

Launched in 2012, Home Manager is a comprehensive electric load monitoring and direct load control program. This system controls three types of devices: HVAC units, electric water heaters, and pool pumps. When CPS Energy calls an event, all Home Manager thermostats are adjusted upward by three degrees from their pre-event set points. Water heaters and pool pumps are powered off for the duration of the event. Customers can reset their thermostat set points or drop completely out of the event at any time.

In summer 2018, CPS Energy successfully called 8 test events and 14 additional events[30], ranging from one to two hours in duration. Apart from one event on September 1st, 2018 (Saturday), the rest of the events took place on weekdays. By January 31st, 2019, total participation in the Home Manager program was 1,643. The Home Manager population is shrinking as customers are being transitioned to the Nest Direct Installation (DI) program. The transition provides customers a newer technology and mobile app while also enabling CPS Energy to replace the Home Manager meter gateway with an AMI meter. The Home Manager program closed on April 30, 2019. All customers were targeted for transition to Nest Direct Install.

6.4.2 Participation Trends

Figure 6-20 shows the number of participants during each event in the summer of 2018.

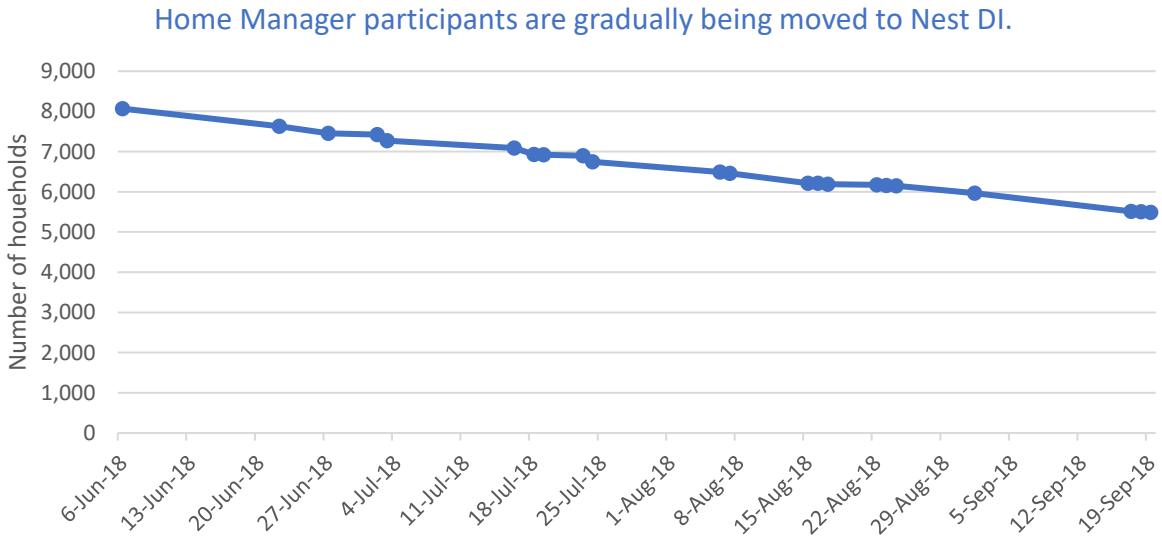


Figure 6-20: Home Manager – Participation Trend

[30] One event was called in 05/15/2018, but this early event was not taken into analysis.

6.4.3 Event kW and kWh Savings Methodology

CPS Energy provided Frontier with overall aggregated interval meter data for the Home Manager program. Frontier produced estimates of total kW and kWh savings and scaled the results to end of the fiscal year participation numbers and new installment numbers to generate EOY program capability and incremental savings.

For weekday events, a "top 3-of-10 baseline" method was applied to estimate kW savings. For the only event that took place on a Saturday (09/01/2018), a "similar day" method was adopted. Both methods can be described with the equation below:

$$kW\ savings = original\ baseline\ kW * adjustment\ factor - event\ kW$$

In the equation above:

Original baseline kW:

- Definition under top 3-of-10 baseline method: for each weekday event, the previous 10 non-event, non-holiday weekdays were ranked based on kW during the event period. The three days with the highest load during the curtailment period were selected and averaged as the original baseline.
- Definition under similar day method: for the Saturday event (09/01/2018), the previous Saturday's load served as the original baseline.

Adjustment factor: The ratio of event day kW versus original baseline day(s) kW during the 2pm – 3pmtime period.[31] This ratio was applied to the original baseline kW, intending to make up for variations caused by weather effects and customer operation levels to some extent.

Event kW: Event day kW during event time period.

Frontier also employed a linear regression model to quantify the kWh savings using 5-minute average energy consumption data per household from the Home Manager program. This model takes temperature and any snapback effect into consideration. Whole summer 5-minute interval kW data was fed into the model. The model equation is stated as follows:

$$5\text{-}minute\text{-}kW\text{-}per\text{-}household_t = \beta_0 + \beta_1 * cdh_t + \sum_{k=2}^{23} \beta_k * event_t + \sum_{l=24}^{45} \beta_l * snapback_t + \beta_{46} * weekday + \sum_{m=47}^{69} \beta_m * hour_t + \sum_{n=70}^{72} \beta_n * month_t + \varepsilon_{i,t}$$

In the equation above:

cdh: cooling degree hours. Balance point is set at 65°F, i.e., cdh = max(hourly temperature – 65°F, 0)

[31] For most of the Home Manager events in summer 2018, unusual load increases were observed starting around 3pm. As a result, the pre-event period after 3pm was skipped and 2pm-3pm was used as an adjustment window period.

event:	a set of 22 dummy variables, 1 if within an event period; 0 otherwise
snapback:	a set of 22 dummy variables, 1 if within a 1-hour post event period; 0 otherwise
weekday:	dummy variable, 1 if within a weekday; 0 if on a weekend
hour:	a set of 23 dummy variables indicating the hour of the day
month:	a set of 3 dummy variables indicating the month

Take the first event (06/06/2018, 16:00 - 17:30) of summer 2018 as an example. -β_2 is the estimate for kW savings per household during the event period (16:00 -17:30). β_{24} is the estimate for kW snapback per household during the 1-hour post event period (17:30 – 18:30). Thus, the net kWh savings per household for this event is -β_2 * 1.5 hours (event duration) – β_{24} * 1 hour (snapback duration). Multiplying net kWh savings by the total number of households on this event yields program level net energy savings.

6.4.3.1 Coincident Peak Demand Savings (kW)

To estimate coincident peak demand kW savings, we estimated program-level total demand savings using top 3-of-10 baseline analysis for each weekday event and similar day analysis for the weekend event. An average kW savings of 19 out of 22 high temperature[32] events in 2018 was then calculated. To estimate program capability based on end-of-year enrollment, we scaled the result to the number of active premises at the end of FY 2019. Since Home Manager customers are gradually migrating to the Nest DI program, there is no new enrollment this year. Therefore, incremental impacts are set to zero.

6.4.3.2 Non-Coincident Peak (NCP) Demand Savings (kW)

To estimate delivered non-coincident peak savings, Frontier estimated program-level total demand savings using either top 3-of-10 baseline analysis or similar day analysis for each event. We then selected the single event with the highest savings. For the year-end capability calculations, we scaled the result to the number of active premises at the end of FY 2019.

6.4.3.3 ERCOT 4CP Demand Savings (kW)

During the summer of 2018, four of the 22 Home Manager events coincided with ERCOT 4CP events, with a success rate of 100%. To estimate ERCOT 4CP demand savings, we estimated program-level per-event kW savings using either top 3-of-10 baseline analysis or similar day analysis, selected the four events which coincided with the ERCOT 4CPs, and multiplied the result by the ERCOT 4CP success rate. For the year-end capability calculations, we scaled the result to the number of active premises at the end of FY 2019.

[32] The high temperature threshold is set at 95°F.

6.4.4 Results

For demand response programs, we present impacts in two ways:

1) Estimated achieved program impacts during DR events called during the summer of 2018.

2) End-of-year program capability based on program enrollment at the end of FY 2019, which is useful for planning purposes.

The incremental impact is set to zero since no new Home Manager participants were added to the program in FY 2019.

6.4.4.1 Estimated Impacts during Summer 2018 DR Events

Per-participant demand reduction achieved through this program during high-temperature events called by CPS Energy averaged 1.20 kW in the summer of 2018. The total impacts of events ranged from 3,500 kW (8/24/2018 event) to 15,116 kW (6/6/2018 event). Four events coincided with the four coincident peak intervals (4CPs) used by ERCOT to allocate transmission costs to load-serving entities. These demand reduction estimates are shown in Figure 6-21.

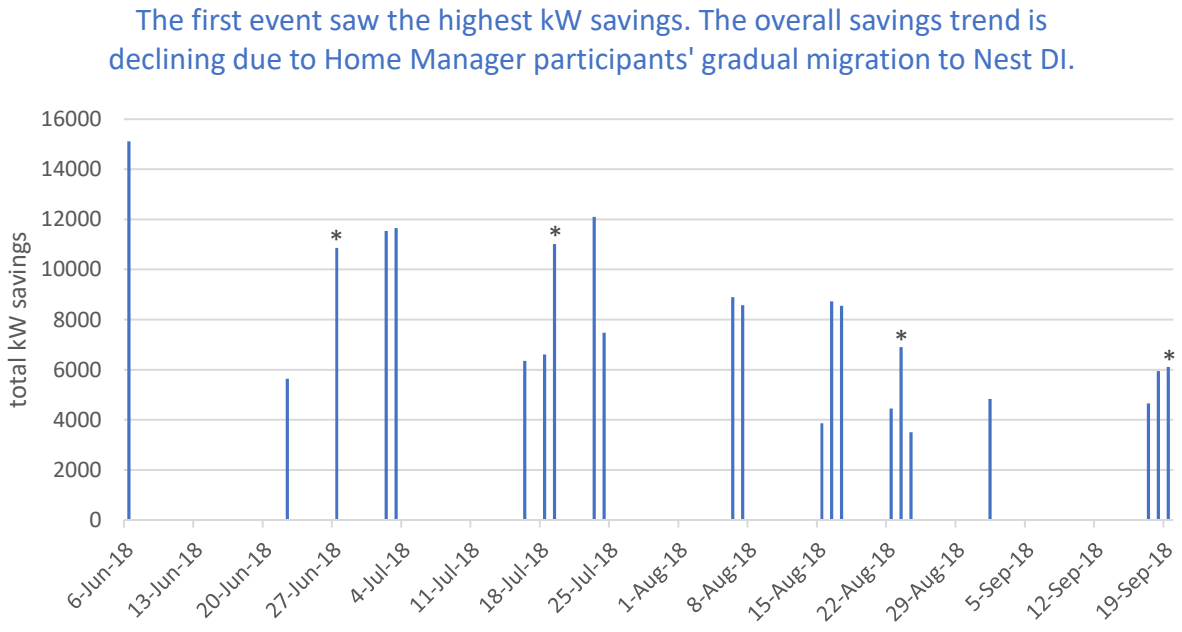


Figure 6-21: Home Manager – Achieved Demand Reduction during Summer 2018 Called Events

Note: Events coinciding with ERCOT 4CP intervals are designated with an asterisk (*).

The per-participant per-event energy savings averaged 1.59 kWh with later snapback of 0.34 kWh. Therefore, net energy savings per-participant per event is 1.25 kWh. Annual achieved total net energy savings for the Home Manager program is estimated at 183,772 kWh.

Table 6-17: Home Manager Gross Energy and Demand Savings – FY 2019 Delivered

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Total	183,772	8,244	15,116	8,724

6.4.4.2 End-of-year Program Capability

By the end of FY 2019, there were 1,643 accounts remaining in the Home Manager program, with the majority of participants having shifted to the Nest DI program. The energy, CP, NCP and 4CP demand savings capabilities for the 1,643 accounts are shown in Table 6-18.

Table 6-18: Home Manager Gross Energy and Demand Savings – End-of-year Capability

Measure	End-of-Year Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Total	1,643	45,267	2,004	3,078	2,204

6.5 BRING YOUR OWN THERMOSTAT (BYOT) PROGRAM

6.5.1 Overview

BYOT (Bring Your Own Thermostat) is a program that integrates customers' own thermostats with load curtailment events. The program began in FY 2015 when CPS Energy partnered with Nest Labs to implement the Rush Hour Rewards (RHR) pilot program for customers with Nest thermostats. Rush Hour Rewards uses a combination of pre-cooling in anticipation of a 'rush hour' – a demand response event initiated by CPS Energy – and air conditioner cycling during the events to achieve load reduction. Because of Nest's 'learning' capabilities, reductions may vary based on whether the home is occupied at the time of the event, or other variables. More information on Nest's Rush Hour Rewards (RHR) program is available from the Nest Labs website.[33]

Starting in FY 2016, CPS Energy began incorporating existing Nest RHR customers into a more broadly defined BYOT program,[34] which offers similar incentives to customers who self-install any of several qualifying thermostats. In FY 2019, Emerson BYOT and Honeywell BYOT migrated to the Whisker Labs platform, which also includes single family and commercial WiFi thermostats in the Smart Thermostat platform. To summarize, the FY 2019 BYOT program included several types of thermostats that operate as follows:

- Nest BYOT thermostats run on the Nest platform;
- Honeywell single family BYOT thermostats run on the Whisker Labs platform with Whisker Labs cycling;
- Emerson BYOT thermostats, also run on the Whisker Labs platform and sharing the same schedule as Honeywell BYOT thermostats; and
- EnergyHub thermostats, which have a schedule of their own.

The key differentiator of BYOT relative to other residential DR programs is that the customer purchases and installs the qualifying thermostat under BYOT, reducing direct install costs otherwise incurred by CPS Energy.

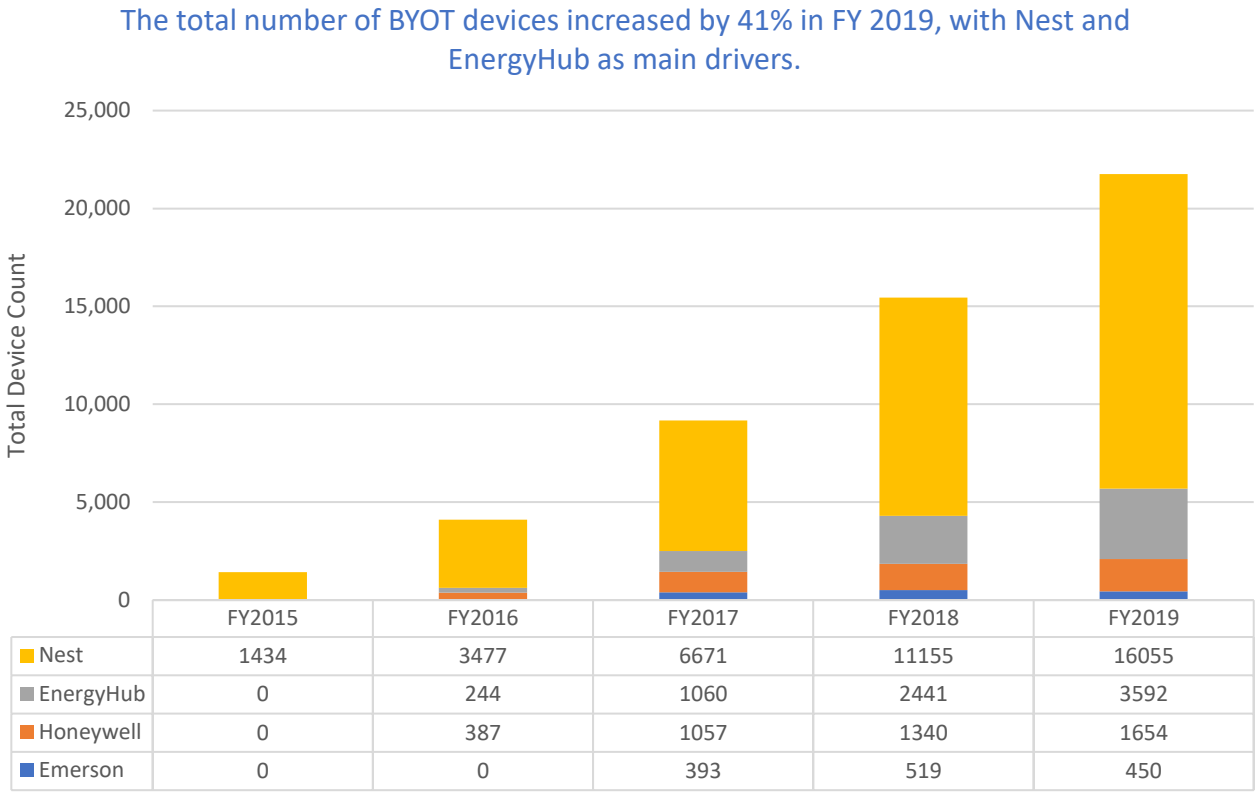
CPS Energy has typically passed these savings on to the customer via a one-time credit (which previously was $85, and in late 2018 increased to $150) upon enrollment in the program. The customer also receives a $30 bill credit at the end of each summer for participating in the program.

[33] Nest Support. *Learn more about Rush Hour Rewards.* Online. Available: https://nest.com/support/article/What-is-Rush-Hour-Rewards.
[34] CPS Energy has marketed this program as the My Thermostat Rewards program, and most recently, WiFi Thermostat Rewards.

6.5.2 Participation Trends & Demographics Information

6.5.2.1 BYOT Program Level Overall Participation Trends

CPS Energy has rapidly expanded its BYOT customer base since the introduction of the program. Figure 6-22 shows the number of enrolled BYOT devices by thermostat brand from FY 2015 to FY 2019.



	FY2015	FY2016	FY2017	FY2018	FY2019
Nest	1434	3477	6671	11155	16055
EnergyHub	0	244	1060	2441	3592
Honeywell	0	387	1057	1340	1654
Emerson	0	0	393	519	450

Figure 6-22: Bring Your Own Thermostat – Participation Trend (FY 2015 – FY 2019)

From the participation trend in Figure 6-22, it can be seen that:

- The total number of BYOT devices increased by 41% in FY 2019 compared with FY 2018.
- In FY 2019, the majority of BYOT thermostats are still Nest, which accounted for 74% of the total program.
- The fastest growing category is EnergyHub, which increased by approximately 47% in FY 2019, from 2,441 to 3,592 devices.

6.5.3 Savings Calculation Method

6.5.3.1 Per Device kW and kWh Savings

For each type of thermostat, Frontier developed deemed savings tables in FY 2017 and FY 2018. Those tables are still considered valid and were used to calculate FY 2019 savings.

Nest Thermostats

In FY 2017, Frontier developed a time temperature matrix (TTM) for Nest customers using per AMI account 15-minute interval data. The TTM serves as an expedited method for estimating kW savings by omitting the steps of calculating savings using raw interval consumption data. The time temperature matrix is shown in Table 6-19.

Table 6-19: BYOT Nest AMI household level TTM

	Apartments per household kW Savings estimate			Single family per household kW Savings estimate		
Temperature(°F)	1st hour	2nd hour	3rd hour	1st hour	2nd hour	3rd hour
88	0.71	0.55	0.39	1.4	0.93	0.65
89	0.74	0.58	0.41	1.46	0.97	0.68
90	0.77	0.6	0.42	1.52	1.01	0.71
91	0.8	0.63	0.44	1.58	1.05	0.74
92	0.83	0.65	0.46	1.64	1.09	0.76
93	0.86	0.67	0.48	1.7	1.13	0.79
94	0.89	0.7	0.49	1.76	1.17	0.82
95	0.92	0.72	0.51	1.83	1.21	0.85
96	0.95	0.75	0.53	1.89	1.25	0.88
97	0.98	0.77	0.54	1.95	1.29	0.9
98	1.01	0.79	0.56	2.01	1.33	0.93
99	1.04	0.82	0.58	2.07	1.37	0.96
100	1.08	0.84	0.59	2.13	1.41	0.99
101	1.11	0.87	0.61	2.19	1.45	1.02
102	1.14	0.89	0.63	2.25	1.49	1.05
103	1.17	0.91	0.65	2.31	1.53	1.07
104	1.2	0.94	0.66	2.37	1.57	1.1
105	1.23	0.96	0.68	2.43	1.61	1.13

The number of Nest devices for apartments and single family are provided for each event in summer 2018. The number of households by each dwelling type is calculated with a device/household ratio of 1.25. Multiplying the number of households of each dwelling type by the savings estimate in the TTM under the corresponding temperature yields estimated total kW savings. It should be noted that the Nest platform reports all Nest thermostats including Nest BYOT and Nest DI as a whole, so the savings contributed by Nest DI during each event were later subtracted, to reflect only Nest BYOT savings.

Take the first event (6/6/2018, 16:00 – 17:30) as an example. There were 2,084 Nest thermostats from apartments and 18,757 from single family on the Nest platform.[35] Savings can be calculated as follows:

- Step 1: Calculate total number of households. Total number of apartments and single family that participated is estimated at 2,084/1.25 = 1,667 and 18,757/1.25 = 15,006 respectively.
- Step 2: Find temperature for each hour of the event. Temperature at 16:00 – 17:00 (1st hour of the event) was 100°F and 101°F at 17:00 – 17:30 (2nd hour of the event).
- Step 3: Look up per household savings in TTM based on temperature. Savings per household in the 1st hour can be found in TTM at 1.08kW for apartments and 2.13kW for single family, 0.87kW and 1.45kW for apartments and single family respectively in the 2nd hour.
- Step 4: For each category, calculate per household kW savings from the event using time-weighted average:
  Per household kW savings for apartment Nests: (1.08 * 1 + 0.87 * 0.5) / 1.5 = 1.01 kW
  Per household kW savings for single family Nests: (2.13 * 1 + 1.45 * 0.5) / 1.5 = 1.90 kW
- Step 5: Calculate total kW savings on Nest platform from the event:
  1.01 kW * 1,667 + 1.90 kW * 15,006 = 30,245 kW

In FY 2016, Frontier employed billing analysis to quantify the electricity and gas savings attributable to installation of a Nest thermostat and enrollment in the Nest RHR program. Frontier's model found that the presence of a Nest thermostat reduced electricity consumption by 51 kWh per household per month, a conservation effect of around 3.2%. We will continue using 51 kWh per household per month as a year-round energy savings estimate.

[35] The device counts in this example include Nest DI, which was subtracted in actual reporting. This example is only for illustrative purposes.

Honeywell Thermostats

Honeywell BYOT thermostats are under Whisker Labs cycling and are incorporated in the Whisker Labs platform along with single family WiFi thermostats in the Smart Thermostat Program. Only the total number of thermostats was available on the Whisker Labs platform for each event; thermostat brands were not distinguished. To estimate Honeywell thermostats in the BYOT program, an average of the start of FY 2019 and end of FY 2019 thermostat counts[36] was used throughout summer 2018.

A temperature bin was designed in FY 2018 with Smart Thermostat single family WiFi thermostats under Whisker Labs cycling, as shown in Table 6-20.

Table 6-20: Temperature Bin Savings per Device for Single Family WiFi Whisker Labs Cycling Thermostats

Temperature(°F)	kW savings/device	Temperature(°F)	kW savings/device
90	0.84	100	1.18
91	0.88	101	1.22
92	0.91	102	1.25
93	0.95	103	1.28
94	0.98	104	1.32
95	1.01	105	1.35
96	1.05	106	1.38
97	1.08	107	1.42
98	1.11	108	1.45
99	1.15	109	1.49
		110	1.52

Pre and Post Event Over-consumption for kWh savings Calculation (unit: kW)	
1-hour precool:	-0.01
1-hour snapback:	0.17

Frontier applied this temperature bin to calculate Honeywell BYOT thermostats savings in FY 2019. The detailed calculation process is explained in Section 0 Smart Thermostat Program.

[36] The start of FY 2019 device count is 1,340 and end of FY 2019 device count is 1,654 for Honeywell BYOT thermostats.

EnergyHub Thermostats

In FY 2018, Frontier developed temperature bin deemed savings for EnergyHub thermostats to expedite the EM&V process in the coming fiscal years.

Table 6-21: Temperature Bin for EnergyHub Thermostats

Temperature (°F)	kW savings per device for EnergyHub
90	1.01
91	1.05
92	1.09
93	1.13
94	1.17
95	1.21
96	1.25
97	1.29
98	1.33
99	1.37
100	1.41
101	1.45
102	1.49
103	1.53
104	1.57
105	1.61
106	1.65
107	1.69
108	1.73
109	1.77
110	1.81
EnergyHub Pre and Post Event Over consumption for kWh savings Calculation (unit: kW))	
precool:	0.34
snapback:	0.89

Frontier considers this temperature bin still valid for the FY 2019 evaluation since there was no substantial change to event cycling for EnergyHub thermostats. Savings per event calculation is illustrated as follows, using the first event (6/6/2018 16:00 – 17:30) as an example:

To calculate kW savings: average temperature during the event period was 100^{o}F, which corresponds to 1.41 kW savings per device in the EnergyHub temperature bin. The total number of thermostats on that day was 2,818, therefore total kW savings is calculated by 2,818 * 1.41 kW = 3,977 kW.

To calculate energy (kWh) savings: 1-hour precool and 1-hour snapback period is taken into consideration, to account for consumption change before and after event period. In this case, precool

and snapback periods are 15:00 – 16:00 and 17:30 – 18:30 respectively. During the 1.5-hour event period, each EnergyHub thermostat saved 1.41 kW * 1.5 hours = 2.12 kWh. Subtracting 0.34 kWh precool and 0.89 kWh snapback over-consumption yields net energy savings of 2.12 – 0.34 – 0.89 = 0.88 kWh per device. Total net energy savings = 0.89 kWh * 2818 = 2,498 kWh.

Savings from other events can be calculated in the same manner.

Emerson Thermostats

The total number of Emerson thermostats also needs to be estimated since they are cycled under the Whisker Labs platform, which did not distinguish device number by type in summer 2018. It is known to us that on 9/29/2018 there were a total of 506 Emerson thermostats, so this number was used as an approximate device count throughout summer 2018.

Similar to EnergyHub and Honeywell BYOT thermostats, a temperature bin matrix was developed in FY 2018, and is available for Emerson thermostat savings calculations:

Table 6-22: Temperature bin for Emerson Thermostats

Temperature (°F)	kW savings per device for Emerson
90	0.53
91	0.55
92	0.57
93	0.59
94	0.61
95	0.63
96	0.66
97	0.68
98	0.70
99	0.72
100	0.74
101	0.76
102	0.78
103	0.80
104	0.82
105	0.85
106	0.87
107	0.89

Temperature (°F)	kW savings per device for Emerson
108	0.91
109	0.93
110	0.95
	Emerson Pre and Post Event Over consumption for kWh savings Calculation (unit: kW))
precool:	-0.11
snapback:	0.42

To calculate savings, the Emerson thermostat temperature bin can be used in the same manner as the EnergyHub temperature bin.

6.5.3.2 Coincident Peak (CP) Demand Savings (kW)

To compute coincident peak (CP) demand savings, the per device demand savings value is multiplied by the total number of devices for each event. The claimed achieved CP demand savings is the average kW savings during high temperature events. In summer 2018, all the events called in September were below the 95^{o}F high temperature threshold, therefore CP kW savings is the average savings during June, July and August. Scaling the average kW savings by the EOY customer count and newly installed customer count yield EOY and incremental CP demand savings.

6.5.3.3 Non-Coincident Peak (NCP) Demand Savings (kW)

Achieved non-coincident peak savings represents the maximum event demand savings among FY 2019 events. End-of-year and incremental estimates of NCP savings were obtained by scaling the delivered NCP by EOY device count and newly installed devices, respectively.

6.5.3.4 ERCOT 4CP Demand Savings (kW)

For all types of thermostats during the summer of 2018, four events coincided with ERCOT 4CP events, with a success rate of 100%. To estimate the 4CP demand savings, we estimated kW savings for each event, selected the events which coincided with the ERCOT 4CPs, and multiplied the result by the ERCOT 4CP success rate. For the year-end capability and incremental calculations, we scaled the result to the number of devices at the end of FY 2019 and to the number devices added during FY 2019.

6.5.4 Results

For BYOT DR programs, we present impacts in four sections:

1) Estimated per device kW and net kWh savings by thermostat type during summer 2018.
2) Estimated program impacts during summer 2018 DR events.
3) End-of-year program capability based on program enrollment at the end of FY 2019.
4) End-of-year program capability based on incremental enrollment during FY 2019. This information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

6.5.4.1 Estimated per device kW and net kWh savings by thermostat brands

Table 6-23 summarizes per device kW and net kWh savings by thermostat brand in the summer 2018 BYOT program.

Table 6-23: Estimate per Device kW and Net kWh Savings by Thermostat Brands

Category	Average kW savings per device	Average net kWh savings per device per event
Nest	1.35	NA
EnergyHub	1.32	0.94
Honeywell	1.12	1.76
Emerson	0.70	0.89

6.5.4.2 Estimated Impacts during Summer 2018 DR Events

Event schedules vary under different platforms. Table 6-24 summarizes the number of events called and the average event duration in summer 2018 for Nest, EnergyHub and the Whisker Labs platform.

Table 6-24: Number of Events Called and Event Duration Summary for BYOT Platforms

Platform Name	Number of Events called	Average Event duration
Nest	15	1.57
EnergyHub	20	1.66
Whisker Labs (includes Honeywell and Emerson thermostats)	19	1.74

BYOT program-level total impacts of FY 2019 events ranged from 3,935 kW (8/15/2018 event) to 25,692 kW (7/23/2018), with the Nest thermostats group contributing most of the kW savings across all events except the event on 7/18/2018.[37] These demand reduction estimates are shown Figure 6-23.

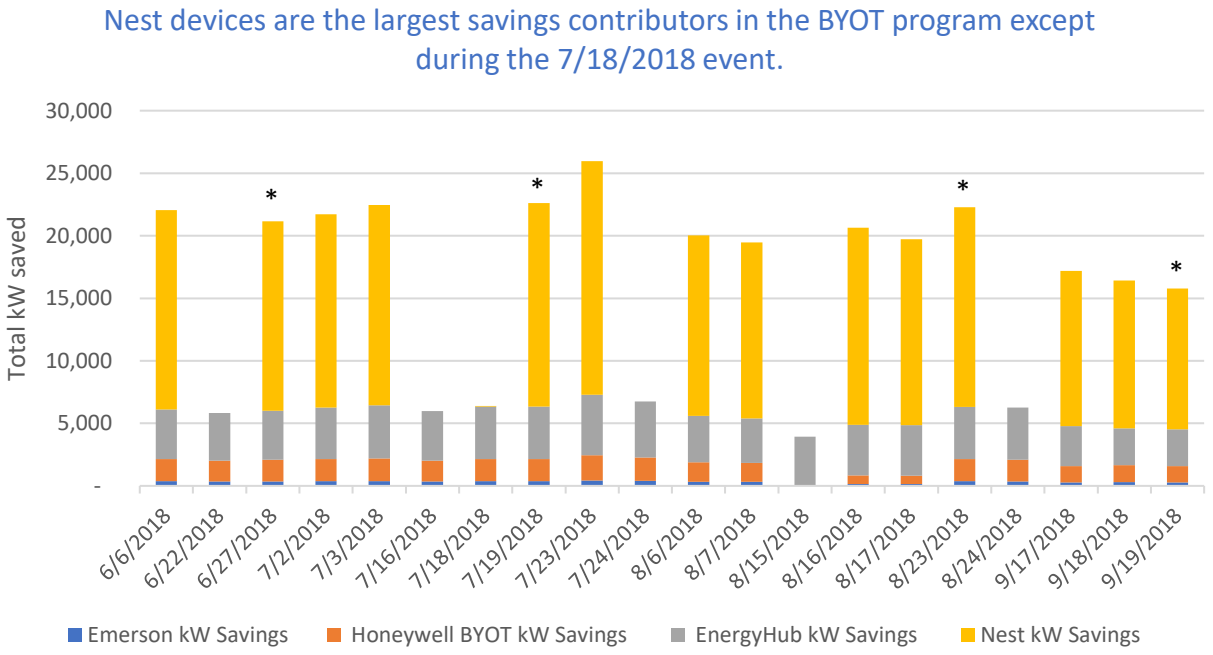


Figure 6-23: Bring Your Own Thermostat – Achieved Demand Reduction during summer 2017 DR Events

Note: Events coinciding with ERCOT 4CP intervals are designated with an asterisk (*).

Table 6-25 shows estimated energy, peak demand, non-coincident peak demand, and ERCOT 4CP demand savings delivered by the program in FY 2019. For each type of thermostat, coincident peak demand savings are the average of estimated savings during high temperature events. ERCOT 4CP savings are the average estimated savings during ERCOT 4CP events, multiplied by success rate. Non-coincident peak savings are the highest savings achieved during any event. Due to variations in schedule and cycling strategy among the different thermostat types, total savings are presented as the sum of the savings delivered by each of the respective programs.

[37] Only 55 Nest thermostats (including Nest DI) were successfully called during 7/18/2018 due to a Nest platform issue.

Table 6-25: BYOT Gross Energy and Demand Savings – FY 2019 Delivered

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Nest[38]	6,895,098	14,384	18,669	14,655
EnergyHub	56,222	4,080	4,843	3,806
Honeywell	46,983	1,610	2,021	1,642
Emerson	8,021	341	428	348
Total	7,006,324	20,415	25,962	20,451

Rows may not sum to total due to rounding.

6.5.4.3 End-of-year Program Capability

End-of-year program capability is based on end-of-year enrollment and is shown in Table 6-26.

Table 6-26: BYOT Gross Energy and Demand Savings – End-of-year Capability

Measure	End-of-year Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Nest	16,055	8,202,024	22,346	26,073	20,865
EnergyHub	3,592	67,852	4,941	5,793	4,591
Honeywell	1,654	55,364	1,916	2,233	1,815
Emerson	450	7,608	326	381	309
Total	21,751	8,332,848	29,529	34,480	27,580

Rows may not sum to total due to rounding.

[38] Achieved Nest BYOT energy savings during FY 2019 is calculated in the following manner: first the average device/household ratio throughout FY 2019 was estimated at 1.21; next the average number of devices throughout FY 2019 is estimated by the average of start-of-year device count and end-of-year device count – (11,155 + 16,055)/2 = 13,605; the third step is to estimate approximate number of households throughout FY 2019 by applying the device/household ratio: 13,605 /1.21 = 11,267. The last step is to multiply annual per household savings by estimated average number of households: 11,267 * 51 kWh/month * 12 months = 6,895,098 kWh. (Numbers may not match exactly due to rounding.)

6.5.4.4 Incremental Impacts

The incremental impacts used in benefit-cost analysis are based on gross incremental enrollment during the program year and are shown in Table 6-27.

Table 6-27: BYOT Gross Energy and Demand Savings – Incremental Impacts

Measure	Gross Incremental Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Nest	5,214	2,614,464	7,257	8,467	6,776
EnergyHub	1,151.0	21,742	1,583	1,856	1,471
Honeywell	213	7,130	247	288	234
Emerson[39]	0	-	-	-	-
Total	6,578	2,643,336	9,087	10,611	8,481

Rows may not sum to total due to rounding.

[39] For Emerson thermostats, End of FY 2019 device count (450) is less than that of start of FY 2019 device count (519). Incremental device number is consequently set as 0.

6.6 NEST DI (DIRECT INSTALL)

6.6.1 Overview

Nest DI (Direct Install) is a program that launched in FY 2018. Starting in early summer 2017, Home Manager customers were gradually migrated to the Nest DI program. CPS Energy offers these customers free Nest(s) and free installation to replace the older Home Manager Consert devices in their homes. After the customers have installed a Nest, they are automatically enrolled in Nest RHR (Rush Hour Rewards) in synchronization with BYOT Nest customers. As with BYOT customers, at the end of each September, a $30 bill credit will also be applied to customers' bills.

6.6.2 Program Participation

By the end of FY 2019, approximately 11,455 households had shifted from the Home Manager program to the Nest DI program, with a total of 15,119 Nest thermostats installed. In FY 2019 alone, there were 10,514 thermostats installed in 7,920 newly participating households. The overall device/household ratio is approximately 1.32 for this program.

Figure 6-24 shows the number of installed devices vs participating homes throughout FY 2019.

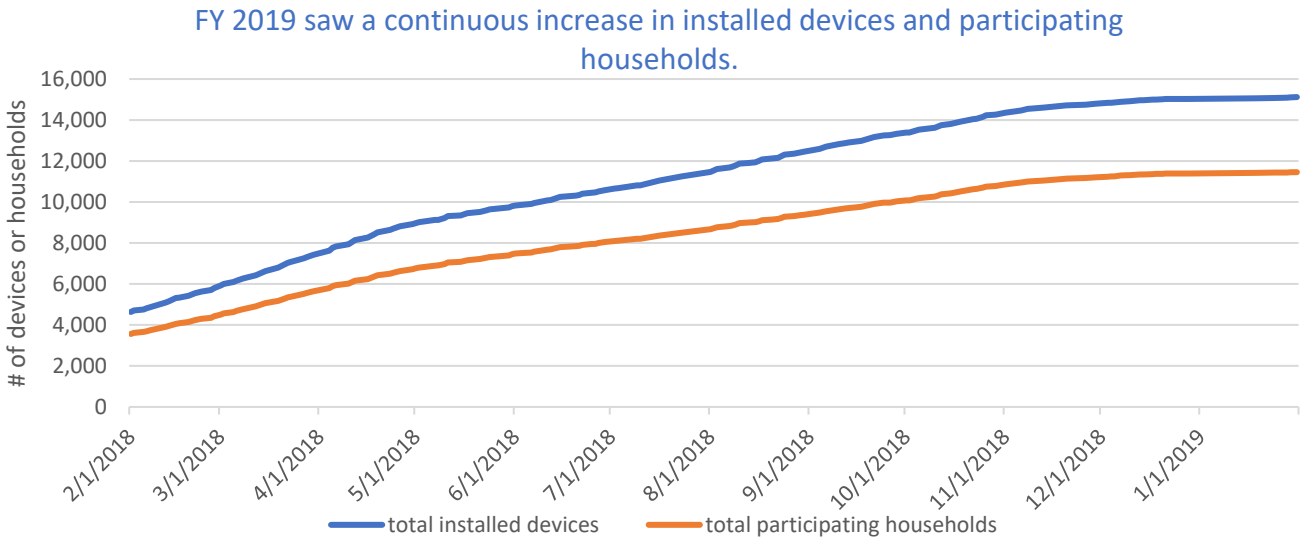


Figure 6-24: Cumulative Device Count vs Household Count for Nest DI in FY 2019

There was a continuous increase in Nest direct installations throughout FY 2019, with the total number of devices increased by 228% and households increased by 224%. The participation trend began to slow down after November 2018, with a final device count of 15,119 and final household count of approximately 11,455.

6.6.3 Savings Calculation Method

6.6.3.1 Per Device kW and kWh Savings

Since Nest DI thermostats are incorporated in the Nest platform along with BYOT Nests, savings from these two programs are calculated all together. Section 0 explained in detail how CP, NCP, 4CP and energy savings are calculated for Nest BYOT; those per device savings will be directly applied to the Nest DI program:

Table 6-28: Nest DI per Device Savings

Category	Savings per device
CP/Average per device kW savings	1.40 kW
NCP per device kW savings	1.62 kW
4CP per device kW savings	1.30 kW
Annual energy (kWh) per household savings	612 kWh[40]

6.6.3.2 Coincident Peak (CP) Demand Savings (kW)

To compute coincident peak (CP) demand savings, the per device demand savings is multiplied by the total number of devices installed by each event. The claimed achieved CP demand savings is the average kW savings during high temperature events. Scaling the average kW savings by the EOY customer count and newly installed customer count yield EOY and incremental CP demand savings.

6.6.3.3 Non-Coincident Peak (NCP) Demand Savings (kW)

Achieved non-coincident peak savings is based on the maximum event demand savings among FY 2019 events. Multiplying the NCP per device demand savings in Table 6-28 by the total number of devices in the summer of 2018 yields the total achieved NCP demand savings value. End-of-year and incremental estimates of NCP savings were obtained by scaling the delivered NCP to the EOY device count and newly installed devices, respectively.

6.6.3.4 ERCOT 4CP Demand Savings (kW)

During the summer of 2018, four of the Nest DI events coincided with ERCOT 4CP events, yielding a 100% success rate in hitting the 4CPs. To estimate ERCOT 4CP demand savings, we estimated the kW savings for each event, selected the events which coincided with the ERCOT 4CPs, and multiplied the result by the ERCOT 4CP success rate. For the year-end capability and incremental calculations, we scaled the result to the number of devices at the end of FY 2019 and to the number of new devices added during FY 2019.

[40] Nest thermostat monthly per household energy savings are estimated at 51 kWh, annual energy savings = 51 * 12 = 612 kWh. EOY device/household ratio is 1.32, therefore EOY per device savings annually is 612 / 1.32 = 464 kWh.

6.6.4 Results

For Nest DI program, we present impacts in three ways:

1) Estimated program impacts during summer 2018 DR events.

2) End-of-year program capability based on program enrollment at the end of FY 2019.

3) End-of-year program capability based on incremental enrollment during FY 2019.
This information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

6.6.4.1 Estimated Impacts During Summer 2018 DR Events

Same as BYOT Nest, 15 events were called in summer 2018 for the Nest DI program. Event impacts ranged from 41 kW (7/18/2018 event)[41] to 17,945 kW (7/23/2018 event). These demand reduction estimates are shown in Figure 6-25.

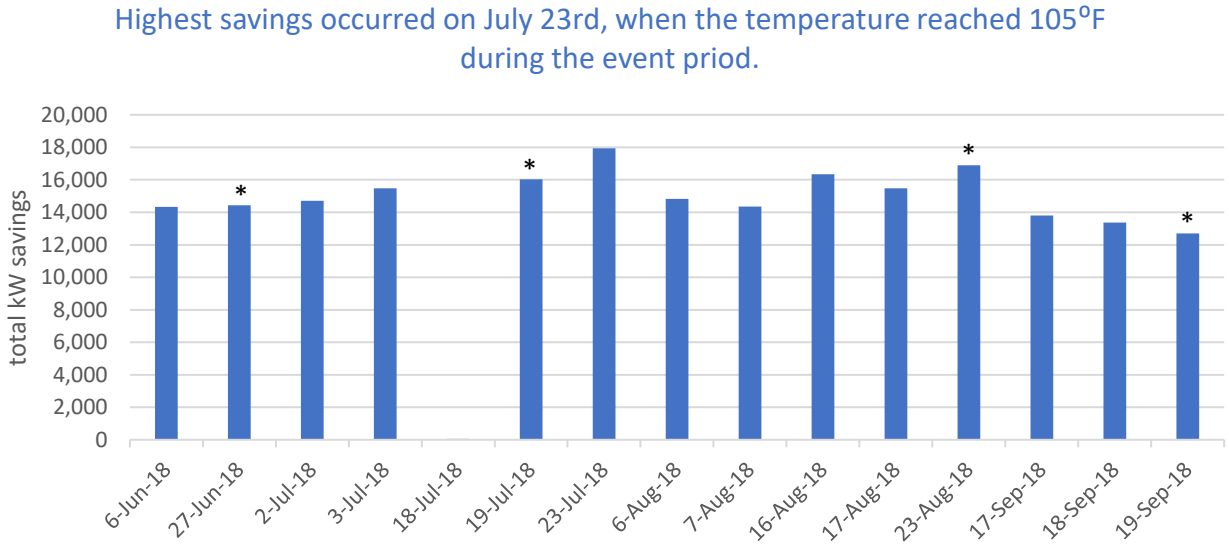


Figure 6-25: Nest DI – Achieved Demand Reduction during Summer 2018 DR Events

Note: Events coinciding with ERCOT 4CP intervals are designated with an asterisk (*).

[41] An issue with NEST deployment occurred during the 7/18/2018 event. Only 55 Nest thermostats were successfully called, including both Nest BYOT and Nest DI. We assume 27 of the 55 thermostats belong to Nest DI, based on the proportion from the previous event (7/3/2018).

Table 6-29 shows estimated energy, peak demand, non-coincident peak demand, and ERCOT 4CP demand savings delivered by the program in FY 2019.

Table 6-29: Nest DI Gross Energy and Demand Savings – FY 2019 Delivered

Measure	Gross Energy Savings (kWh) [42]	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Nest DI	4,586,940	14,239	17,945	15,018

6.6.4.2 End-of-year Program Capability

End-of-year program capability is based on end-of-year enrollment and is shown in Table 6-30.

Table 6-30: Nest DI Gross Energy and Demand Savings – End-of-year Capability

Measure	End-of-year Enrollment	Gross Energy Savings (kWh) [43]	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Nest DI	15,119	7,010,460	21,044	24,553	19,649

6.6.4.3 Incremental Impacts

Incremental impacts used in benefit-cost analysis are based on gross incremental enrollment during the program year. FY 2019 Nest DI incremental savings are shown in Table 6-31.

Table 6-31: Nest DI Gross Energy and Demand Savings – Incremental Impacts

Measure	Gross Incremental Enrollment	Gross Energy Savings (kWh) [44]	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Nest DI	10,514	4,847,040	14,634	17,075	13,664

[42] Achieved energy savings during FY 2019 is calculated in the following manner: first the average device/household ratio throughout FY 2019 was estimated at 1.3152; next the average number of devices throughout FY 2019 is estimated by the average of start-of-year device count and end-of-year device count – (4,596 + 15,119)/2 = 9,858; the third step is to estimate approximate number of households throughout FY 2019 by applying device/household ratio: 9,858/1.3152 = 7,495. Last step is to multiply annual per household savings by estimated average number of households: 7,495 * 612 kWh = 4,586,940 kWh.

[43] By the end of FY 2019, the device/household ratio for Nest DI program is 1.3199. EOY energy savings is therefore calculated as 15,119 / 1.3199 * 612 = 7,010,460 kWh.

[44] In FY 2019 alone, 10,514 new thermostats were installed in 7,920 homes. Incremental energy savings = 612 kWh * 7,920 = 4,847,040 kWh.

6.7 REDUCE MY USE/BEHAVIORAL DEMAND RESPONSE (BDR)

6.7.1 Overview

CPS Energy partnered with Oracle to implement a pilot Behavioral Demand Response (BDR) program for residential customers beginning in summer 2017. This program was implemented as an opt-out randomized controlled trial (RCT). Participating households were all equipped with AMI meters, and did not participate in other CPS Energy DR programs.

Participants receive a welcome letter before the annual program starts. One day before each event, participants receive a notification message through an email and phone call between 11 a.m. and 1 p.m. This notification also contains information explaining what a peak day is and personalized energy conservation tips. After each event, customers receive a follow-up call. Also, personalized customer performance feedback is also provided to participants within three days after the event. In summer 2018, only single family participants were selected in BDR program.

Throughout summer 2017, only one event was successfully called. However, in summer 2018, 11 events were called, each lasting from 3:00pm to 6:00pm.

6.7.2 Program Participation

Participation in FY 2019 is a combination of participants enrolled in summer 2017 (the 2017 “wave”) and in summer 2018 (the 2018 “wave”). Table 6-32 summarizes the number of participating households by treatment or control group and different “waves”:

Table 6-32: Number of Participating Households by Group and Wave in FY 2019

	Treatment Group # of Households	Control Group # of Households
2017 Wave	102,989	23,080
2018 Wave	18,919	5,411
Total	121,908	28,491

In summer 2018, there were 18,919 additional households who participated in the BDR program, comprising 16% of the total treatment group; 5,411 households were newly included in control group, accounting for 19% of the total control group.

6.7.3 Savings Calculation Method

6.7.3.1 Per Household kW and kWh Savings

CPS Energy provided Frontier with aggregated 15-minute interval AMI meter level data from 06/01/2018 to 09/30/2018 for all participants by group and wave. Simple difference methodology was adopted to calculate savings.

For each event, kW savings per household is simply the average household consumption difference between treatment and control group during 3pm – 6pm event period, and the difference is calculated by each wave separately.

Energy (kWh) savings per household is calculated based on the following rationale: participants were notified of most of the events between 11 a.m. and 1 p.m. the previous day, so it is likely that participants took conservation actions in advance of the start (3 p.m.) of each of the events. To calculate energy savings, we assume that treatment group participants start taking conservation actions as early at 9am on event day. In other words, the energy savings is the consumption difference between treatment and control group during event period (3pm – 6pm) and pre-event period (9am – 3pm) combined.

Take the first event (6/22/2018) as an example. Load per household by group, wave and time period is tabulated below:

Table 6-33: Average Consumption by Group, Wave and Time Period for 6/22/2018 BDR Event

	Event period (3pm – 6pm) (kW per household)		Pre-event period (9am – 3pm) (kW per household)	
	Treatment Group	Control Group	Treatment Group	Control Group
2017 Wave	4.30	4.32	2.92	2.95
2018 Wave	4.97	5.02	3.51	3.54

For the 6/22/2018 event, per household kW savings for 2017 wave is estimated at 4.32 – 4.30 = 0.02 kW; kW savings for 2018 wave = 5.02 – 4.97 = 0.05 kW. Combining the two waves of kW savings together yields 0.02 kW * 102,989 + 0.05 kW * 18,919 = 2,880 kW. Energy savings during the event period is calculated as 2,880 kW * 3 hours = 8,639 kWh.[45]

[45] Results may not sum to total due to rounding.

kW savings during the pre-event period can be calculated in the same manner:

(2.95 kW – 2.92 kW) * 102,989 + (3.54 kW – 3.51 kW) * 18,919 = 3,377 kW

Energy savings during the pre-event period is calculated as 3,377 kW * 6 = 20,262 kWh.

Total energy savings for the 6/22/2018 event is the savings combination of pre-event period and event period: 8,639 + 20,262 = 28,901 kWh.[46]

Savings from other events can be calculated in the same manner.

6.7.3.2 Coincident Peak (CP) Demand Savings (kW)

Coincident peak (CP) demand savings is estimated by the average kW savings across all high temperature events. Since participants are recruited each year, the EOY and incremental savings are identical to the FY 2019 achieved savings.

6.7.3.3 Non-Coincident Peak (NCP) Demand Savings (kW)

Achieved non-coincident peak savings represent the maximum event demand savings among FY 2019 events. Similar to coincident peak (CP) savings, EOY and incremental NCP savings are equivalent to achieved maximum savings in FY 2019.

6.7.3.4 ERCOT 4CP Demand Savings (kW)

During the summer of 2018, three of the BDR events coincided with ERCOT 4CP events, with a rate of success in hitting the event of 75%. To estimate ERCOT 4CP demand savings, we estimated kW savings for each event, selected the events that coincided with ERCOT 4CP, and multiplied the result by the ERCOT 4CP success rate. Year-end capability and incremental calculations are also the same as achieved 4CP savings.

[46] Results may not sum to total due to rounding.

6.7.4 Results

For the BDR program, we present impacts in three ways:

1) Estimated program impacts during summer 2018 DR events.

2) End-of-year program capability based on program enrollment at the end of FY 2019.

3) End-of-year program capability based on incremental enrollment during FY 2019. This information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

6.7.4.1 Estimated Impacts During Summer 2017 DR Events

There were 11 events called in summer 2018 for the BDR program. Event impacts ranged from 2,880 kW (6/22/2018 event) to 11,322 kW (7/19/2018 event). These demand reduction estimates are shown in Figure 6-26.

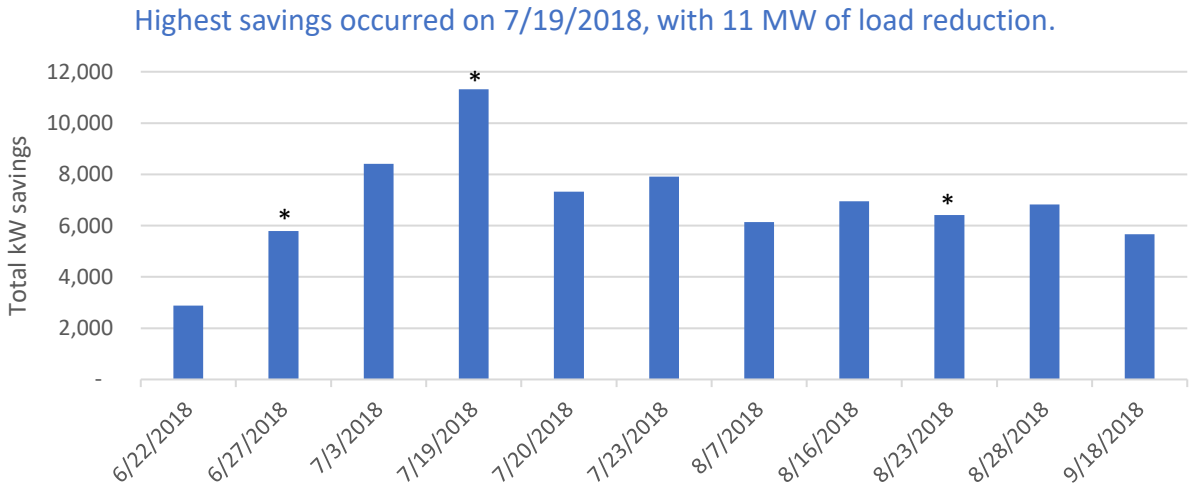


Figure 6-26: FY 2019 BDR kW Reduction by Event

Note: Events coinciding with ERCOT 4CP intervals are designated with an asterisk (*).

The table below shows estimated energy, peak demand, non-coincident peak demand, and ERCOT 4CP demand savings delivered by the program in FY 2019.

Table 6-34: Reduce My Use (BDR) Program Energy and Demand Savings – FY 2019 Delivered

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	ERCOT 4CP Demand Reduction (kW)
Total	518,620	6,996	11,322	5,880

6.7.4.2 End-of-year Program Capability

End-of-year program capability is based on end-of-year enrollment and is shown in the Table 6-35. These values are the same as the achieved savings.

Table 6-35: Reduce My Use (BDR) Program Energy and Demand Savings – End of FY 2019

Measure	End-of-year Enrollment	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	ERCOT 4CP Demand Reduction (kW)
Total	121,908	518,620	6,996	11,322	5,880

6.7.4.3 Incremental Impacts

Incremental impacts used in benefit-cost analysis are based on gross incremental enrollment during the program year. In this case, incremental impacts are the same as the achieved and EOY impacts.

Table 6-36: Reduce My Use (BDR) Program Energy and Demand Savings – Incremental Impacts

Measure	Gross Incremental Enrollment	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	ERCOT 4CP Demand Reduction (kW)
Total	121,908	518,620	6,996	11,322	5,880

6.8 DEMAND RESPONSE PROGRAM RECOMMENDATIONS

6.8.1 Commercial and Auto Demand Response Programs

Although the algorithms in the "multiple-baselining" method can cover most load pattern situations, there may still be a need to manually inspect load data in rare situations. In the future, this algorithm can be improved by adding a feature to export load data for events and accounts with irregular load profiles for manual investigation.

6.8.2 Smart Thermostat Program

Frontier provides the following recommendations for the Smart Thermostat program:

- Whisker Labs cycling contributes the majority of the saving increases. Consider shifting multifamily WiFi thermostats to Whisker Labs cycling as well.
- To improve accuracy of savings estimates, a full EM&V analysis should be conducted for commercial WiFi thermostats with Whisker Labs cycling.

6.8.3 Bring Your Own Thermostat (BYOT) Program

Frontier provides the following recommendations for the BYOT program:

- Several different brands of thermostats are running on Whisker Labs platform currently. In FY 2019, we received the total number of thermostats on the platform as a whole, not a count by brand. Different brands of thermostats may have different cycling strategies, and we recommend reporting separate device counts by each brand in the future.
- The device/household ratio for Nest thermostats may need to be re-evaluated next year.
- There may be a need to investigate whether the Emerson thermostat cycling feature has changed after migrating to the Whisker Labs platform.
- The 51 kWh monthly energy savings per Nest household was estimated in FY 2016. This deemed savings value might need to be revisited in the future.

6.8.4 Reduce My Use/Behavioral Demand Response (BDR)

Though parsimonious and straight-forward, the simple difference method might have the following limitations:

- The characteristics of the groups could change a little from the time they are originally selected until the time of an event.
- It is not clear whether the control group has a demand level similar to the participant group under "event conditions" – i.e., hot summer afternoons.

Before adopting the simple difference method in FY 2019, Frontier also tried some other means of analysis, which could yield different savings results. Considering the limitations above, we recommend investigating further into the consumption data and arriving at a common methodology over the next year.

7. SOLAR ENERGY PROGRAMS

7.1 SUMMARY OF SOLAR ENERGY IMPACTS

CPS Energy offered the following solar energy programs in FY 2019:

- Solar Rebate – Residential – offers incentives for the installation of solar photovoltaic systems.
- Solar Initiative – Commercial – offers incentives for the installation of solar photovoltaic systems.
- SolarHost SA – CPS Energy contracts with developers to install solar PV systems on residential and commercial rooftops. CPS Energy pays the developer a contracted price for energy generated from the systems, and in addition credits host customers for the use of their rooftops.
- Roofless Solar – For customers who cannot or do not wish to install solar on their own property, the Roofless Solar program presents a means to purchase a share in a larger "community" solar installation elsewhere and see the benefits monthly on their electric bill.

The contribution of each solar energy program to peak demand, non-coincident peak demand, and energy savings are shown in Figure 7-1, Figure 7-2, and Figure 7-3. Note that for Roofless Solar, costs and savings were credited in the FY 2017 evaluation. No additional generation was added to the program in FY 2019, and therefore no incremental savings are evaluated in this report.

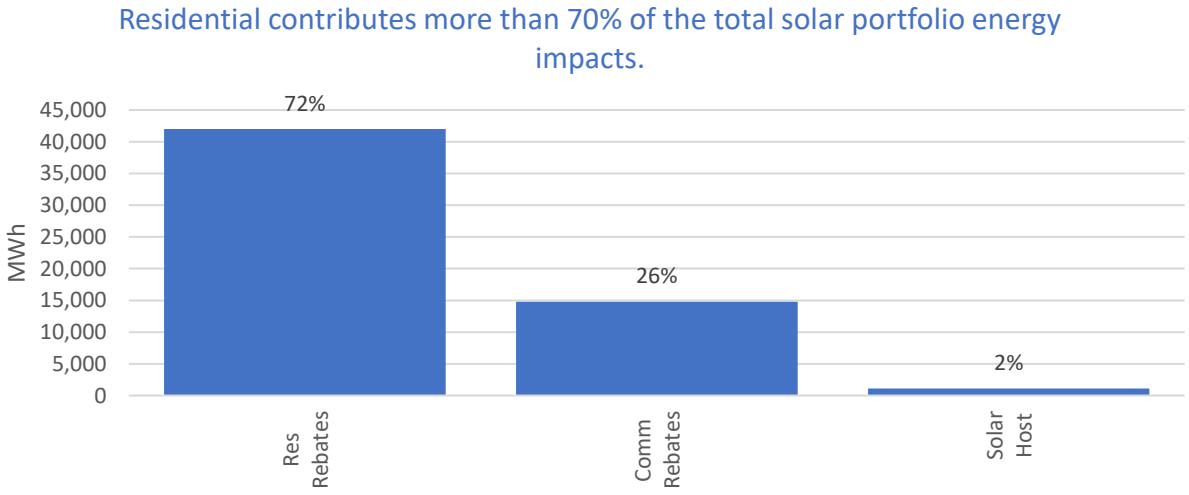


Figure 7-1: Summary of Solar Energy Impacts – Energy (kWh) by Program

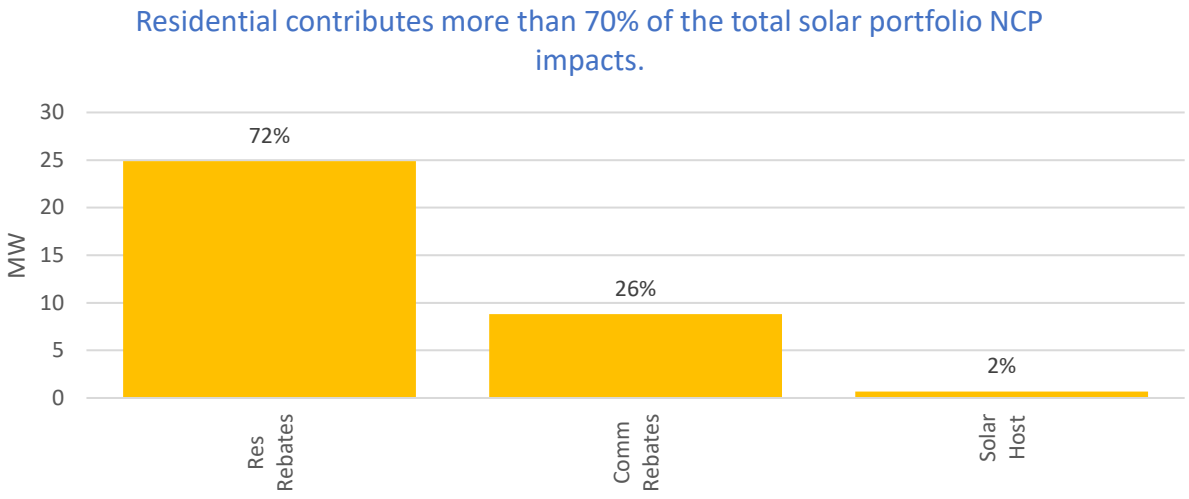


Figure 7-2: Summary of Solar Energy Impacts – Non-Coincident Peak Demand (kW) by Program

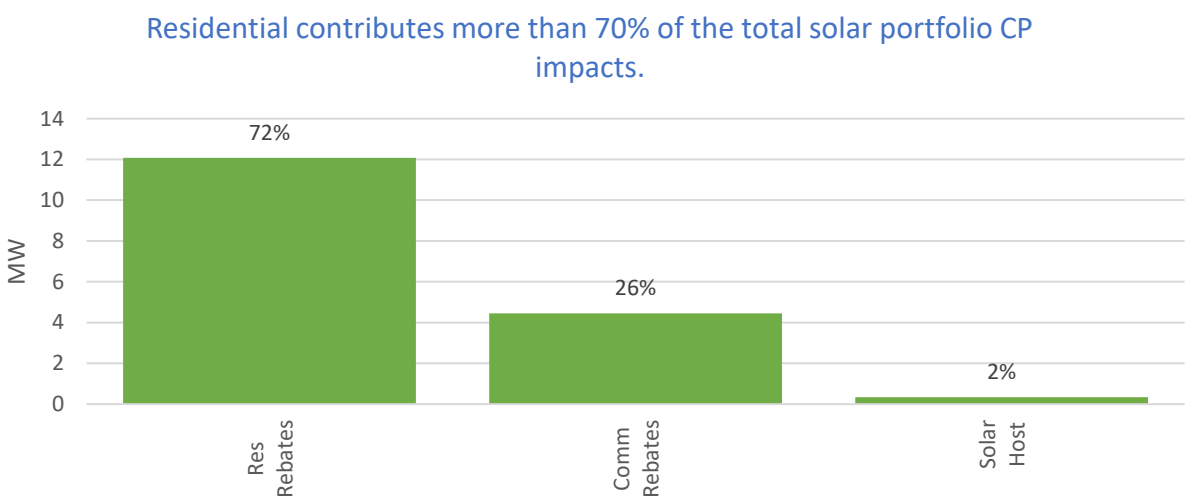


Figure 7-3: Summary of Solar Energy Impacts – Peak Demand (kW) by Program

7.2 SOLAR INITIATIVE – RESIDENTIAL PROGRAM

7.2.1 Overview

CPS Energy has offered rebates for residential solar photovoltaic (PV) systems for over 12 years. At the beginning of FY 2019, the base rebate was $0.60/Wac with an additional $0.10/Wac for systems that use locally-manufactured components ($0.08/Wac premium for local modules and $0.02/Wac premium for local inverters). Residential projects were limited to $25,000 or 50% of project cost. Rebates for non-local installers were 75% of the local installer rebate amount, starting at $0.45/Wac.

In December 2018, CPS Energy announced a transition of the residential and commercial rebate programs to a new rebate design and allocated an additional $15 million to the program. The first $9 million would pay a flat rebate of $2,500 per project, plus $500 for locally-produced panels. The next $5 million would pay a flat rebate of $1,500 per project, plus $500 for locally-produced panels. These flat rebates would apply to both residential and commercial systems.[47] All solar projects completed during FY 2019, however, were completed under the previous rebate design.

All residential solar PV systems are required to be installed by a CPS Energy-registered contractor. Rebates are not available for leased equipment.

Throughout FY 2019, solar projects were rebated based on the applicable rebate tier at the time of application. During FY 2019, some solar rebates were paid at higher rebate levels; these were projects that applied for and were approved for solar rebates at earlier dates. Table 7-1 presents a summary of the number and capacity of residential solar projects at various rebate levels paid during FY 2019.

Table 7-1: Residential Solar Rebates in FY 2019

Rebate Level $/Wac	# of Projects	Capacity (kWdc)	Rebated Amount
$0.45	10	103	$38,988
$0.55	10	79	$36,223
$0.60	1,920	15,845	$8,485,129
$0.68	312	2,691	$1,554,486
$0.70	1,150	9,702	$6,205,841
$1.00	1	9	$7,775
Total	3,403	28,430	$16,328,442

Columns may not sum to total due to rounding.

All systems are required to be interconnected to the CPS Energy distribution system on the customer's side of the meter. Net metering is available to systems less than 25 kW per CPS Energy's E5 Tariff.

[47] See https://www.cpsenergy.com/en/my-home/savenow/rebates-rebate/solar-photovoltaic-rebate/comm-solar-rebate-incentive-tiers.html, accessed 5/7/2019.

Systems must be permitted, pass all required inspections, and comply with CPS Energy's requirements for interconnection.

In FY 2019 there were 3,403 residential solar PV systems installed through the program, totaling 28,430 kWdc and $16.3 million in rebates distributed. The average residential solar PV system size was 8.35 kWdc. The figure below summarizes the residential solar PV program history in terms of capacity installed, average installed system prices and average rebate levels annually.

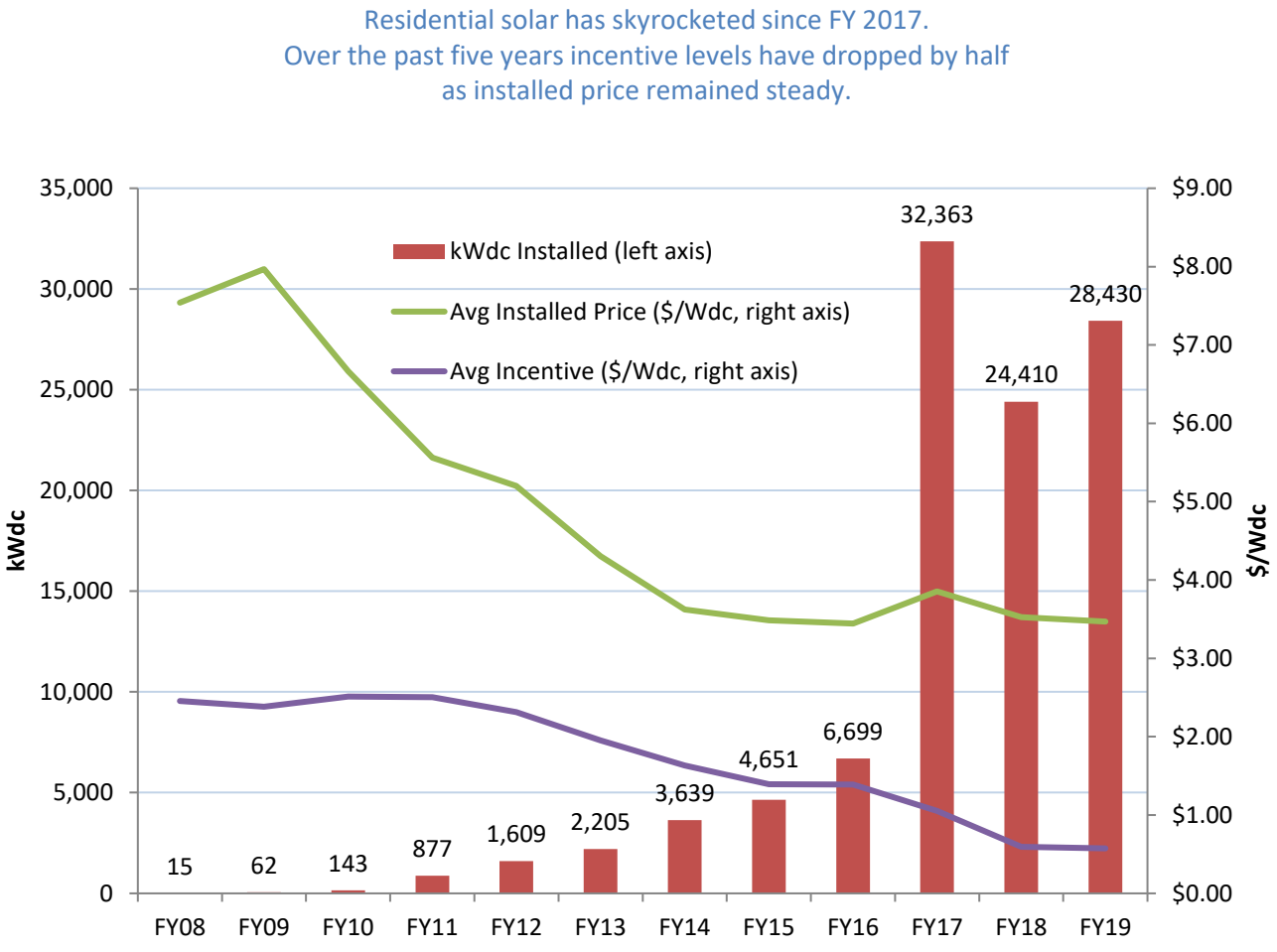


Figure 7-4: Residential Solar PV Program History – Annual Capacity Installed, Average System Price, and Average Rebate Levels

7.2.2 Savings Calculation Methods

The following subsections describe Frontier's approach to estimating savings for residential PV installations.

7.2.2.1 Energy Savings (kWh)

Energy savings estimates were generated via a deemed savings methodology as described in the *CPS Energy Guidebook* provided by Frontier Energy. The method assumes an average production index of 1,402 kWh per kWdc installed among a variety of residential PV systems at various tilts and orientations.

The method is based on modeling the annual energy production from a representative fleet of residential PV systems using the National Renewable Energy Laboratory's (NREL) PVWatts Version 5 (released in November 2014) and Typical Meteorological Year Version 3 (TMY3) weather data from the San Antonio Kelly Field Air Force Base (Kelly AFB) station.[48] The representative fleet was constructed from a weighted average of seven different array tilt and orientation combinations, with weightings conforming to expected residential distributions and producing an annual energy production estimate that was consistent with the sum of production estimates for individual systems produced by CPS Energy and stored in the CPS Energy program database.

7.2.2.2 Coincident Peak (CP) Demand Savings (kW)

Frontier's approach to estimating peak demand savings utilizes a deemed savings factor of 0.39 kW of coincident peak savings per kWdc installed and is described in the *CPS Energy Guidebook*.

The *CPS Energy Guidebook* methodology utilizes a probabilistic analysis based on modeled system performance during the 20 highest probability summer peak hours. The approach relates actual historical weather data, day-of-week, and time-of-day variables to ERCOT zonal peak conditions and applies those historical relationships to TMY3 hourly weather data to estimate the hours in a TMY data file most likely to coincide with hours of high demand in ERCOT's CPS Energy zone. Estimates of CPS Energy's residential PV fleet energy production were derived using PVWatts, and hours associated with high demand in the TMY data were identified. Finally, Frontier calculated a probability-weighted estimate of PV production during those peak hours.

7.2.2.3 Non-Coincident Peak (NCP) Demand Savings (kW)

Non-coincident demand savings represent the maximum kW produced by the modeled representative fleet of residential PV systems in any hour. The *CPS Energy Guidebook* presents a deemed value of 0.804 kW of NCP savings per kWdc installed.

[48] Frontier examined PV production as modeled using three different San Antonio TMY3 data sources and used Kelly AFB to be consistent with the probabilistic analysis for Demand Savings. Annual energy production estimates generated by PVWatts Version 5 have been demonstrated to more closely match measured system performance data, and Version 5 addresses concerns that PVWatts Version 1 tended to under-predict PV system performance given the default input assumptions. See http://pvwatts.nrel.gov/version_5.php for more information.

7.2.2.4 ERCOT 4CP Demand Savings (kW)

The ERCOT 4CP demand savings estimate represents the average estimated demand savings produced by the modeled representative fleet of residential PV systems during ERCOT 4CP intervals. The *CPS Energy Guidebook* presents a deemed value of 0.351 kW of ERCOT 4CP savings per kWdc installed.

7.2.3 Results

The gross energy and demand savings for the Residential Solar Initiative are presented in Table 7-2.

Table 7-2: Residential Solar Initiative Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	ERCOT 4CP Demand Savings (kW)
Residential Solar PV	39,858,397	11,088	22,857	9,979

During FY 2019, Frontier conducted desk reviews of 56 residential rebate files to confirm consistency of key data in the files and in the CPS Energy solar program database. Reported capacity installed matched filed data in every case, and Frontier found just three cases where Frontier's rebate calculation did not match CPS Energy's. In each of these cases, the variance in rebate amount was trivial.

CPS Energy's reported estimated annual energy production and demand savings metrics varied more widely compared to Frontier's, in part due to:

- Differences between the methodologies used by CPS Energy and Frontier (CPS Energy's program has developed several different metrics and methods organically since its inception in response to various in-house requests; these do not align with the metrics and methods used by Frontier for evaluating savings);
- Inconsistency in the method used by CPS Energy for estimating annual energy production; and,
- A lack of clear data in the database capturing systems with multiple arrays at various tilts and orientation (CPS Energy is currently making progress in capturing such data more accurately in the database going forward).

Together, these differences have little effect on program implementation and are easily accounted for during the evaluation process. The desk review process did not uncover any issues that necessitate updates to administrative processing or energy or demand savings methodologies. The key baseline metric of installed system capacity – kWdc – and the method for determining it, are shared, and all of Frontier's savings estimations are derived from this key baseline metric.

7.3 SOLAR INITIATIVE – COMMERCIAL AND SCHOOLS PROGRAM

7.3.1 Overview

CPS Energy has been offering rebates for solar photovoltaic (PV) systems installed on commercial and school buildings for more than 12 years. At the beginning of FY 2019, the base commercial rebate was $0.60/Wac with an additional $0.10/Wac for systems that use locally-manufactured components ($0.08/Wac for local modules and $0.02/Wac for local inverters). Commercial and school projects were limited to $80,000 or 50% of project cost. Rebates for non-local installers were limited to 75% of the local installer rebate amount, starting at $0.45 per ac watt.

In December 2018, CPS Energy added $1 million in commercial incentives at $0.60/Wac, plus an additional $0.10/Wac for locally-produced panels, to serve existing commercial program demand. At the same time, CPS Energy announced a transition of the residential and commercial rebate programs to a new rebate design and allocated an additional $15 million to the programs. The first $9 million would pay a flat rebate of $2,500 per project, plus $500 for locally-produced panels. The next $5 million would pay a flat rebate of $1,500 per project, plus $500 for locally-produced panels. These flat rebates would apply to both residential and commercial systems. All solar projects completed during FY 2019, however, were completed under the previous rebate design.

Throughout FY 2019, solar projects were rebated based on the applicable rebate tier at the time of application. During FY 2019, some solar rebates were paid at higher rebate levels; these were projects that applied for and were approved for solar rebates at earlier dates. Table 7-3 presents a summary of the number and capacity of commercial and school solar projects at various rebate levels awarded during FY 2019.

Table 7-3: Commercial and School Solar Rebates in FY 2019

Rebate Level $/Wac	# of Projects	Capacity (kWdc)	Rebated Amount
$0.45	21	7,100	$1,521,454
$0.60	22	1,600	$672,491
$0.68	5	195	$118,176
$0.70	3	124	$76,484
$0.80	1	119	$79,700
$1.00	1	82	$79,684
$1.20	2	924	$159,400
Total	55	10,143	$2,707,389

Columns may not sum to total due to rounding.

All systems are required to be interconnected to the CPS Energy distribution system on the customer's side of the meter. Systems must be permitted, pass all required inspections, and comply with CPS Energy's requirements for interconnection.

In FY 2019, there were 55 commercial and school solar PV systems installed through the program, totaling 10,143 kWdc and $2.7 million in rebates distributed. The average commercial/school solar PV system size was 184 kWdc. The figure below summarizes the commercial/school solar PV program history in terms of capacity installed, average system prices and rebate levels annually.

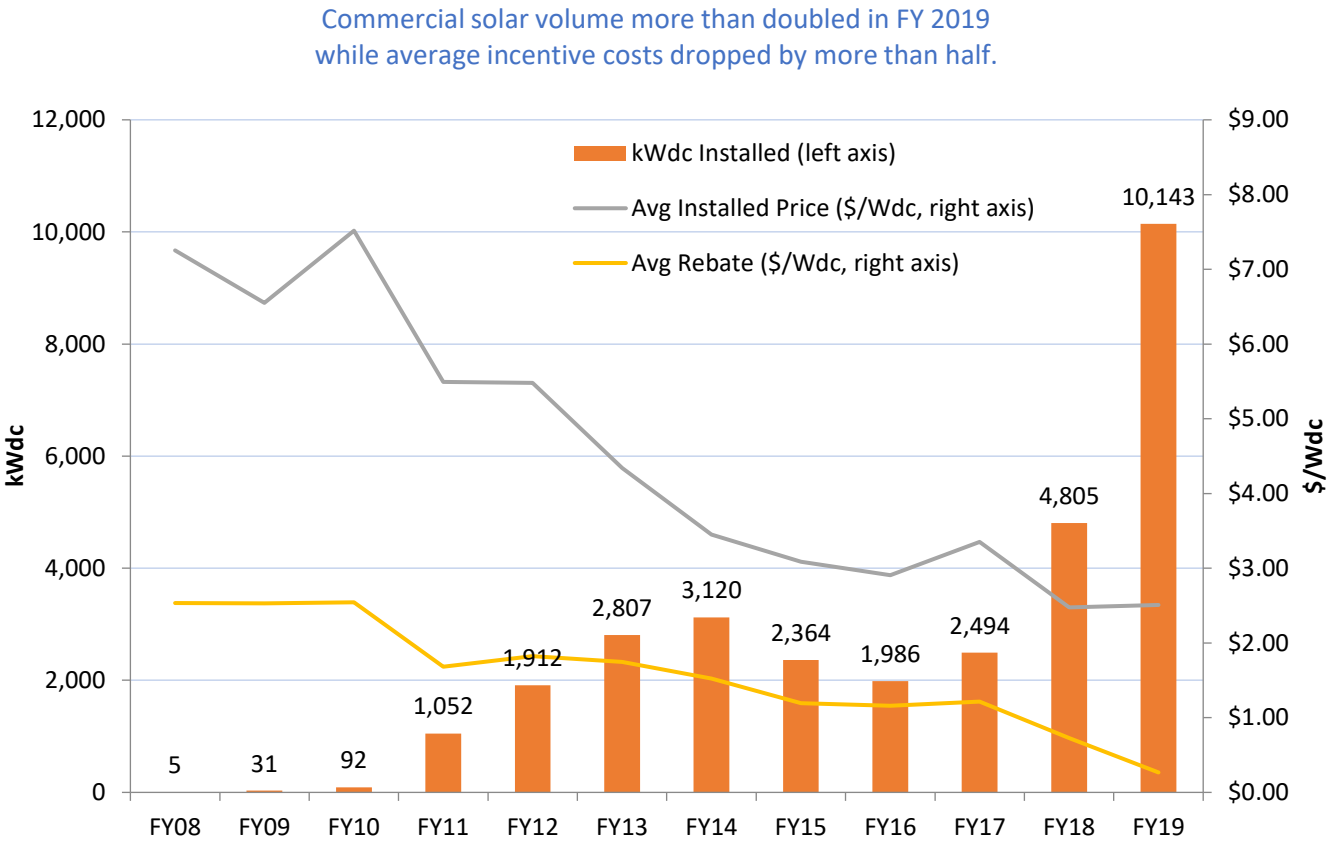


Figure 7-5: Solar Initiative – Commercial and Schools Program History: Annual Capacity Installed, Average System Price, and Average Rebate Levels

7.3.2 Savings Calculation Method

The following subsections describe Frontier's approach to estimating savings for commercial and school PV installations.

7.3.2.1 Energy Savings (kWh)

Energy savings estimates were generated via a deemed savings methodology as described in the *CPS Energy Guidebook* provided by Frontier Energy. The method assumes an average production index of 1,385 kWh per kWdc installed among a variety of commercial and school PV systems at various tilts and orientations.

The method is based on modeling the annual energy production from a representative fleet of commercial/school PV systems using the National Renewable Energy Laboratory's (NREL) PVWatts Version 5 (released in November 2014) and Typical Meteorological Year Version 3 (TMY3) weather data from the San Antonio Kelly Field Air Force Base (Kelly AFB) station.[49] The representative fleet was constructed from a weighted average of seven different array tilt and orientation combinations, with weightings conforming to expected commercial/school distributions and producing an annual energy production estimate that was consistent with the sum of production estimates for individual systems produced by CPS Energy and stored in the CPS Energy program database.

7.3.2.2 Coincident Peak (CP) Demand Savings (kW)

Frontier's approach to estimating peak demand savings utilizes a deemed savings factor of 0.403 kW of coincident peak savings per kWdc installed and is described in the *CPS Energy Guidebook*.

The *CPS Energy Guidebook* methodology utilizes a probabilistic analysis based on modeled system performance during the 20 highest probability summer peak hours. In essence, the approach relates actual historical weather data, day-of-week, and time-of-day variables to ERCOT zonal peak conditions and applies those historical relationships to TMY3 hourly weather data to estimate the hours in a TMY data file most likely to coincide with hours of high demand in ERCOT's CPS Energy zone. Estimates of CPS Energy's commercial PV fleet energy production were derived using PVWatts, and hours associated with high demand in the TMY data were identified. Finally, Frontier calculated a probability-weighted estimate of PV production during those peak hours.

7.3.2.3 Non-Coincident Peak (NCP) Demand Savings (kW)

Non-coincident demand savings represent the maximum kW produced by the modeled representative fleet of commercial PV systems installed in any hour. *CPS Energy Guidebook* presents a deemed value of 0.797 kW of NCP savings per kWdc installed.

[49] Frontier examined PV production as modeled using three different San Antonio TMY3 data sources and used Kelly AFB to be consistent with the probabilistic analysis for Demand Savings. Annual energy production estimates generated by PVWatts Version 5 have been demonstrated to more closely match measured system performance data, and Version 5 addresses concerns that PVWatts Version 1 tended to under-predict PV system performance given the default input assumptions. See http://pvwatts.nrel.gov/version_5.php for more information.

7.3.2.4 ERCOT 4CP Demand Savings (kW)

The ERCOT 4CP demand savings estimate represents the average estimated demand savings produced by the modeled representative fleet of commercial PV systems installed during ERCOT 4CP intervals. The *CPS Energy Guidebook* presents a deemed value of 0.351 kW of ERCOT 4CP savings per kWdc installed.

7.3.3 Results

The gross energy and demand savings for the Commercial and Schools Solar Initiative are presented below.

Table 7-4: Solar Initiative – Commercial & Schools Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	ERCOT 4CP Demand Savings (kW)
Commercial & Schools Solar PV	14,047,390	4,087	8,084	3,560

During FY 2019, Frontier conducted desk reviews of 29 commercial rebate files to confirm consistency of key data in the files and in the CPS Energy solar program database. Reported capacity installed matched database entries in all but one case, and Frontier's rebate calculation matched CPS Energy's in all but two cases. In one instance, the variance in calculated rebate amount was over $4,000.

CPS Energy's reported estimated annual energy production and demand savings metrics varied more widely compared to Frontier's, in part due to:

- Differences between the methodologies used by CPS Energy and Frontier (CPS Energy's program has developed several different metrics and methods organically since its inception in response to various in-house requests; these do not align with the metrics and methods used by Frontier for evaluating savings);
- Inconsistency in the method used by CPS Energy for estimating annual energy production; and,
- A lack of clear data in the database capturing systems with multiple arrays at various tilts and orientation (CPS Energy is currently making progress in capturing such data more accurately in the database going forward).

Together, these differences have little effect on program implementation and are easily accounted for during the evaluation process. The desk review process did not uncover any issues that necessitate updates to administrative processing or energy or demand savings methodologies.

Frontier further conducted onsite reviews of nine commercial systems and observed installed equipment consistent with that reported in every case.

7.4 SOLARHOSTSA PROGRAM

7.4.1 Overview

Under SolarHostSA, CPS Energy contracted with a developer to install solar PV systems on residential and commercial rooftops within CPS Energy's service area. Unlike typical customer-owned residential and commercial PV systems, which are interconnected on the customer's side of the utility meter and reduce a customer's metered demand and energy consumption, these systems inject energy directly into the CPS Energy distribution system. CPS Energy pays the developer a contracted price for energy generated from the systems, and in addition credits host customers $0.03/kWh generated for the use of their rooftops for this purpose.

The SolarHostSA program thus works as a long-term generation contract for solar energy that is produced locally, on the distribution system. An advantage of the program design is that it enables customers who otherwise could not afford to make an investment in solar PV the opportunity to host such generators and to earn financial rewards for doing so. All installed systems are directly metered by CPS Energy.

By the end of FY 2019, the SolarHostSA program had resulted in the installation of 5,911 kWdc of solar capacity on 599 local rooftops, including additions of 775 kWdc at seven commercial rooftops in FY 2019. The figure below shows the cumulative capacity of installations over the installation period. Production is contracted over a 20 year period.

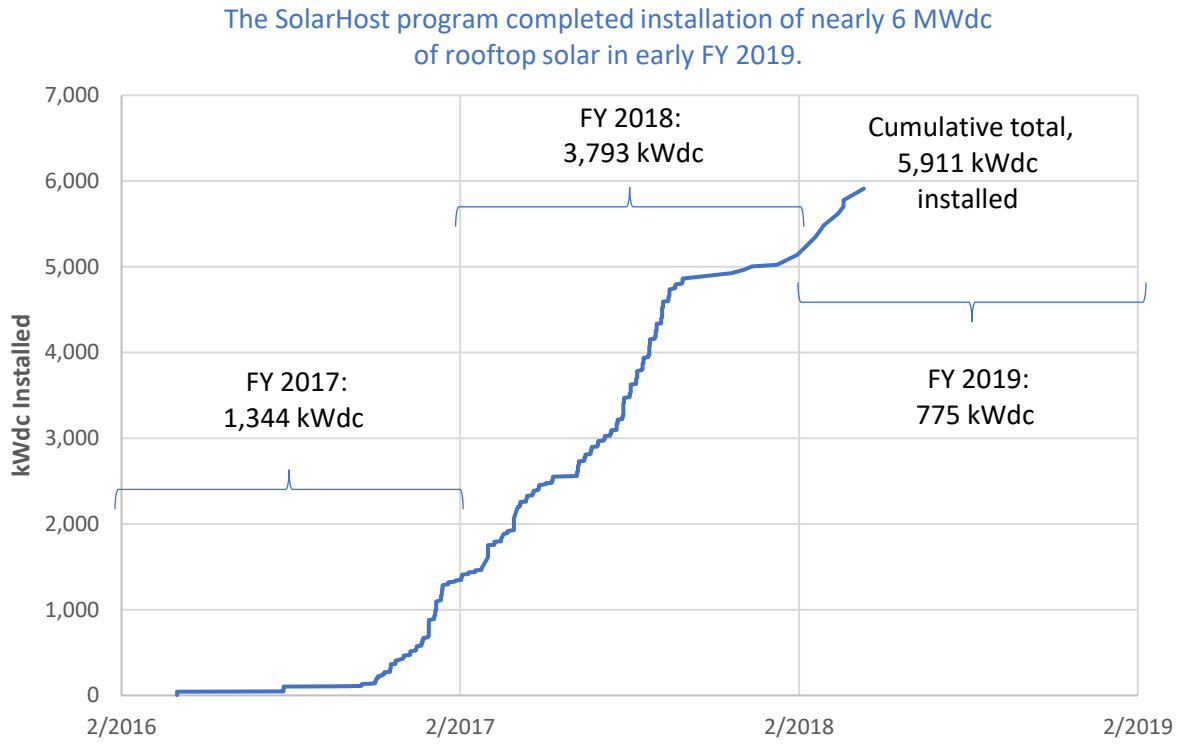


Figure 7-6: SolarHostSA Program – Cumulative Capacity Installed by Fiscal Year

7.4.2 Savings Calculation Methods

These subsections describe Frontier's approach to estimating savings for SolarHostSA PV installations.

7.4.2.1 Energy Savings (kWh)

All systems installed via the SolarHostSA program in FY 2019 were hosted by residential and commercial customers on residential and commercial rooftops. Energy savings estimates were therefore generated via the residential and commercial solar deemed savings methodology as described in the *CPS Energy Guidebook* provided by Frontier. The method assumes an average production index of 1,402 kWh per kWdc installed for residential, and 1,385 kWh per kWdc installed for commercial, assuming a distribution of PV systems at various tilts and orientations.

7.4.2.2 Coincident Peak (CP) Demand Savings (kW)

Frontier's approach to estimating peak demand savings utilizes a residential solar deemed savings factor of 0.39 kW, and a commercial deemed savings factor of 0.403, of coincident peak savings per kWdc installed and is described in the *CPS Energy Guidebook*.

7.4.2.3 Non-Coincident Peak (NCP) Demand Savings (kW)

Non-coincident demand savings represent the maximum kW produced by the modeled representative fleet of PV systems installed in FY 2019 in any hour. The *CPS Energy Guidebook* presents a deemed value of 0.804 kW of NCP savings per kWdc installed for residential solar systems, and a deemed value of 0.797 kW of NCP savings per kWdc installed for commercial solar systems.

7.4.2.4 ERCOT 4CP Demand Savings (kW)

The ERCOT 4CP demand savings estimate represents the average estimated demand savings produced by the modeled representative fleet of residential PV systems installed in FY 2019 during ERCOT 4CP intervals from 2011-2015. The *CPS Energy Guidebook* presents a deemed value of 0.351 kW of ERCOT 4CP savings per kWdc installed for residential and commercial solar systems.

7.4.3 Results

The gross energy and demand savings for the FY 2019 incremental additions to the SolarHostSA program are presented in Table 7-5. These represent the estimated annual energy and demand savings that would have been produced had all systems installed during FY 2019 been operational throughout the fiscal year, which is consistent with how savings are estimated for all energy efficiency programs.

Table 7-5: SolarHostSA Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	ERCOT 4CP Demand Savings (kW)
SolarHost SA	1,073,583	312	618	272

7.5 ROOFLESS SOLAR PROGRAM

For customers who cannot or do not wish to install solar on their own property, the Roofless Solar program presents a means to purchase a share in a larger "community" solar installation elsewhere and see the benefits monthly on their electric bill.

In FY 2017, CPS Energy contracted with a developer to build a 1,212.6 kWdc single-axis tracking solar photovoltaic system at a site southeast of the San Antonio urban core. CPS Energy provided the developer with a solar rebate designed to be roughly equivalent to those offered in the residential and commercial solar rebate programs. The developer, in turn, passed these rebates on to customers who purchased shares of the community solar system.

The community solar system became commercially operational on August 26, 2016, with 245 CPS Energy customers owning shares. CPS Energy monitors production from the community system and offers bill credits to participating customers. The bill credit is designed to approximate the value customers would have received had the generation occurred behind the customer's meter, less 15% held in escrow to pay for operations and maintenance on the community solar system.

Costs and savings for this program were credited in the FY 2017 evaluation. No additional generation was added to the program in FY 2019, and therefore no incremental savings are evaluated in this report.

7.6 SOLAR ENERGY PROGRAM RECOMMENDATIONS

Frontier's recommendations pertaining to continued solar rebate programs, for both residential and commercial are:

- Changing to a flat rebate design presents an opportunity to streamline paperwork and recordkeeping processes associated with the program.
- CPS Energy should perform field inspections of larger installations and for a randomly-selected sample of smaller installations to ensure accuracy of submitted data.
- The accuracy of energy savings estimates could be enhanced over time with access to meter data, including data from both solar meters and customer revenue meters.

8. TOTAL IMPACTS AND COST-EFFECTIVENESS

8.1 NET PROGRAM IMPACTS & COST-EFFECTIVENESS

Program impacts presented in the Residential Energy Efficiency, Commercial Energy Efficiency, Demand Response, and Solar Energy sections of this report are gross program impacts (measured at the customer's meter) without any adjustments for distribution losses or Net-to-Gross (NTG) adjustments.

The net program energy savings values shown here and in the executive summary were derived by converting the program-level gross energy savings at the meter to savings at the source using a CPS Energy-provided energy loss factor equal to 5.08%. The net program capacity savings values were derived by converting the program-level gross capacity savings at the meter to savings at the source using a CPS Energy-provided capacity loss factor equal to 8.15%.

The gross energy and capacity savings were further adjusted using the NTG values seen in the below table. These values were provided by CPS Energy and based on previous evaluations, except for the Weatherization program. Based on Frontier experience and industry standards used in Texas, a 100% NTG factor was used for this program.

Overall, CPS Energy's Energy Efficiency, Demand Response, and Solar portfolio produced positive net benefits. Frontier also calculated the three following economic metrics, in-line with previous evaluations:

1. Cost of Saved Energy (includes DR) ($/kWh) = $0.0363/kWh
2. Reduction in Revenue Requirements (includes DR) = $137,921,517
3. Benefit-Cost Ratio = 2.68

The net program impacts and results of the benefit-cost tests are provided in Table 8-1.

Table 8-1: FY 2019 Net Portfolio Impacts and Cost-Effectiveness

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Net Present Value of Avoided Cost Benefits	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio
Weatherization Program										
Weatherization	100%	13,463,844	5,516	15,749	5,264	$16,903,900	$16,566,801	$1,886,917	$18,453,718	0.86
Energy Efficiency Programs										
Residential HVAC	95%	15,697,173	6,826	6,901	5,800	$17,250,024	$3,949,136	$145,785	$4,094,921	4.21
Home Efficiency	93%	2,903,160	1,018	2,283	990	$3,308,543	$1,059,219	$38,451	$1,097,670	3.01
New Home Construction	100%	1,584,930	967	1,362	1,111	$2,979,181	$1,952,173	$75,089	$2,027,262	1.47
Retail Channel Partnerships	77%	5,061,832	508	2,515	795	$3,281,491	$1,194,821	$34,389	$1,229,210	2.67
Energy Savings Through Schools	95%	1,184,254	71	412	84	$409,409	$289,987	$8,346	$298,333	1.37
Home Energy Assessments	84%	2,267,904	2016	1,058	328	$1,211,535	$1,338,810	$56,186	$1,394,996	0.87
Multi-Family	92%	153,548	16	73	24	$86,738	$105,499	$4,729	$110,228	0.79
Cool Roof	100%	31,348	27	55	36	$60,170	$15,109	$6,493	$21,602	2.79
Residential Subtotal		28,884,149	9,648	14,658	9,170	$28,587,091	$9,904,754	$369,468	$10,274,222	2.78

Table continues on next page.

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Net Present Value of Avoided Cost Benefits	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio
Energy Efficiency Programs (cont.)										
C&I Solutions	96%	44,870,338	7,467	10,921	7,297	$25,034,137	$6,713,486	$285,382	$6,998,867	3.58
Schools & Institutions	96%	9,748,345	3,372	3,919	2,871	$6,850,596	$2,966,322	$124,573	$3,090,894	2.22
Small Business Solutions	85%	27,988,174	5,199	6,808	5,210	$14,011,492	$3,206,468	$129,739	$3,336,207	4.20
Whole Building Optimization	96%	14,185,675	1,946	2,009	1,741	$1,789,771	$1,877,322	$76,408	$1,953,730	0.92
Commercial Streetlights	96%	1,309,113	25	316	29	$480,937	$350,679	$12,875	$363,554	1.32
Commercial Subtotal		98,101,646	18,009	23,973	17,148	$48,166,933	$15,114,278	$628,977	$15,743,253	3.06
Energy Efficiency Subtotal		126,985,794	27,657	38,631	26,318	$76,754,024	$25,019,032	$998,445	$26,017,475	2.95
Demand Response Programs										
Smart Thermostat	100%	918,788	37,457	43,632	35,447	$5,303,592	$3,077,518	$102,706	$3,180,223	3.59
Reduce My Use (Behavioral DR)	100%	564,638	7,617	12,327	6,402	$1,082,806	$419,000	$11,458	$430,458	2.52
Nest DI	100%	7,632,510	22,911	26,732	21,197	$20,642,110	$3,890,848	$115,664	$4,006,512	3.18
BYOT	100%	9,072,235	32,895	37,539	30,027	$12,634,919	$1,572,783	$48,300	$1,621,083	5.67
Home Manager*	100%	49,284	2,182	3,351	2,400	$0	$560,775	$54,066	$614,841	0.00
C&I DR	100%	2,658,296	79,216	96,152	77,128	$11,408,351	$4,910,195	$189,998	$5,100,193	2.26
Auto DR	100%	122,441	3,987	5,835	3,347	$545,309	$212,435	$7,183	$219,618	3.07
Demand Response** Subtotal		21,018,191	186,944	225,567	175,946	$51,617,087	$14,643,553	$529,375	$15,172,927	3.13

Table continues on next page.

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Net Present Value of Avoided Cost Benefits	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio
Renewable Energy Programs										
Res. Solar Rebates	100%	41,991,569	12,072	24,885	10,864	$52,113,750	$15,118,988	$655,569	$15,774,557	3.30
Comm. Solar Rebates	100%	14,799,189	4,450	8,801	3,876	$18,719,618	$2,744,191	$118,987	$2,863,178	6.54
Roofless Solar	100%	0	0	0	0	$0	$0	$18,040	$18,040	0.00
Solar Host SA***	100%	1,131,040	340	673	296	$1,113,036	$0	$0	$0	0.97
Solar Energy Subtotal		57,921,797	16,862	34,359	15,037	$71,946,404	$17,863,179	$792,596	$18,655,775	3.63
Grand Total		219,389,627	235,553	314,307	222,565	$216,221,415	$74,092,565	$4,207,333	$78,299,895	2.68

* Home Manager did not have any incremental participation. Therefore, no PACT score is calculated. Savings and costs reported are for end-of-year participation.

**The PACT for Demand Response Programs is calculated based on the net present value of avoided cost benefits divided by the net present value of program costs *attributable to new, incremental participants during the program year.* Because total program costs in the table represent the costs attributable to all participants, the PACT for Demand Response Programs cannot be directly calculated from data presented in the table. Demand response program net energy and demand savings (in lighter shade) represent end-of-year program capability, based on end-of-year enrollment.

*** In calculating the PACT for the SolarHostSA Pilot program, Frontier considered all energy purchases and bill credits paid to host site customers as part of the program costs. This differs from CPS Energy's accounting, which shows $0 in rebates paid to customers. Thus, the PACT for the SolarHostSA Pilot program cannot be directly calculated from the data presented in the table.

Additional table notes: Net savings = Gross savings * Net to Gross ratio / (1 – line loss factor). Rows may not sum to total due to rounding.

8.2 EMISSIONS REDUCTION

Emission reductions are based on annual energy savings, those attributable to the gross number of new participants in each program in the current year. Emission factors were provided by CPS Energy.

Table 8-2: FY 2019 Emissions Reduction Impacts by Program (lbs.)

Program	CO_2	NO_x	SO_2	TSP
Weatherization	14,783,301	7,001	13,733	539
Residential HVAC	17,235,495	8,163	16,011	628
Home Efficiency	3,187,669	1,510	2,961	116
New Home Construction	1,740,254	824	1,617	63
Retail Channel Partnerships	5,557,892	2,632	5,163	202
Energy Savings Through Schools	1,300,311	616	1,208	47
Home Energy Assessments	2,490,158	1,179	2,313	91
Multi-Family	168,596	80	157	6
Cool Roof	34,421	16	32	1
Residential Subtotal	31,714,796	15,020	29,462	1,155
C&I Solutions	49,267,631	23,333	45,768	1,795
Schools & Institutions	10,703,683	5,069	9,943	390
Small Business Solutions	30,731,015	14,554	28,548	1,120
Whole Building Optimization	15,575,871	7,377	14,469	567
Legacy Projects	1,437,406	681	1,335	52
Commercial Subtotal	107,715,607	51,013	100,064	3,924
Smart Thermostat	1,008,829	478	937	37
Reduce My Use (Behavioral DR)	619,973	294	576	23
Nest DI	8,380,495	3,969	7,785	305
BYOT	9,961,314	4,718	9,254	363
Home Manager	54,113	26	50	2
C&I DR	2,918,809	1,382	2,711	106
Auto DR	134,440	64	125	5
Demand Response Subtotal	23,077,974	10,929	21,439	841
Res. Solar Rebates	46,106,742	21,836	42,831	1,680
Comm. Solar Rebates	16,249,509	7,696	15,095	592
Roofless Solar	-	-	-	-
Solar Host SA	1,241,881	588	1,154	45
Solar Energy Subtotal	63,598,133	30,119	59,080	2,317
Grand Total	240,889,811	114,083	223,777	8,776

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