Evaluation, Measurement, and Verification of CPS Energy's FY 2022 DSM Portfolio

May 27, 2022

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1. EXECUTIVE SUMMARY

CPS Energy's Save for Tomorrow Energy Plan (STEP) is an initiative that aimed to save 771 MW of electricity from 2009 to 2020. Fiscal Year (FY) 2020 marked the final year counted toward the 771 MW target. Based on the successful completion of the original STEP goal, and to allow CPS Energy time to complete the development of a new long-term energy efficiency and conservation plan, the City of San Antonio authorized the extension of STEP through July 31, 2022. CPS Energy retained Frontier Energy ("Frontier") to conduct a comprehensive and independent evaluation, measurement and verification (EM&V) of demand side management (DSM) programs for this extension year in FY 2022.

This report encompasses all STEP-funded DSM program activity accounted for by CPS Energy within FY 2022, which ran from February 1, 2021 through January 31, 2022. It 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 2022 DSM programs on an annualized basis. Additionally, the evaluation team reviewed program expenditures to calculate program cost-effectiveness and recommended enhancements to program design and implementation for CPS Energy's consideration.

1.1 SPECIAL CONSIDERATIONS FOR COVID-19 IN FY 2022

Fiscal Year 2022 built upon recent trends in program design and implementation, but program performance and this evaluation were affected by the coronavirus disease 2019 (COVID-19). While greatly reduced compared to FY 2021, lingering effects limiting a return to business-as-usual operations were still experienced throughout FY 2022. For example, implementers, service providers and Frontier's evaluation team experienced fewer restrictions to entering homes and facilities to identify savings opportunities and install energy efficiency measures. At the same time, supply chain disruptions affected installation timelines for a variety of measures. This context should be considered when evaluating longer term program trends.

1.2 SPECIAL CONSIDERATIONS FOR VENDOR TRANSITION IN FY 2022

Residential energy efficiency programs continue to be managed by an implementation vendor, except for the Cool Roof program, which is fully managed internally by CPS Energy staff. In August 2021, CPS Energy transitioned to a new residential implementation vendor, and budgets shifted to support prioritized programs, including the Residential HVAC, Home Efficiency and New Home Construction programs.

The Residential Home Energy Assessments and Retail Partners programs saw no participation for the duration of FY 2022. The Energy Savings Through Schools program only saw participation prior to the vendor transition.

1.3 ANNUAL AND CUMULATIVE ACHIEVED DEMAND REDUCTION

In FY 2020, CPS Energy marked the final year counted toward the 771 MW target with a cumulative demand reduction of 845 MW. During the FY 2022 extension, CPS Energy delivered an additional 54 MW for STEP. Annual STEP contributions are counted as the net avoided non-coincident peak (NCP) MW delivered by incremental program participants.

54 MW	980 MW
Demand reduction, FY 2022	Demand reduction, cumulative FY 2009 – FY 2022

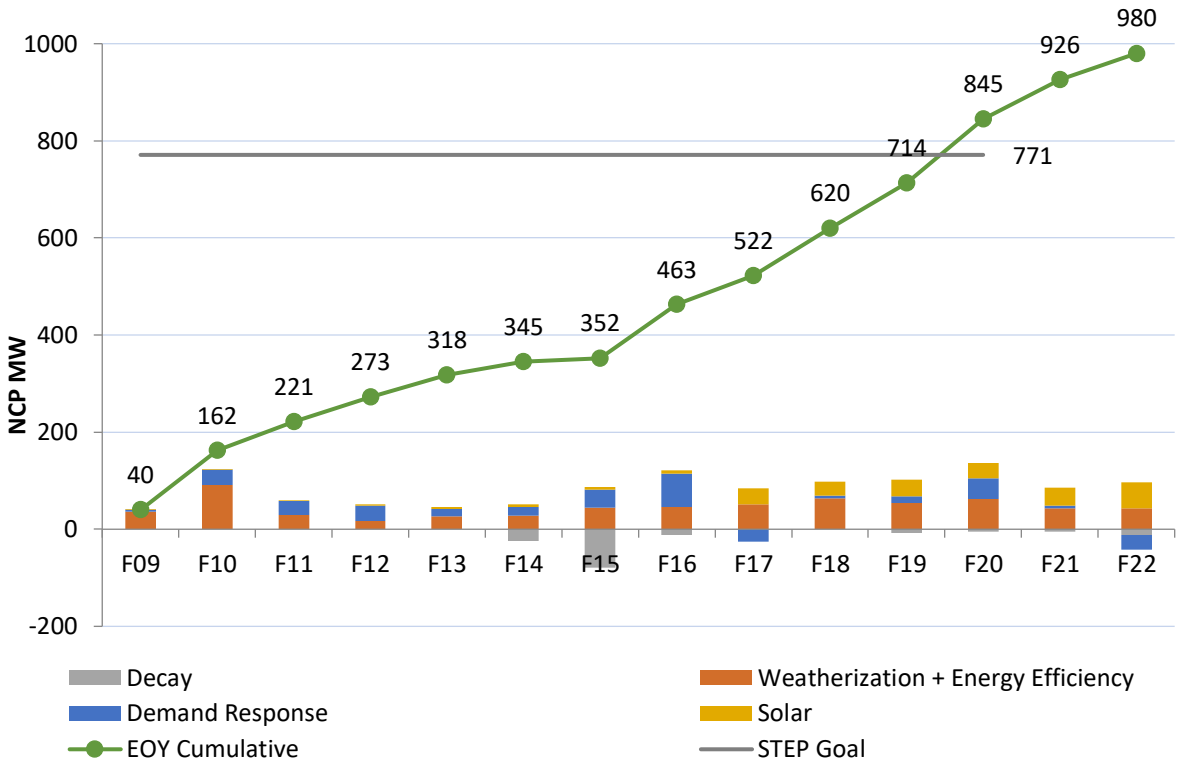


Figure 1-1: Cumulative Progress toward Meeting STEP Goal
In the figure: NCP = non-coincident peak, EOY = end of year.

Measures that were previously installed and have reached the end of their useful lives or otherwise rendered ineligible due to regulatory changes are accounted for as decay. Measures reaching the end of their useful lives caused 11.83 MW of decay in FY 2022 and are detailed in the table below.

Table 1-1: FY 2022 Measure Decay

Sector	Measure	FY2021 Decaying MW	Reason for Decay
Residential	Refrigerator Recycling	-0.122	Expiring EUL
Residential	WashRight	-1.949	Expiring EUL
Commercial	Lighting	-7.745	Expiring EUL
Commercial	Restaurant Equipment	-0.003	Expiring EUL
Commercial	Whole Building Optimization	-2.009	Expiring EUL
	Total	**-11.828**	

The STEP portfolio includes contributions from a diverse mix of programs reaching all customer sectors. Incremental impacts in FY 2022 were predominantly driven by residential solar and commercial energy efficiency programs, while demand response programs delivered reduced NCP savings relative to FY 2021.

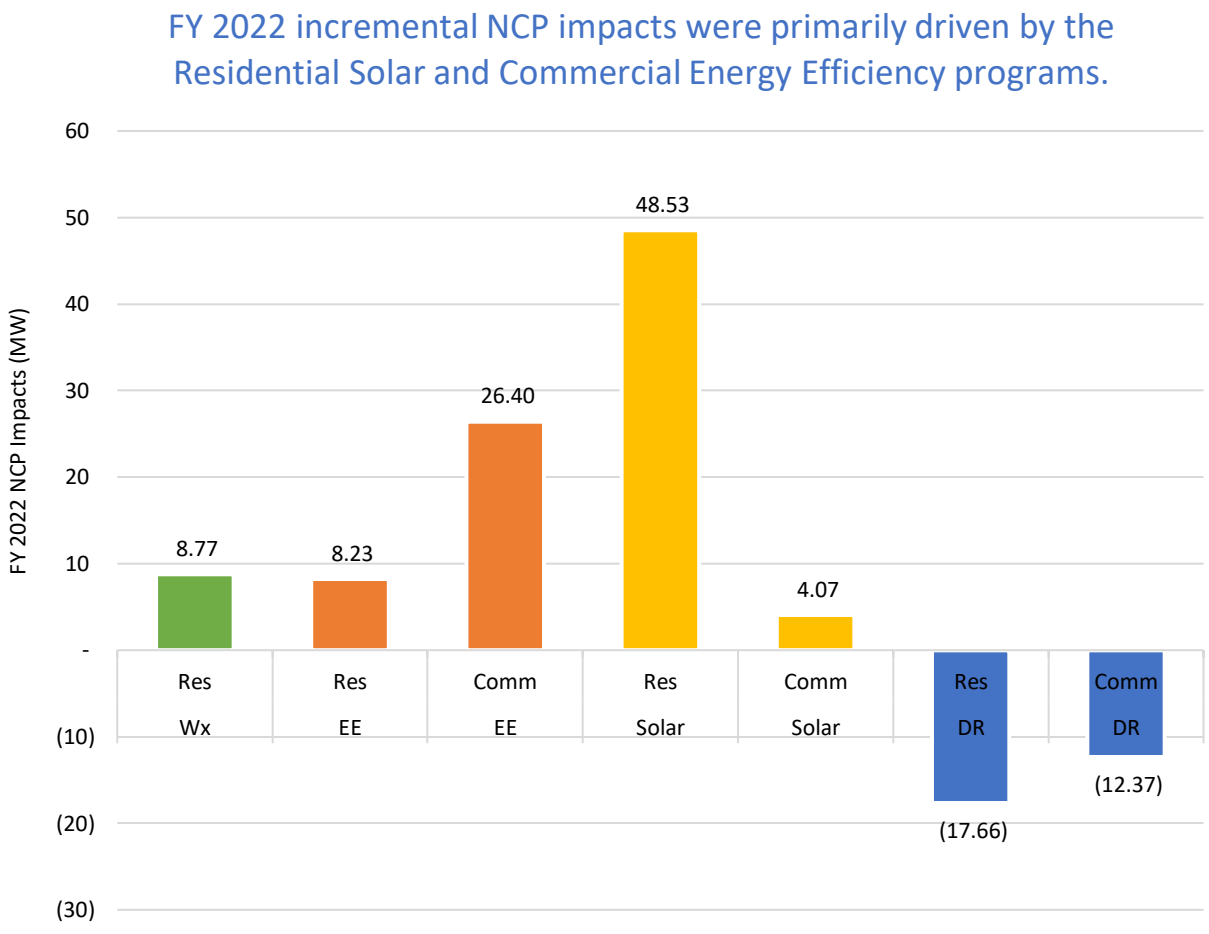


Figure 1-2: FY 2022 Net Incremental Contribution toward STEP by Portfolio and Sector
In the figure: Res = Residential, DR = Demand Response, Comm = Commercial, EE = Energy Efficiency, Wx = Weatherization.

The FY 2022 STEP portfolio reached more than 477,000 homes and almost 3,200 businesses through weatherization, energy efficiency, demand response, and solar programs. Demand response programs reach the most customers due to their broad applicability and little to no investment cost for the participating customers. The participation counts listed in Table 1-2 represent enrolled/participating customers in FY 2022.

Table 1-2: FY 2022 Count of Customers Served

Portfolio	Residential	Commercial
Demand Response*	454,662	1,927
Energy Efficiency**	14,385	1,233
Solar***	4,974	38
Weatherization	1,649	0
Total	477,295	3,198

* Demand Response customer residential counts include devices per customer estimate that ranges from 1.19 to 1.33 depending on the program; the devices per customer estimate for commercial dwellings ranges from 1.53 to 3.27.

** The Commercial Energy Efficiency count does not include commercial customers affected by the midstream lighting program. Because impacts are quantified by lamp/fixture count for this program, there is no way to align program participation metrics with other program designs.

*** The Solar count does not include customers of the Roofless Solar program.

1.4 PORTFOLIO ENERGY AND DEMAND IMPACTS AND COST-EFFECTIVENESS

The FY 2022 portfolio consists of Energy Efficiency programs contracted out to two implementers, with Cool Roof, Renewable Energy, and Demand Response programs implemented internally by CPS Energy. This year's report includes Frontier's evaluation of 21 different programs. Net energy and demand savings are listed in Table 1-3. The savings are represented on an annualized basis to simplify the reporting structure and for easy comparison from year to year.

Table 1-3: FY 2022 Portfolio Impacts and Cost-Effectiveness

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net Coincident Demand Savings (kW)	Net Non-Coincident Peak Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Weatherization Program									
Weatherization	100%	7,412,745	3,297	8,771	3,123	$9,200,243	$1,142,050	$10,342,293	0.81
Energy Efficiency Programs									
Residential HVAC	95%	9,952,208	4,461	4,461	3,820	$3,525,472	$166,832	$3,692,304	2.85
Home Efficiency	93%	2,526,532	835	1,766	736	$824,936	$38,929	$863,865	2.61
New Home Construction	100%	1,923,236	1,118	1,656	1,342	$1,873,850	$88,445	$1,962,295	1.74
Residential Retail Partners	77%	-	-	-	-	$0	$0	$0	NA
Energy Savings Through Schools	95%	833,031	61	313	80	$196,869	$9,604	$206,473	1.07
Home Energy Assessments	84%	-	-	-	-	$0	$0	$0	NA
Cool Roof	100%	18,714	15	30	21	$9,344	$446	$9,790	3.46
Residential Subtotal		15,253,722	6,489	8,226	6,000	$6,430,472	$304,256	$6,734,728	2.44
C&I Solutions	100%	34,689,172	6,071	8,222	6,019	$5,347,524	$248,626	$5,596,150	3.19
Schools & Institutions	96%	38,216,377	3,768	12,100	3,759	$3,796,054	$182,566	$3,978,620	3.10
Small Business Solutions	93%	24,040,850	5,157	6,081	5,143	$2,690,695	$125,540	$2,816,235	4.31
Commercial Subtotal		96,946,400	14,996	26,403	14,921	$11,834,273	$556,732	$12,391,005	3.41
Energy Efficiency Subtotal		112,200,121	21,486	34,628	20,921	$18,264,744	$860,988	$19,125,732	3.07

Table continues on next page.

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net Coincident Demand Savings (kW)	Net Non-Coincident Peak Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Demand Response Programs*									
Smart Thermostat	100%	1,058,429	30,435	45,608	30,745	$908,978	$40,855	$949,833	4.18
Power Players - Behavioral DR	100%	933,510	17,537	18,113	8,564	$779,894	$34,245	$814,139	3.32
Nest DI	100%	14,379,486	16,361	17,997	11,991	$376,343	$21,847	$398,189	0.00
BYOT	100%	34,537,105	47,167	53,792	39,553	$3,791,865	$173,850	$3,965,715	4.89
C&I DR	100%	4,609,381	91,708	107,069	66,255	$4,885,475	$334,762	$5,220,237	2.61
FlexEV Smart Rewards	100%	0	13	25	8	$132,784	$93,905	$226,690	0.11
FlexEV Off-Peak Rewards	100%	0	7	30	7	$51,343	$36,310	$87,653	0.19
Demand Response Subtotal		55,517,911	203,228	242,634	157,122	$10,926,682	$735,775	$11,662,456	2.98
Renewable Energy Programs**									
Residential Solar PV	100%	59,435,770	20,088	48,526	16,887	$12,674,285	$2,894,133	$15,568,418	4.74
Commercial Solar PV	100%	3,550,617	1,250	2,784	1,050	$1,271,648	$291,596	$1,563,244	2.89
Roofless Solar	100%	2,176,755	675	1,282	572	$0	$27,436	$27,436	4.44
Solar Energy Subtotal		65,163,142	22,013	52,592	18,508	$13,945,933	$3,213,165	$17,159,099	4.57
Grand Total		240,293,918	250,023	338,625	199,674	$52,337,602	$5,951,978	$58,289,580	3.11

*The Program Administrator Cost Test (PACT) output, the benefit-cost ratio, is the ratio of the net present value (NPV) of avoided energy and capacity benefits, divided by the program's incentives and administrative costs. A PACT ratio greater than 1 indicates that the program delivered more benefits than costs incurred from the utility's perspective.

**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.

***CPS Energy's solar rebate programs are evaluated independently from the utility's net metering rate policy. If the estimated costs of net metering credits are factored in, the Residential and Commercial Solar program PACTs would be adjusted to 2.62 and 1.16, respectively. The Roofless Solar program is evaluated independently of customer bill credits that are paid out over time to subscribers. If the estimated costs of bill credits are factored in, the Roofless Solar PACT would be adjusted to 1.20.

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

1.5 SUMMARY OF SAVINGS EVALUATION APPROACH

Frontier applied evaluation standards as published in the FY 2022 CPS Energy Guidebook, which 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 CPS Energy 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 CPS Energy Guidebook is updated annually to maintain consistency with the TRM.

1.6 SUMMARY OF ECONOMIC IMPACTS

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

- Benefit-Cost Ratio, representing the output of the Program Administrator Cost Test (PACT) run at the portfolio level, was 3.11.
- Cost of Saved Energy (CSE), which represents the levelized program cost per annual kWh saved, was $0.0290/kWh, virtually unchanged from the previous year.

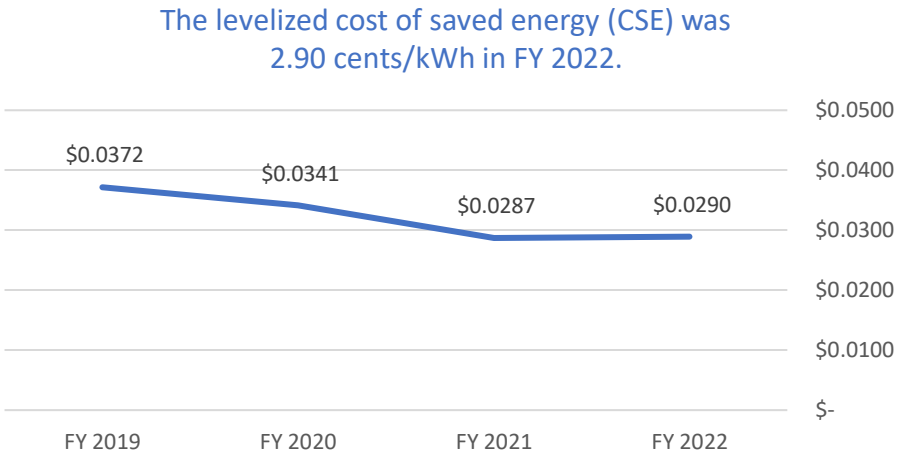
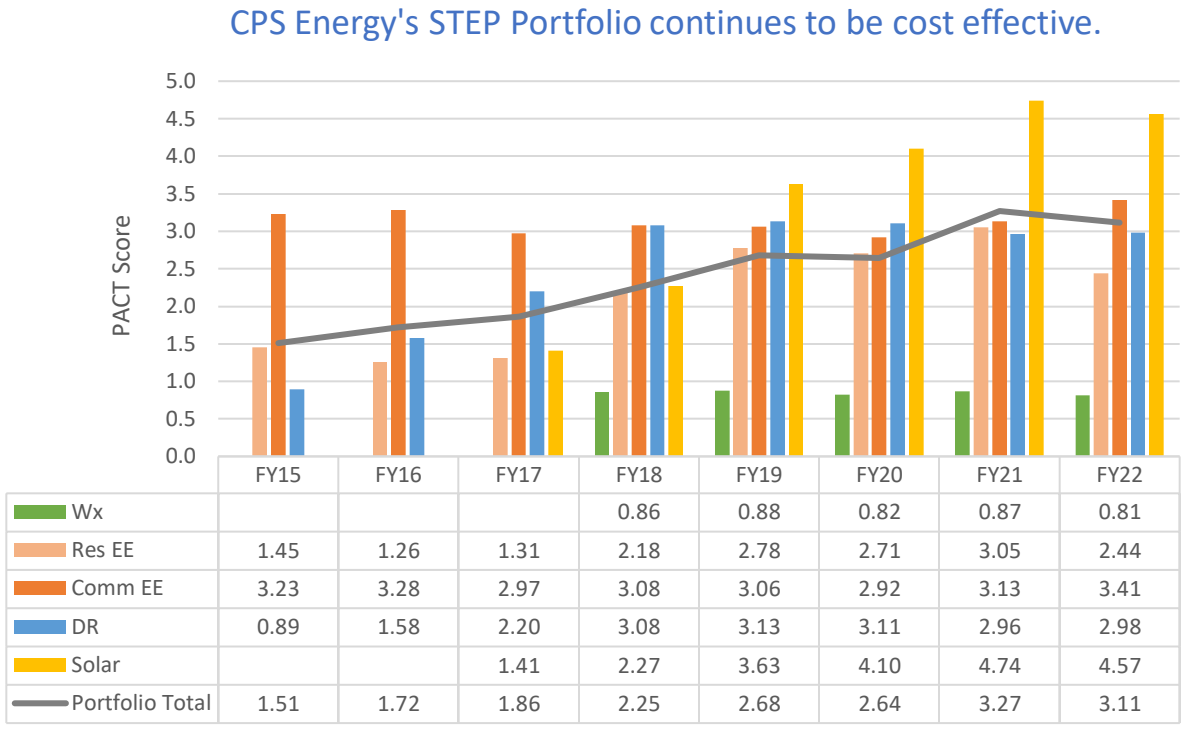


Figure 1-3: Levelized CSE Trend

- 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 $114,379,183.

1.7 YEAR BY YEAR COST-EFFECTIVENESS COMPARISON

CPS Energy's STEP portfolio continues to deliver cost-effective overall performance as measured by the PACT. These trends should be considered along with the following notes on structural changes to STEP programming.



	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22
Wx				0.86	0.88	0.82	0.87	0.81
Res EE	1.45	1.26	1.31	2.18	2.78	2.71	3.05	2.44
Comm EE	3.23	3.28	2.97	3.08	3.06	2.92	3.13	3.41
DR	0.89	1.58	2.20	3.08	3.13	3.11	2.96	2.98
Solar			1.41	2.27	3.63	4.10	4.74	4.57
Portfolio Total	1.51	1.72	1.86	2.25	2.68	2.64	3.27	3.11

Figure 1-4: STEP Cost-Effectiveness from FY 2015 through FY 2022.

In the figure: Res = Residential, DR = Demand Response, Comm = Commercial, EE = Energy Efficiency, Wx = Weatherization. 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.

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 17 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),[1] 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 FY 2022 CPS Energy Guidebook was used except where noted.

2.2 PEAK DEMAND IMPACTS

To calculate coincident peak (CP) demand savings, Frontier employed a probabilistic analysis using San Antonio Typical Meteorological Year (TMY3) hourly weather data.[2] 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. Frontier used ERCOT data for this zone and added back in demand savings attributable to DR deployments to determine what the hours of highest demand would have been absent the programs. 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 and used by all investor-owned electric utilities beginning in 2016.

[1] 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

[2] 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 2020 using weather and load data from 2016 to 2019.

Estimated coincident peak savings are calculated as 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	0.868682185	6	17	16	97.88	0.056450247
6	19	16	102.92	0.846069683	6	18	16	97.88	0.056450247
6	20	16	102.92	0.846069683	7	30	16	98.96	0.054888921
6	20	15	101.84	0.488013895	8	20	14	98.96	0.035089362
6	19	14	102.92	0.354301558	8	23	14	98.96	0.035089362
6	20	14	102.92	0.354301558	6	10	14	99.86	0.034068906
6	19	17	100.94	0.327982844	6	18	14	99.86	0.034068906
6	10	15	100.94	0.29835023	7	31	14	100.94	0.033104894
6	18	15	100.94	0.29835023	8	18	17	96.98	0.031332186
7	31	15	102.02	0.292170062	8	19	17	96.98	0.031332186
8	20	15	99.86	0.271695164	8	20	17	96.98	0.031332186
8	19	16	98.96	0.267008894	6	17	17	97.88	0.03041755
8	20	16	98.96	0.267008894	6	18	17	97.88	0.03041755
6	10	16	99.86	0.261068678	7	31	17	98.96	0.029553696
8	17	15	98.96	0.142674521	6	13	15	97.88	0.026605034
7	31	16	100.04	0.132695201	6	14	15	97.88	0.026605034
8	18	16	97.88	0.121478099	6	21	15	97.88	0.026605034
6	20	17	98.96	0.076336931	6	5	16	96.98	0.025995256
6	17	15	98.96	0.067167619	6	11	16	96.98	0.025995256
8	18	15	97.88	0.059417704	6	13	16	96.98	0.025995256
8	19	15	97.88	0.059417704	6	21	16	96.98	0.025995256
8	17	16	96.98	0.058100761	8	7	16	95.9	0.022879363
8	23	16	96.98	0.058100761	8	28	16	95.9	0.022879363
6	12	16	97.88	0.056450247	6	17	14	98.96	0.015490447
6	16	16	97.88	0.056450247	7	30	14	100.04	0.015043943

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 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 selective catalytic reduction (SCR) and carbon monoxide (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 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 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 programs. ERCOT energy prices went up to $10,529.75/MWh ($10.53/kWh) during Winter Storm Uri, which is approximately 70 times the 2021 average wholesale price of energy in the CPS Energy zone ($150.74/MWh).[3] 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 various 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, rapid response to an unexpected price spike event would be impossible for a program that requires day-ahead notice to the program implementer.

To estimate the value of energy (kWh) saved during 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.

[3] Average real time market (RTM) price in CPS zone was $22.14/MWh in 2020. The surge in average RTM price in 2021 was due to extremely high prices (around $9000/MWh) which lasted around a week in the February winter storm.

2.5 ECONOMIC ANALYSIS

The following cost-effectiveness metrics were calculated for CPS Energy's programs. For results, see section 1.6.

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 Automated Demand Response (ADR), benefit-cost calculations considered only the cohort of participants added during the current fiscal year. ADR participants are contracted for 10 years, but because the costs and impacts change each year, benefit-cost was calculated with an EUL of one year and the impacts include all active participants. 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 the current and past years, as 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 Weatherization program is implemented by Franklin Energy and provides comprehensive retrofits for income-eligible residential customers. The Weatherization program assists families in need with reducing their monthly utility bills. Eligible participants may receive free upgrades designed to increase the energy efficiency of their homes. In FY 2022, the program provided a range of services to 1,649 homes. Although COVID-19 restrictions limited access to customer homes to perform weatherization services in FY 2021, customers were offered kits containing LED light bulbs, faucet aerators, and pipe insulation.

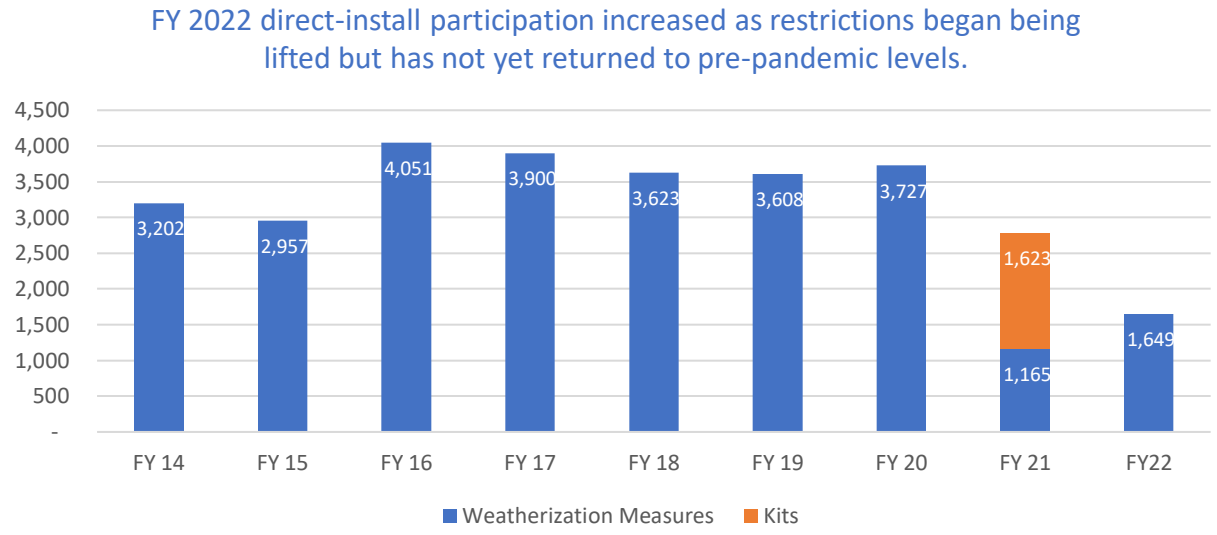


Figure 3-1: Weatherization – Participation Trends

Installed measures included repair, health & safety, and energy-saving measures. The energy-saving measures involved installation of the following equipment:

- LED lamps
- Wall insulation
- Attic insulation
- Floor insulation
- Solar screens
- Smart thermostats
- Air infiltration reduction
- Duct system improvements
- Faucet aerators
- Low-flow showerheads
- Water heater pipe insulation
- Water heater tank insulation

The measure mix was diverse, but envelope measures (including attic insulation, wall insulation, floor insulation, solar screens, air infiltration reduction) were by far the largest contributors to total program impacts for both energy and demand savings in FY 2022.

- Attic insulation was the largest single measure in terms of energy savings and contributed approximately 28% of energy savings, 24% of NCP kW savings, and 41% of CP kW savings.
- Air infiltration reduction is next, contributing approximately 22% of energy savings, 33% of NCP kW savings, and 20% of CP kW savings.
- Solar screens round out the top three measures, contributing approximately 17% of energy savings, 18% of NCP savings, and 17% of CP kW savings.
- In FY 2021, lighting produced the second highest energy savings, but fell to 5th (14%) in FY 2022 behind the three aforementioned measures and wall insulation. Peak impacts are also significantly lower for lighting compared to the envelope measures.

Percent contribution to gross program-level energy and demand impacts are shown in Figure 3-2.

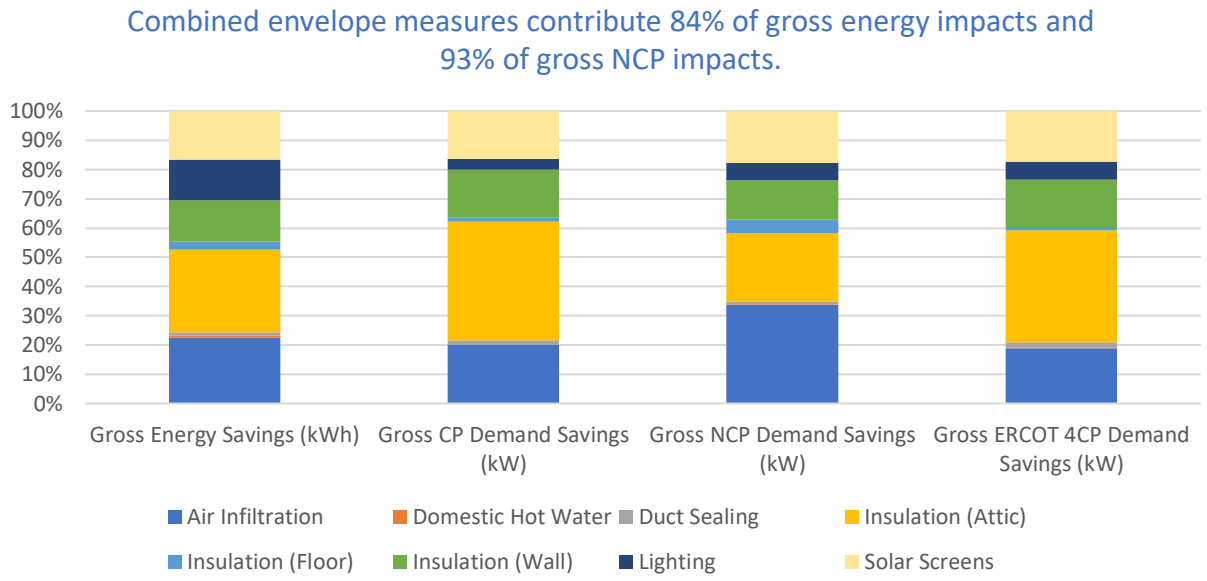


Figure 3-2: Weatherization – FY 2022 Gross Energy and Demand Impact Percentages by Measure

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. Franklin Energy transitioned to a new project tracking system mid-year. Adjustments were made to project-level input assumptions where the reported measure inputs did not match the project documentation and inspection results.

For each of the measures, Frontier determined energy savings using methodology from the FY 2022 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 envelope measures were 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 details on savings determination are presented in the CPS Energy Guidebook.

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 details on those adjustment factors.

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

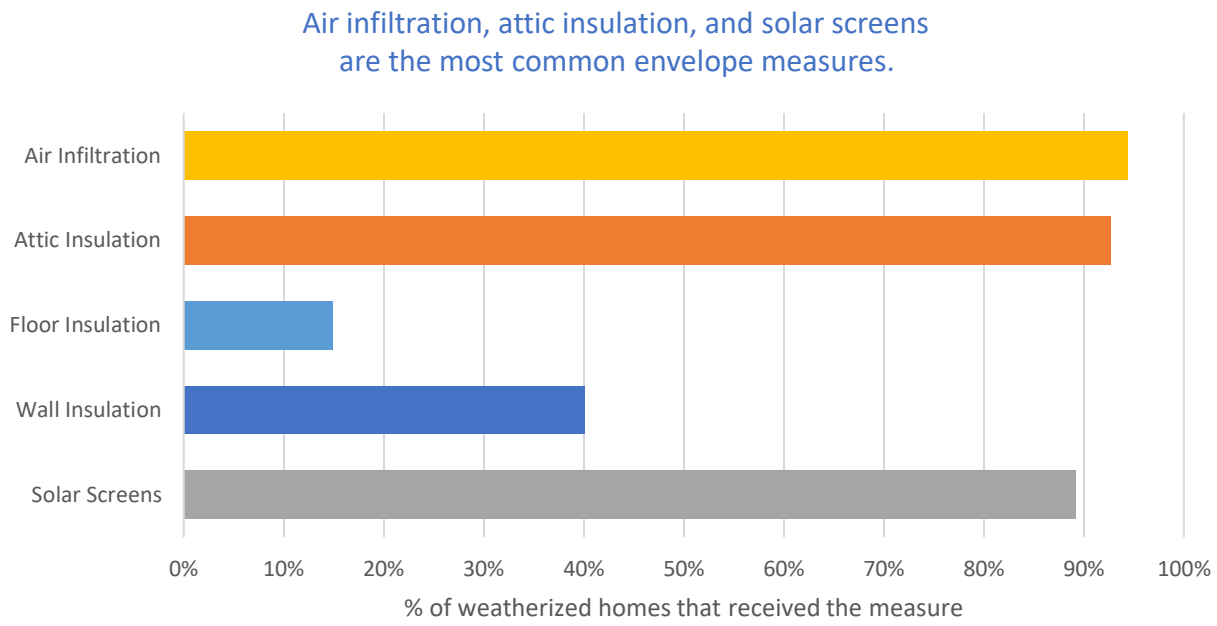


Figure 3-3: Weatherization – Frequency of Installation by Envelope Measure

[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.

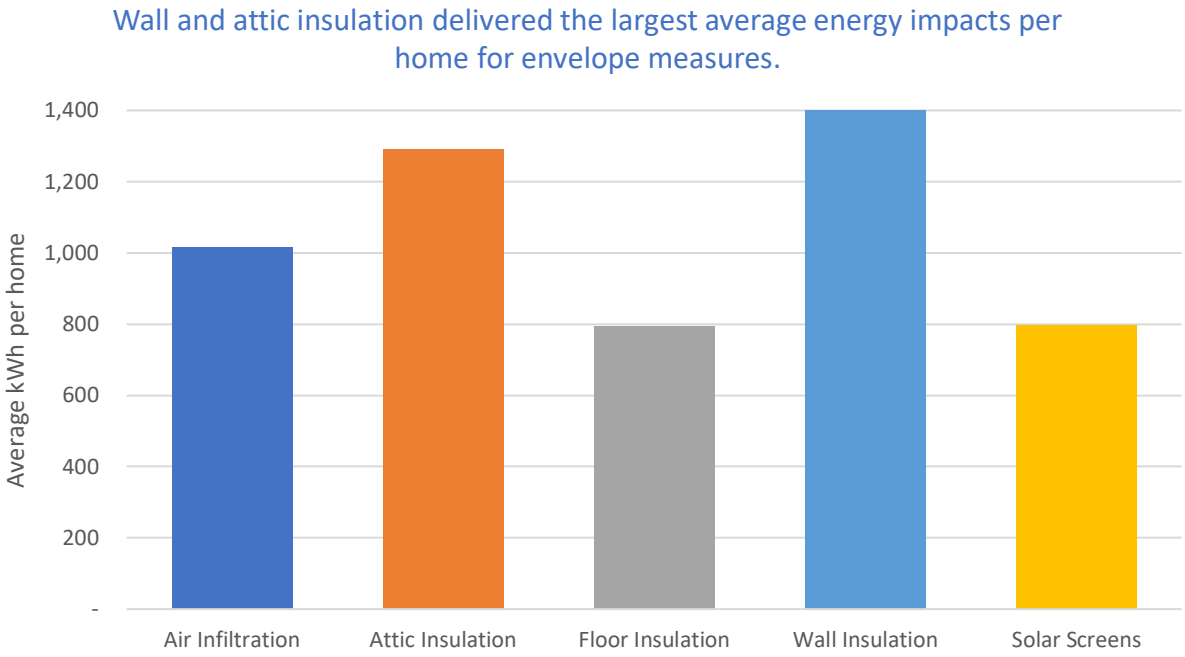


Figure 3-4: Weatherization – Average per Home kWh by Envelope Measure

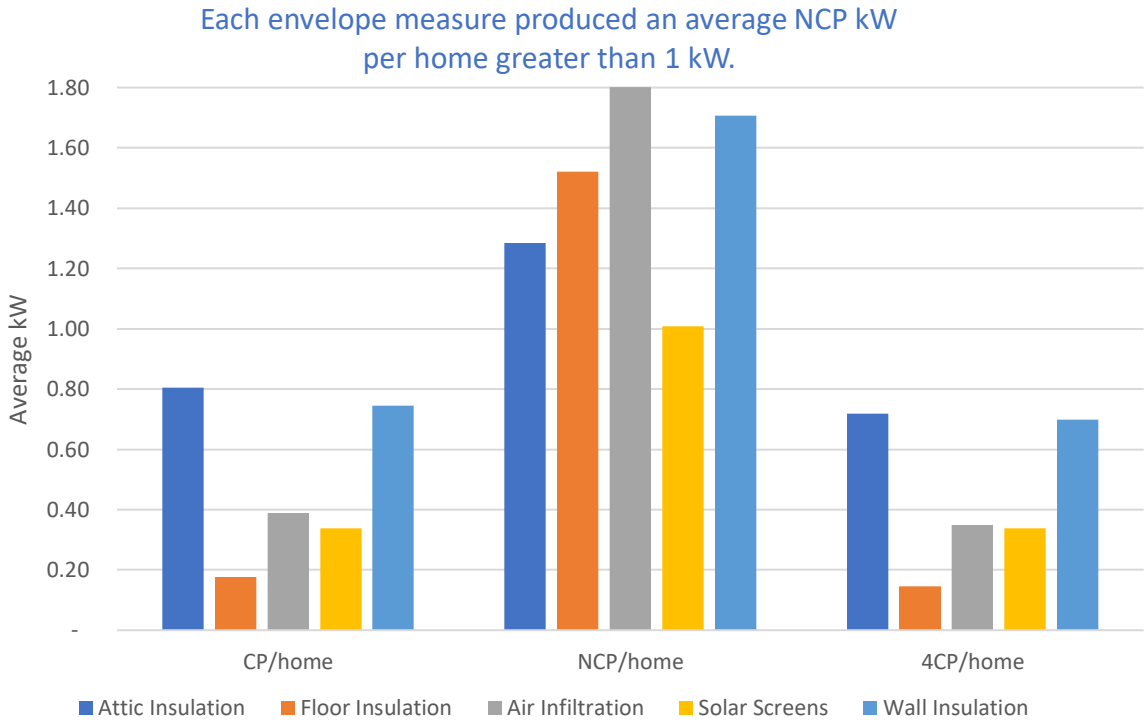


Figure 3-5: Weatherization – Average per Home CP, NCP, and 4CP kW by Envelope Measure

Air Infiltration

Air infiltration control measures were installed in 1,556 homes through the Weatherization program during FY 2022 compared with 1,073 homes in FY 2021. Average gross impacts per home for air infiltration reduction are 1,016 kWh, 0.39 CP kW, 1.80 NCP kW, and 0.35 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 pre- and post-CFM_{50} readings to reasonable values that do not exceed comfort thresholds and building tightness requirements. Where necessary to meet those requirements, pre- and post-CFM_{50} limits were applied to the documented CFM_{50} at each project site.

Attic Insulation

Attic insulation was installed in 1,529 homes through the Weatherization program during FY 2022 compared to 1,073 homes in FY 2021. Average gross impacts per home for attic insulation were 1,292 kWh, 0.80 CP kW, 1.28 NCP kW, and 0.72 4CP kW.

Savings were 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.

Floor Insulation

Floor insulation was installed in 245 homes through the Weatherization program during FY 2022 compared to 224 homes in FY 2021. Average gross impacts per home for floor insulation are 794 kWh, 0.18 CP kW, 1.52 NCP kW, and 0.15 4CP kW.

The baseline was assumed to be a site-built house with pier and beam construction and no floor insulation against the floor of the conditioned area. Savings were determined per square foot of floor 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.

Wall Insulation

Wall insulation was installed in 661 homes through the Weatherization program during FY 2022 compared to 476 homes in FY 2021. Average gross impacts per home for wall insulation were 1,504 kWh, 0.74 CP kW, 1.71 NCP kW, and 0.70 4CP kW.

Energy and demand savings assumed that an under-insulated wall cavity was insulated to bring it to R-13, typically by blowing in cellulose insulation. Savings were determined per square foot of wall insulation installed and varied by heating and cooling system type. Adjustments to claimed savings were made as necessary to apply the appropriate savings factors for each project site.

Solar Screens

Solar screens were installed on 1,471 homes through the Weatherization program during FY 2022 compared to 1,015 homes in FY 2021. Average gross impacts per home for solar screens are 797 kWh, 0.34 CP kW, 1.01 NCP kW, and 0.34 4CP kW.

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

3.1.2.2 Duct Sealing

Duct sealing was performed on 186 homes through the Weatherization program during FY 2022 compared to 164 homes in FY 2021. Average gross impacts per home for air infiltration reduction are 464 kWh, 0.26 CP kW, 0.39 NCP kW, and 0.29 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, duct insulation levels, and the severity of repaired leaks.

3.1.2.3 Domestic Hot Water

Domestic hot water (DHW) measures were installed in 390 homes through the Weatherization program during FY 2022 compared to 269 homes in FY 2021. Installed measures included faucet aerators, low-flow showerheads, and DHW pipe insulation. Average gross impacts per home for DHW measures are 132 kWh, 0.01 CP kW, 0.04 NCP kW, and 0.01 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.

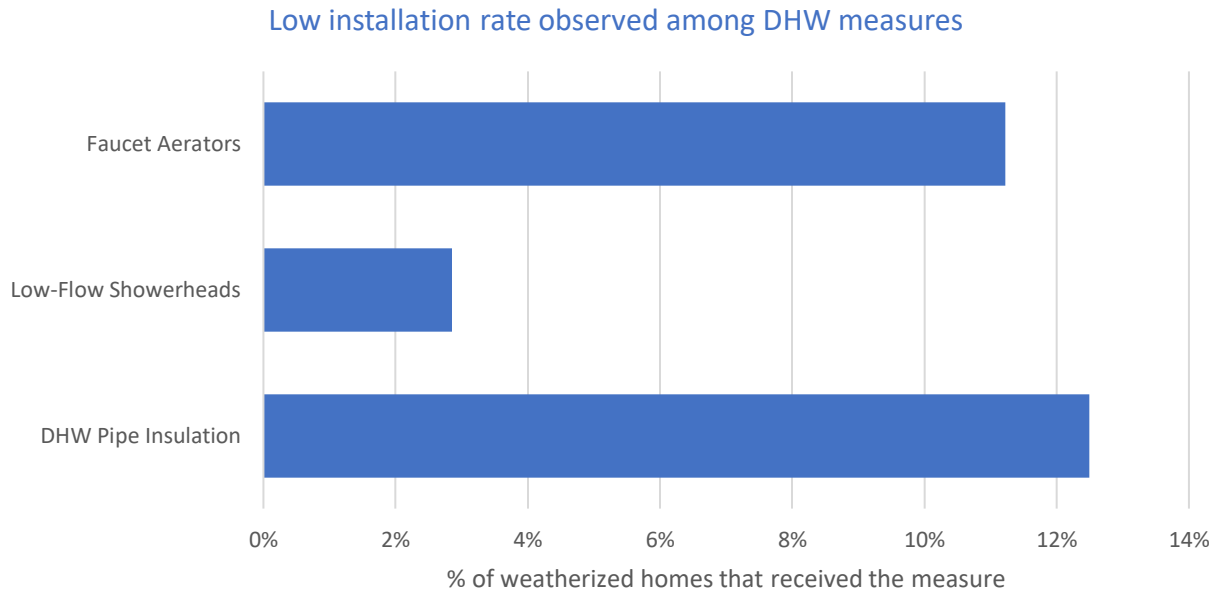


Figure 3-6: Weatherization – Installation Rates Among Domestic Hot Water (DHW) Measures

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.

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.

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 six 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. Pipes were insulated to an R-value of R-3. Savings varied based on the location of the water heater, in conditioned or unconditioned space.

Water Heater Tank Insulation

The CPS Energy Guidebook requires water heaters to be manufactured before 1991 to be eligible for this measure. This requirement was not enforced by Franklin Energy in FY 2021, and all treated water heaters were manufactured after 1991. No installations were reported in FY 2022.

3.1.2.4 LED Lamps

LED lighting was installed in 1,346 homes through the Weatherization program during FY 2022 compared to 1,054 homes in FY 2021. Average gross impacts per home for LED lighting are 729 kWh, 0.08 CP kW, 0.36 NCP kW, and 0.13 4CP kW.

While CP kW is closely aligned with 4CP kW for most measures, there is more significant variance between CP and 4CP demand savings for residential lighting. This is because 4CP kW is calculated for hour ending 17 when most residential participants are returning home after the workday, whereas CP kW is calculated based on a review of hours most consistent with CPS Energy's system peak. This peak period aligns more with hour ending 16, which has significantly less usage based on the deemed load shape for this measure.

The CPS Energy Guidebook includes separate calculation methodologies for omni-directional EISA-compliant and specialty EISA-exempt LED lighting. Historically, EISA-affected lamps have savings that are determined using a two-tiered weighting approach due to the baseline change that was expected in 2020. This dual baseline weighting approach changed for FY 2021 to remove the two-tier approach based on feedback from the U.S. Department of Energy indicating that the backstop will not be triggered. EISA first-tier baselines will remain in effect. This change was applied over a reduced measure life meant to approximate the market adoption of omni-directional LEDs. The Weatherization program was allowed a higher 10-year EUL compared to the 8-year EUL specified for standard programs based on expected slower market adoption among low-income customers.

The savings for specialty EISA-exempt lamps were determined over the entire lifetime of the lamp using the halogen equivalent wattages. Specialty lamp EULs will continue to be calculated based on rated product lifetimes.

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. The savings calculation also incorporates an interactive effects factor to account for the impacts on cooling and heating loads.

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)
Air Infiltration	1,580,337	603.51	2,803.04	542.61
Domestic Hot Water	51,674	2.90	14.38	2.96
Duct Sealing	86,249	47.77	73.06	53.79
Insulation (Attic)	1,975,607	1,229.70	1,963.75	1,099.52
Insulation (Floor)	194,537	43.28	372.56	35.54
Insulation (Wall)	993,851	492.11	1,128.62	461.96
Lighting	981,069	111.17	487.48	174.17
Solar Screens	1,172,854	497.64	1,482.83	498.27
Total*	**7,036,177**	**3,028.10**	**8,325.72**	**2,868.83**

* Note: 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

To ensure consistency of savings methodology between program tracking estimates and evaluation results for individual measures, we recommend revising input assumptions in program tracking systems to match the CPS Energy Guidebook. The evaluation team has identified and detailed specific inputs in a separate memo to program administrators, and include the following general items:

- Air infiltration:
    - Ensure pre-leakage cap, building tightness limit, and 30% reduction caps are all being applied in compliance with CPS Energy Guidebook.
    - Ensure that space heating penalties are applied for space cooling and heating in compliance with CPS Energy Guidebook.
- Pipe Insulation:
    - Reported length should be capped at 6 feet in compliance with CPS Energy Guidebook.
- Lighting:
    - As of May 9, 2022, the Department of Energy published final rules pertaining to the definition and standards for general service lamps (GSLs). The Texas TRM and CPS Energy Guidebook have not yet been updated to reflect evaluator guidance related to the effective date of these updates. The previously published baseline wattages reduced for compliance with the EISA 2020 backstop should not be enforced until the Texas TRM addresses this topic. Continue to monitor the CPS Energy Guidebook for updates.
    - Industry research shows that an average home has approximately 50 sockets per home. For projects with lamp counts exceeding this value, provide documentation of lamp count. Examples may include a detailed invoice or inspection report. Other documentation may also be accepted at the evaluator's discretion.
    - Flood type lamps are installed in both interior and exterior applications. Interior/exterior lamps should be reported separately, and savings should be calculated using separate interior/exterior input assumptions in compliance with CPS Energy Guidebook.

4. RESIDENTIAL PROGRAMS

4.1 SUMMARY OF RESIDENTIAL IMPACTS

CPS Energy's portfolio of residential programs addresses all markets and major residential end use loads. Residential demand response programs are included in Section 6. CPS Energy offered the following energy efficiency programs for the residential sector in FY 2022.

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

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

Home Energy Assessment – a free home assessment to identify energy savings opportunities and direct install measures.

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

New Home Construction – incentives for developers to build at least 15% more energy efficient than current City of San Antonio building codes.

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 at participating retailers.

Most of these programs were implemented by the original residential implementation vendor under contract to CPS Energy through August 2021 before transitioning to a new implementation vendor as of September 2021. The Cool Roof program was fully managed and implemented internally by CPS Energy in FY 2022.

Projects were evaluated against the FY 2022 CPS Energy Guidebook. For programs or measures where other methods were used, those are referenced in each section.

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 2022 program participants as measured at the participant or end-user level and adjusted to account for net-to-gross ratios and line losses.

More than 65% of portfolio net avoided energy comes from HVAC.

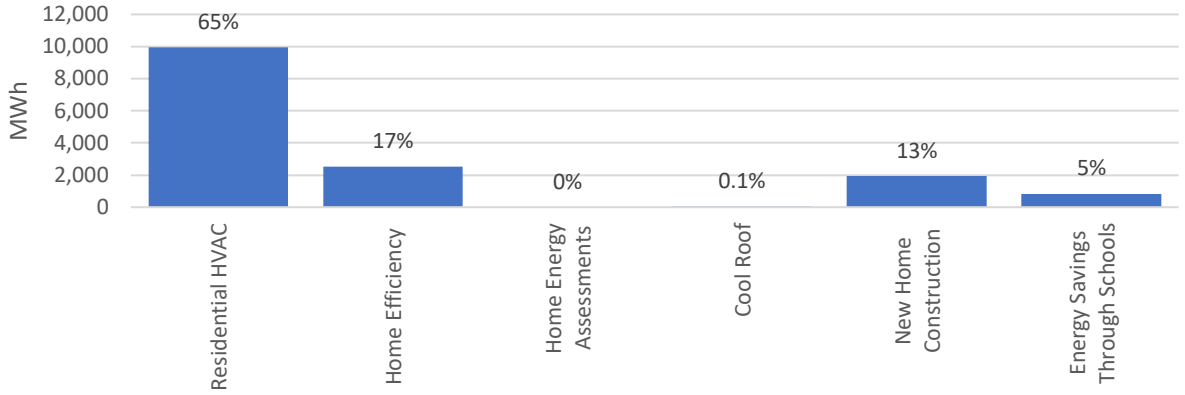


Figure 4-1: Summary of Residential Impacts – Net Avoided Energy by Program

HVAC contributes more than 50% of NCP impacts with Home Efficiency and New Home Construction delivering a combined 42%.

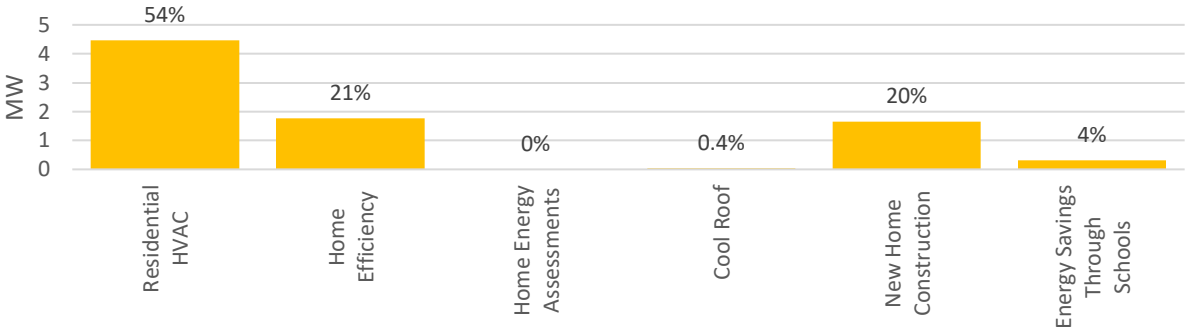


Figure 4-2: Summary of Residential Impacts – Net Avoided Non-Coincident Peak by Program

HVAC dominates CP impacts with almost 70% of the total residential portfolio.

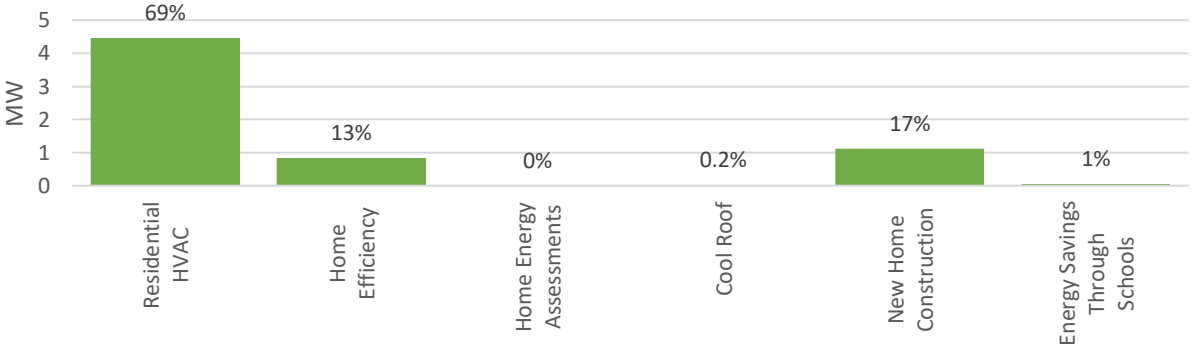


Figure 4-3: Summary of Residential Impacts – Net Avoided Coincident Peak by Program

4.2 RESIDENTIAL HVAC PROGRAM

4.2.1 Overview

CPS Energy's Residential HVAC 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), and window air conditioners (WACs). During FY 2022, a total of 5,836 HVAC systems were incentivized through the program for HVAC equipment installed in 5,385 homes. This represents a small reduction compared to FY 2021, which saw 6,601 systems installed in 6,021 homes. Average gross impacts per home are 2,265 kWh, 1.06 CP kW, 1.09 NCP kW, and 0.91 4CP kW for Central ACs, 2,856 kWh, 1.11 CP kW, 1.15 NCP kW, and 0.95 4CP kW for Central HPs, and 553 kWh, 0.23 CP kW, 0.25 NCP kW, and 0.22 4CP kW for Window ACs.

The following figures illustrate residential HVAC participation trends from FY 2014 to FY 2022. Total participation initially fell off in FY 2015 based on a federal standard change that went into effect January 1, 2015, raising the minimum efficiency requirement from 13 to 14 SEER. Total participation increased in FY 2016 and 2017 as the market caught up to the new standard, peaking in FY 2017 based on a combination of implementation efforts resulting from the transition from CPS Energy to third-party implementation.

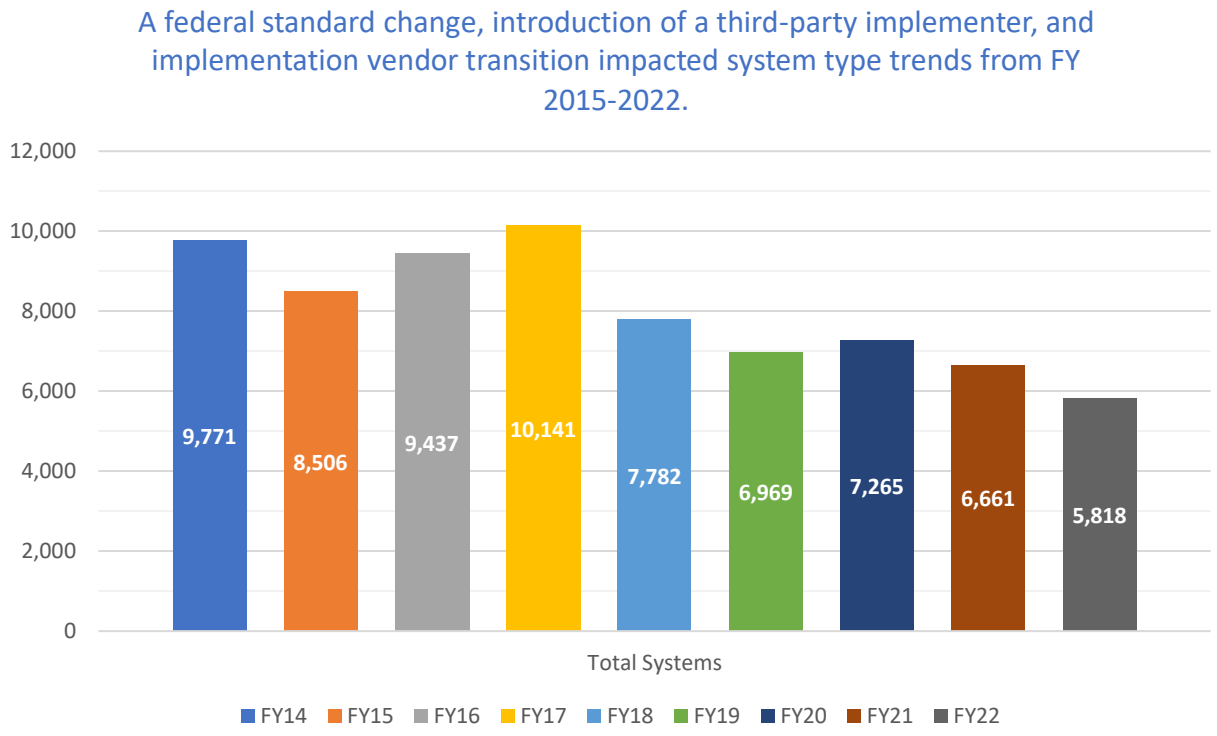


Figure 4-4: Residential HVAC – Participation Trends

Total participation (total system count) dropped more noticeably in FY 2018 based on Franklin Energy's program design providing a greater emphasis on central systems and a decreasing focus on window air conditioners. Individual system type trends show an increase in central air conditioners and heat pumps and a decrease in window air conditioners, with the net impact showing a decrease in total systems based on homes with window units having multiple units per home. Therefore, decreasing HVAC incentives for homes with window units will have a greater impact on total system types than increasing incentives for homes with central units.

The reduction from FY 2021 to FY 2022 is most likely explained by a combination of residual COVID-19 impacts and a temporary program interruption due to a transition in implementation vendors.

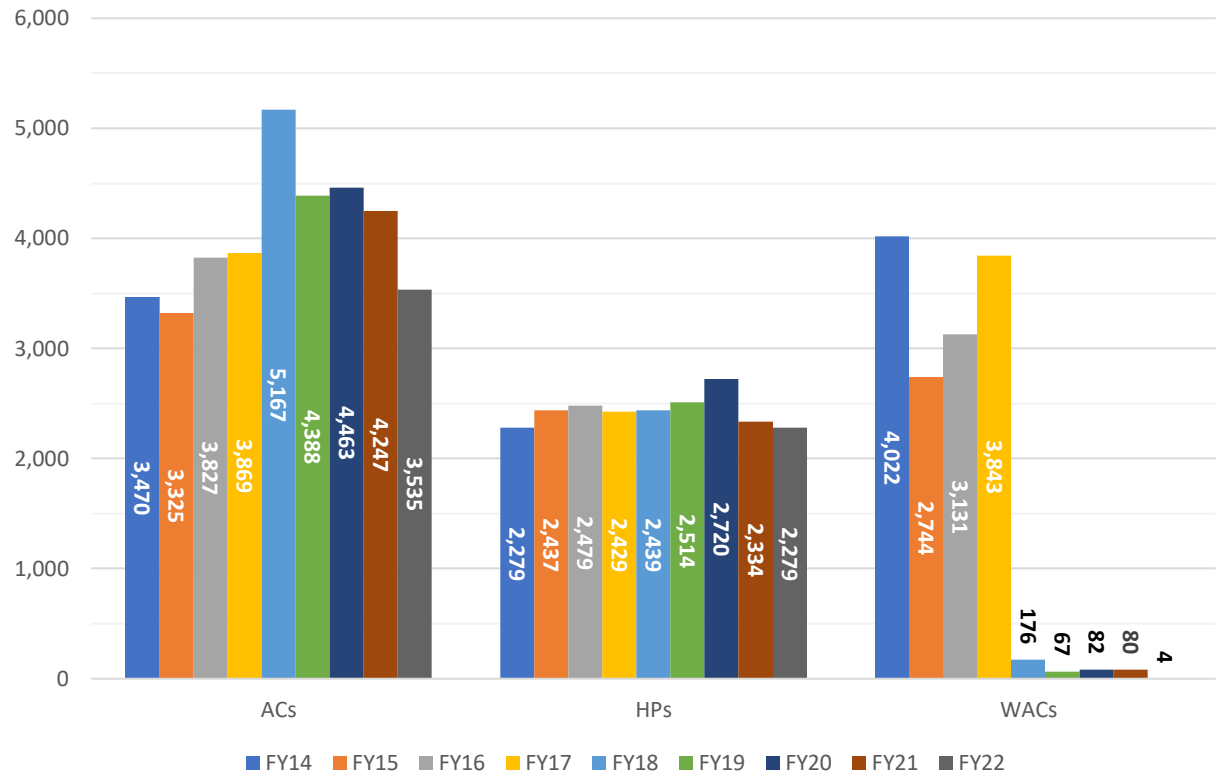


Figure 4-5: Residential HVAC – Participation Trends by System Type[6]

[6] FY 2022 AC and HP counts are not actuals because the new implementation vendor did not report system type. Estimates are based on desk review distribution.

The figure below presents a percentage breakdown of program savings by system type.

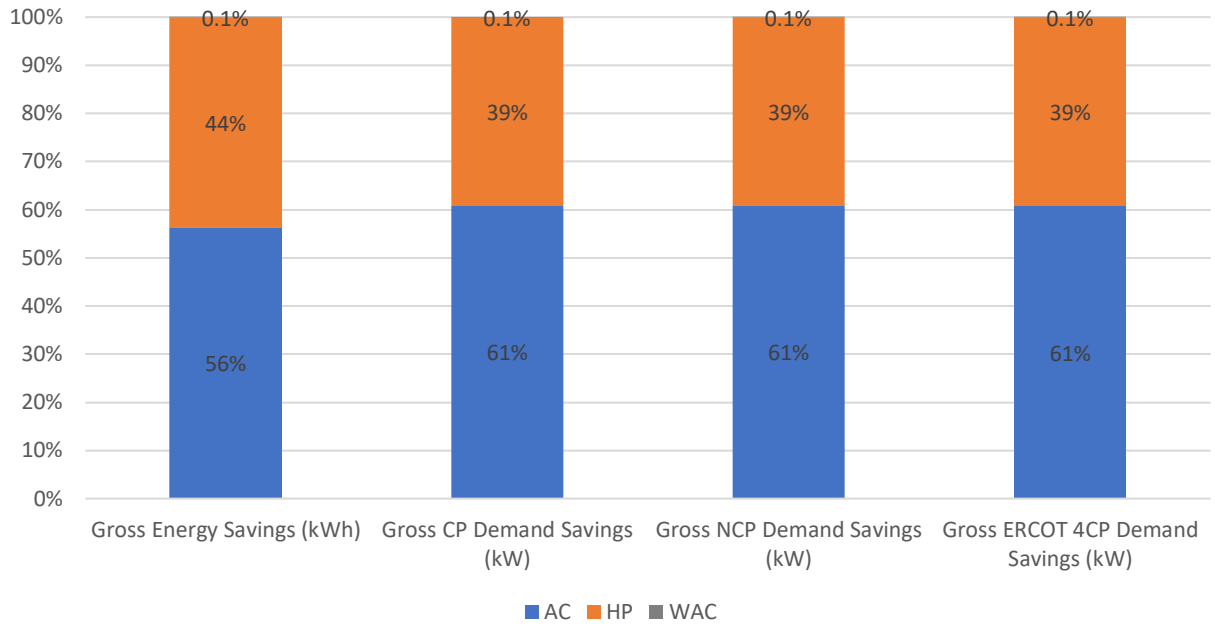


Figure 4-6: Residential HVAC – Gross Energy and Demand Impact Percentages by Measure

4.2.2 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, 2021 and January 31, 2022 were evaluated against the FY 2022 CPS Energy Guidebook.

AC and HP were calculated using two distinct replace-on-burnout and early retirement baselines. New construction 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 (NREL).[7] These performance curves provide the capacity and efficiency of a 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

[7] 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.

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, considering 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.[8]

For early retirement projects, remaining useful life (RUL) assumptions were incremented by a year to account for bulk installation during the 2021 calendar year. First and second-tier baselines were weighted using a net present value methodology applying CPS Energy's applicable discount rate, avoided capacity cost, and avoided energy cost factors.

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.

4.2.3 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[9] for the WAC projects. Minimal discrepancies were identified for all system types. For ACs and HPs, rated capacity variances were typically still within the specified capacity range.

Early retirement projects use an alternate dual baseline that requires confirmation of several additional measure inputs. Frontier validated the reported existing system type, condition, model numbers, and age against available project documentation. Savings were calculated against an adjusted replace-on-burnout baseline for projects where this documentation was not available or inconsistent.

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 or inconsistent.

[8] AHRI Certification Directory: https://www.ahridirectory.org/ahridirectory/pages/home.aspx.
[9] ENERGY STAR® Certified Room Air Conditioners: https://www.energystar.gov/productfinder/product/certified-room-air-conditioners/.

4.2.4 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.

Table 4-1: 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)
Air Conditioners	5,607,977	2,622.42	2,708.95	2,243.14
Heat Pumps	4,327,001	1,687.03	1,737.57	1,446.71
Window Air Conditioners	8,849	3.75	4.02	3.57
Total*	**9,943,827**	**4,313.19**	**4,450.55**	**3,693.43**

* Note: 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 HOME EFFICIENCY PROGRAM

4.3.1 Overview

CPS Energy's Home Efficiency program offers incentives for attic insulation and variable-speed pool pumps. The program served 1,332 homes in FY 2022, down from 1,632 homes in FY 2021.

The pool pump participation share further increased in FY 2022 to 36% after remaining relatively stable near 25% in recent years before increasing to 30% in FY 2021.

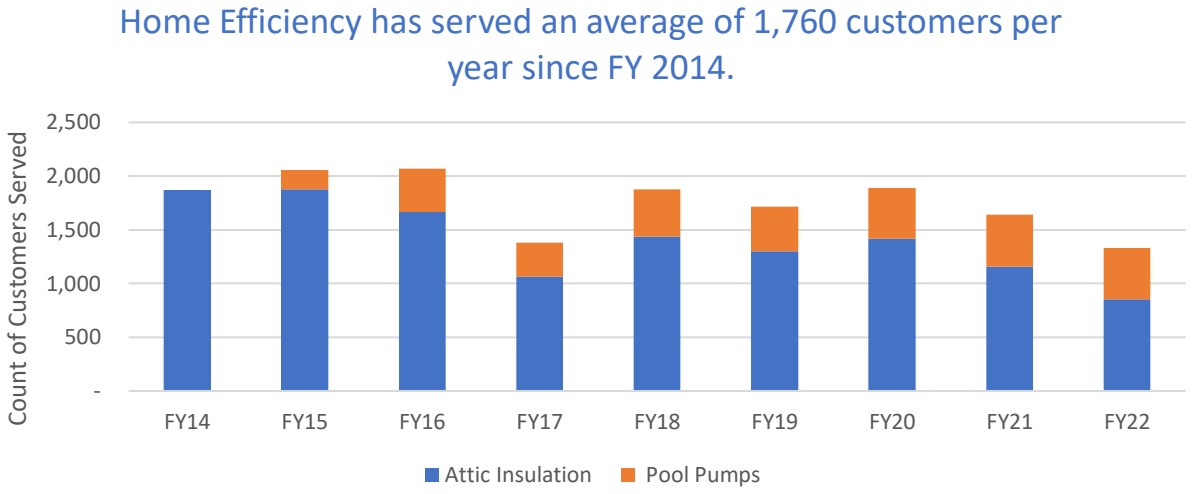


Figure 4-7: Home Efficiency – Participation Trends

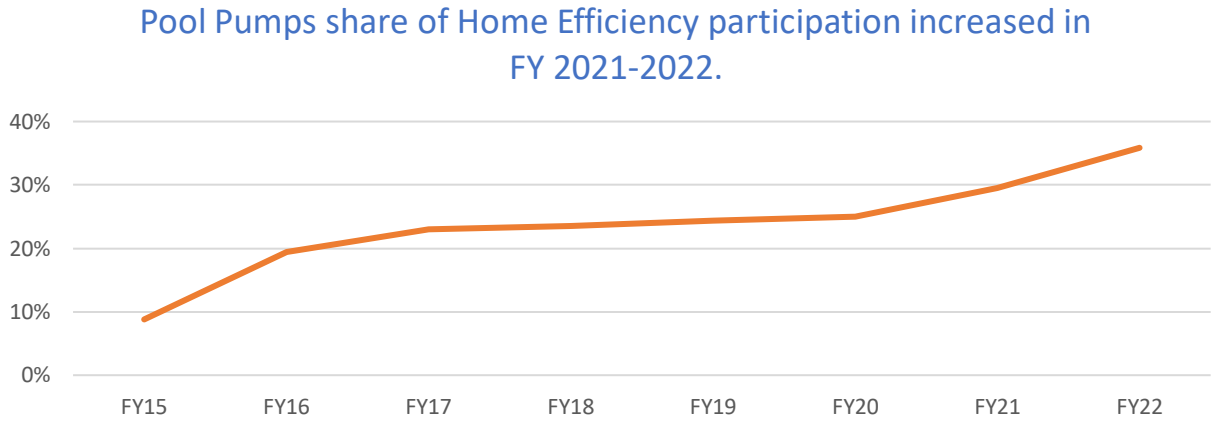


Figure 4-8: Home Efficiency – Pool Pump Participation Share

The proportion of total program energy and peak impacts derived from each measure type is presented in Figure 4-9.

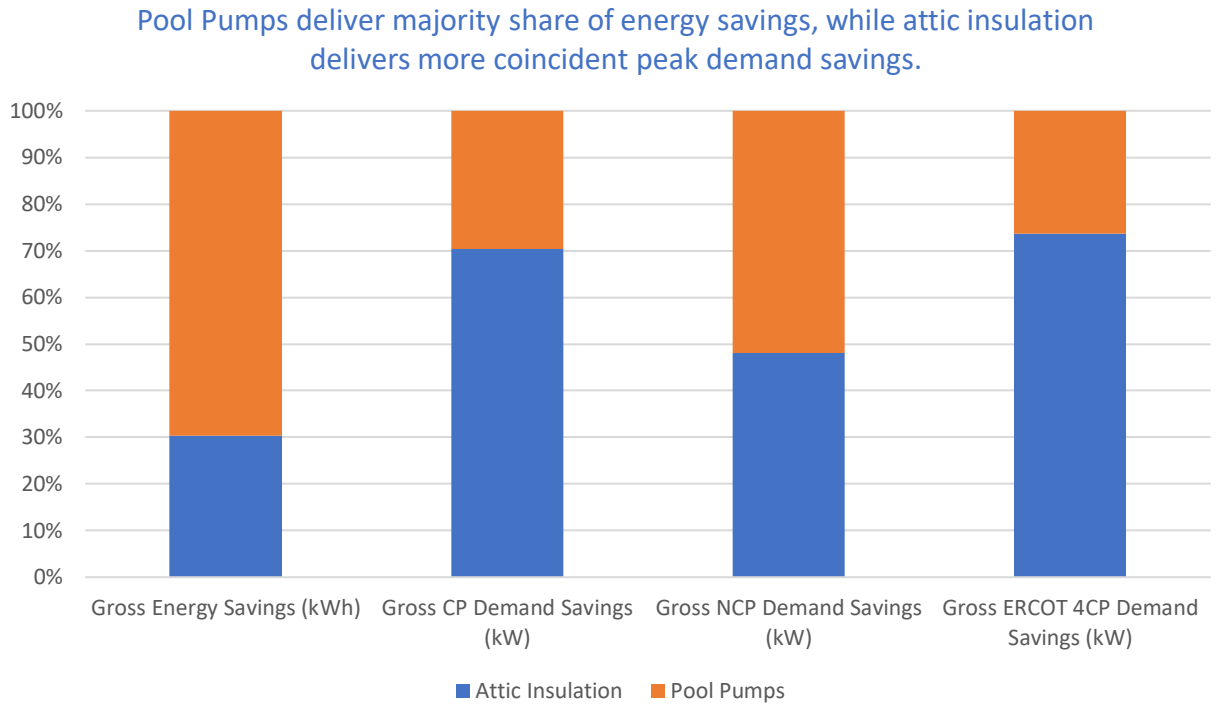


Figure 4-9: Home Efficiency – FY 2022 Gross Energy and Demand Impact Percentages by Measure

4.3.2 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. Projects were evaluated against the FY 2022 CPS Energy Guidebook.

4.3.2.1 Attic Insulation

Attic insulation was installed in 855 homes through the Home Efficiency program during FY 2022 compared with 1,156 treated homes in FY 2021. Average gross impacts per home for attic insulation are 2,099 kWh, 0.29 CP kW, 1.09 NCP kW, and 0.22 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.

4.3.2.2 Variable-Speed Pool Pumps

Variable-speed pool pumps were installed in 478 homes through the Home Efficiency program during FY 2022 compared with 484 treated homes in FY 2021. Average gross impacts per home for pool pumps are 1,640 kWh, 1.21 CP kW, 1.81 NCP kW, and 1.12 4CP kW.

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.

4.3.3 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 4-2: 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	784,086	580.60	866.18	535.45
Pool Pumps	1,794,606	243.70	935.94	191.77
Total*	**2,578,693**	**824.30**	**1,802.13**	**727.22**

* Note: 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 HOME ENERGY ASSESSMENTS

4.4.1 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. This program was not offered in FY 2022.

4.5 COOL ROOF PROGRAM

4.5.1 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.

The Cool Roof program was fully managed and implemented internally by CPS Energy in FY 2022. There were 24 projects with an average roof area of 2,015 square feet and average solar reflectance of 69%. Comparatively, FY 2021 had 50 projects with an average roof area of 2,232 square feet and an average solar reflectance of 68%.

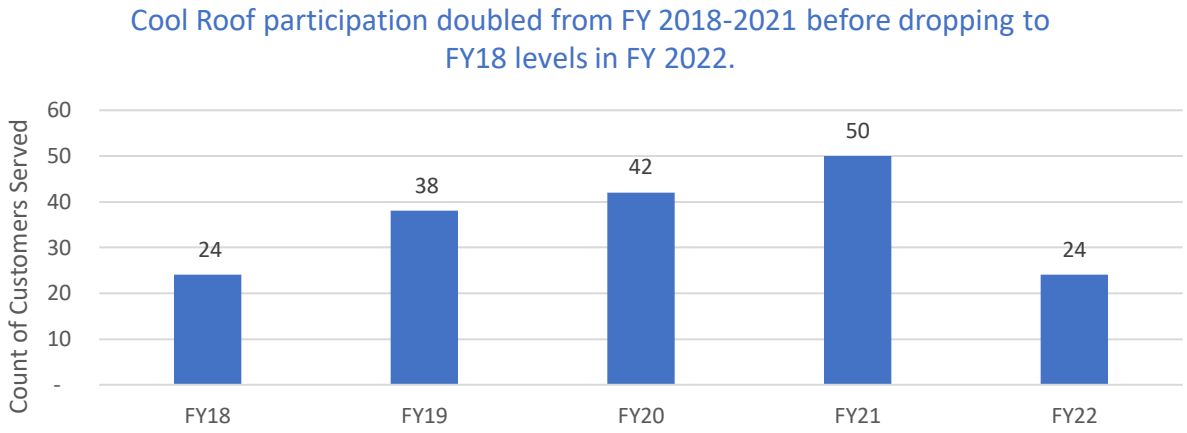


Figure 4-10: Cool Roof – Participation Trends

4.5.2 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. Savings were determined by subtracting the whole house energy use in each hour of the post-retrofit models from the energy use in the pre-retrofit baseline models.

Projects were evaluated based on a desk review of project documentation including square footage, invoices, and confirmation of roofing system reflectivity. Sample project realization rates were applied to the total project population.

4.5.3 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 Cool Roof program.

Table 4-3: 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	17,764	13.44	28.48	18.83

4.6 NEW HOME CONSTRUCTION PROGRAM

4.6.1 Overview

The New Home Construction program offers an incentive to home builders to construct homes that are 15% or 30% more efficient than 2015 International Energy Conservation Code® (IECC) code requirements. Though San Antonio adopted IECC 2018 in June 2018 with an effective date of October 1, 2018, Frontier reviewed the code changes with respect to IECC 2015 and found no substantial changes that impact the measures included in the homes modeled under the IECC 2015 code base. Therefore, estimated savings per home remain unchanged and correspond to the modeling done utilizing the IECC 2015 reference code.

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 Home Energy Rating System® (HERS) rating as well as meeting of all the requirements of the ENERGY STAR® New Homes program.

Table 4-4: New Home Construction – FY 2022 Incentive Levels

Requirement	Incentive
15% or 30% better than IECC 2015 without BSAG Certification	$800
15% or 30% better than IECC 2015 with BSAG Certification	$1,000

4.6.2 Participation Trends

CPS Energy's FY 2022 New Home Construction program provided incentives for 1,690 new homes compared to 2,752 homes in FY 2021.

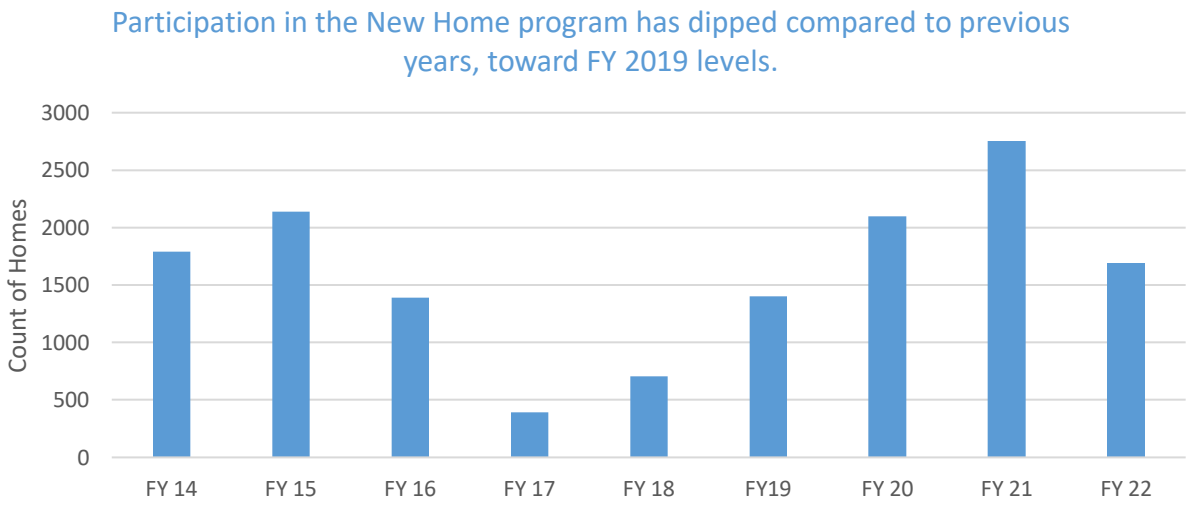


Figure 4-11: New Home Construction – Participation Trends

In the FY 2022 program, there were 1,670 homes certified by BSAG, approximately 98% of the total population (this is an increase of roughly 8% with respect to the FY 2021 BSAG percentage). Two main builders, Lennar and Meritage, built approximately 71% of all the certified homes in the program.

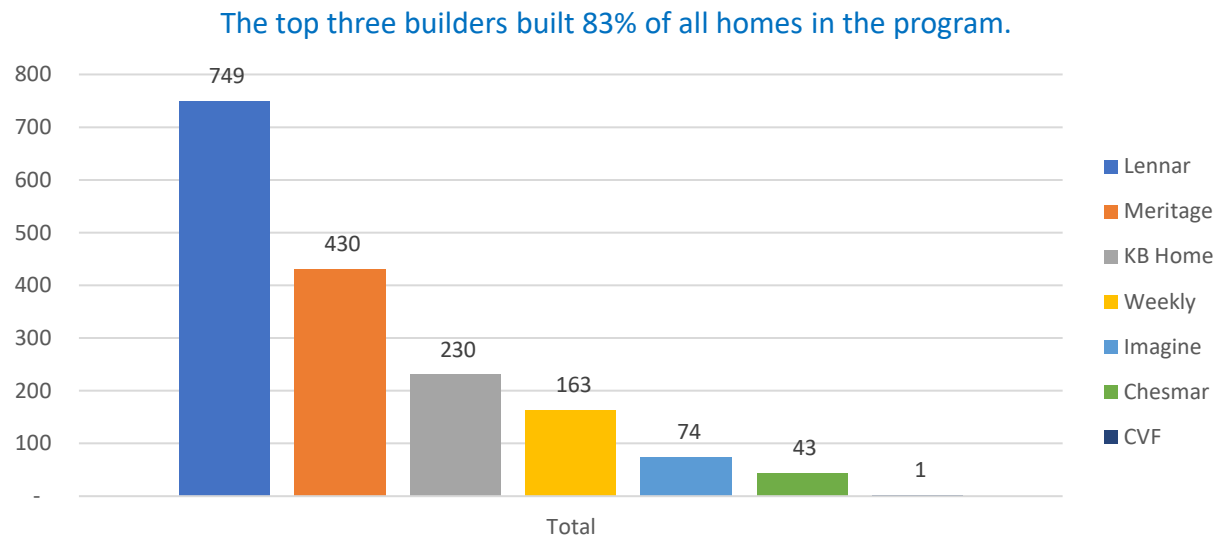


Figure 4-12: New Home Construction – Participation by Builder

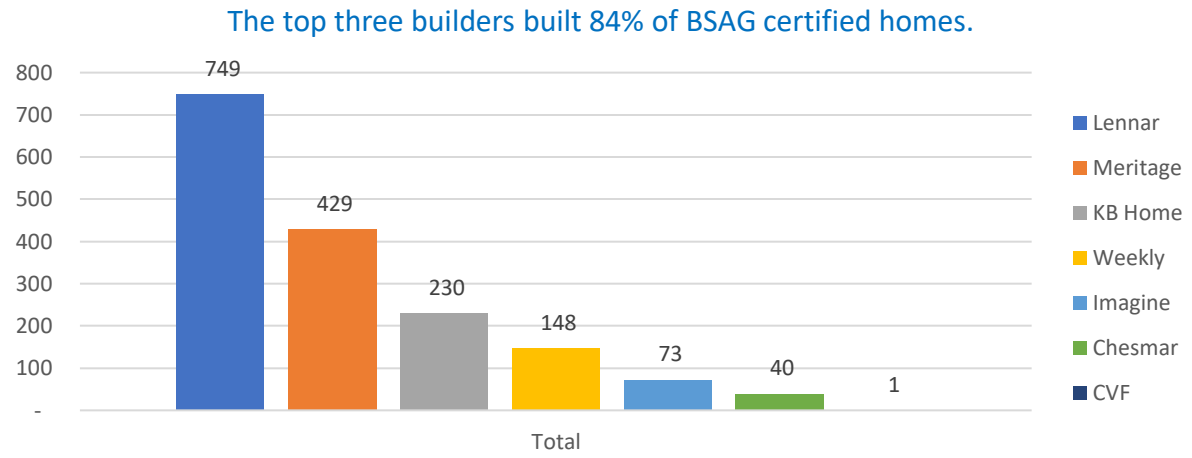


Figure 4-13: New Home Construction – BSAG Certified Participation by Builder

Seven builders participated in the program. Of all homes (i.e., those with BSAG certificates and those without BSAG certificates), Lennar and Meritage still built the most homes (approximately 71% of the FY 2022 total).

4.6.3 Savings Calculation Methods

Homes are accepted into 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 determining the incentive tier for a given project. However, neither tool provides the CP, 4CP, or 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 was able to verify the energy savings estimates from the rating tools and estimate CP, 4CP and NCP demand savings. The base Frontier model was a simple single-story square home with an unfinished attic built on a slab. The reference model was 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. Most 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 exceeded code regulations 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 the following table.[10]

[10] The approach discussed in this section corresponds to homes that are 15% more efficient than the IECC 2015 baseline. However, it should be noted that recent developments have resulted in homes being built which are 30% more efficient than the modeled IECC 2015 baseline. Regardless of this improvement, these homes were reported to have savings equivalent to those of homes which are 15% better than the IECC 2015 baseline. Frontier sought to award additional savings to these homes which were "30%-better-than" by estimating the baseline of a "15%-

Table 4-5: New Home Construction – Deemed Savings per Home

% Above Code	kWh/home	CP kW/home	NCP kW/home	4CP kW/home
15%	1,072	0.603	0.923	0.724
30%	1,385	0.779	1.193	0.936

4.6.4 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. The following are the gross energy and demand savings for the New Home Construction program.

Table 4-6: New Home Construction – 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)
New Home Construction	1,825,536	1,027	1,572	1,233

better-than" home using the modeled output, algebraically computing what a "30%-better-than" home's energy and demand consumption would be using this estimated baseline, calculating energy and demand savings for the scenario in which the fuel utilized in this "30%-better-than" home was 100% electricity, and adjusting these resultant "best-case-scenario" (in which 100% of the fuel utilized is electricity) energy and demand savings by an overall value of percent-electric-fuel (for measures utilized in a newly constructed home) derived from RECS end-use data (sourced below).

https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce2.4.pdf
https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce4.4.pdf
https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce5.1a.pdf
https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce5.1b.pdf
https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce5.2.pdf

4.7 ENERGY SAVINGS THROUGH SCHOOLS

4.7.1 Overview

The Energy Savings Through Schools Program is an in-school education program that provides teachers a classroom curriculum with lessons on conservation and gives students energy efficiency kits to take home. The kits are comprised of three 9-Watt LED lamps, a high-efficiency showerhead, a kitchen faucet aerator, and a bathroom faucet aerator. In FY 2022, the program distributed 5,867 kits, compared to 5,434 in FY 2021.

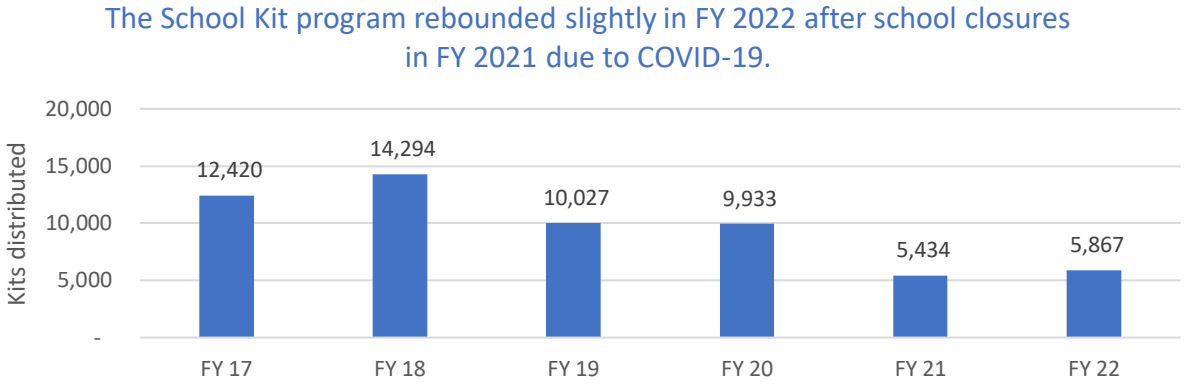


Figure 4-14: Energy Savings Through Schools – Participation Trends

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.

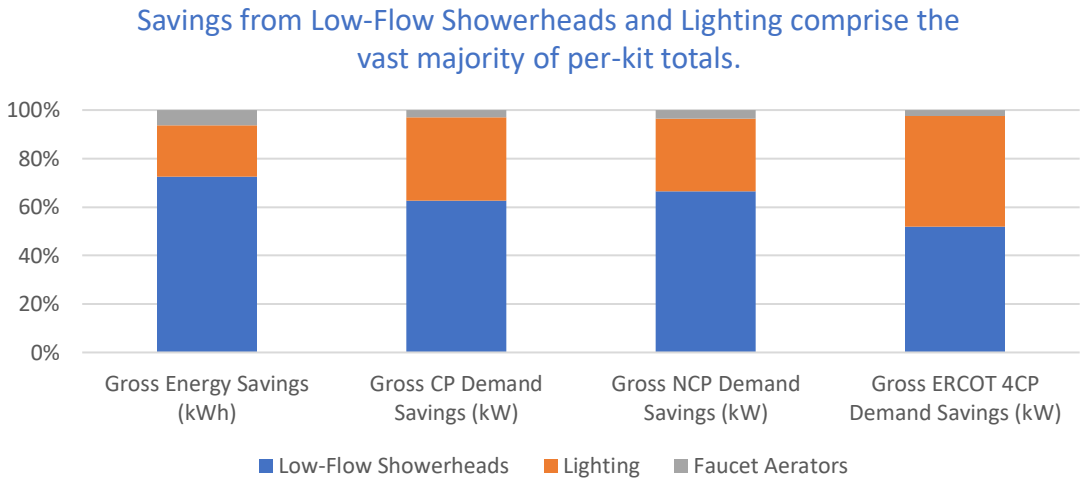


Figure 4-15: Energy Savings Through Schools – Gross Energy and Demand Impacts by Measure

4.7.2 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, 2021 and January 31, 2022 were evaluated against the FY 2022 CPS Energy Guidebook.

As part of the Energy Savings Through Schools program, Franklin Energy distributed 5,867 kits to 53 schools during FY 2022. In comparison to FY 2021, this was an increase in both schools reached and kits distributed. Kits consist of three 9-Watt LED lamps, 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 the sum of electric DHW kit measures are 92 kWh, 0.004 CP kW, 0.029 NCP kW, and 0.004 4CP kW. For the sum of the lighting measures in the kit, the average gross impacts are 50 kWh, 0.006 CP kW, 0.025 NCP kW, and 0.004 4CP kW.

While CP kW is closely aligned with 4CP kW for most measures, there is significant variance between CP and 4CP demand savings for residential lighting. This is because 4CP kW is calculated for hour ending 17 when most residential participants are returning home after the workday, whereas CP kW is calculated based on a review of hours most consistent with CPS Energy's system peak. This peak period aligns more with hour ending 16, which has significantly less usage based on the deemed load shape for residential lighting. This difference was not as noticeable for kits because the bulk of the savings come from the DHW measures, on a per-kit basis. However, the impact is increased as a result of the EISA baseline changes described in the next section.

Given the educational and voluntary nature of this program, energy efficiency measures included in the distributed kits are not directly installed by energy efficiency service providers. Therefore, adjustments are applied to account for kit components that are never installed or are installed in homes with gas water heating.

4.7.2.1 LED Lamps

The CPS Energy Guidebook includes separate calculation methodologies for omni-directional EISA-compliant and specialty EISA-exempt LED lighting. Historically, EISA-affected lamps have savings that are determined using a two-tiered weighting approach due to the baseline change that was expected in 2020. This dual baseline weighting approach changed for FY 2021 to remove the two-tier approach based on feedback from the U.S. Department of Energy indicating that the backstop will not be triggered. EISA first-tier baselines will remain in effect. This change was applied over a reduced measure life meant to approximate the market adoption of omni-directional LEDs.

The savings for specialty EISA-exempt lamps were determined over the entire lifetime of the lamp using the halogen equivalent wattages. Specialty lamp EULs will continue to be calculated based on rated product lifetimes.

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. The savings calculation also incorporates an interactive effects factor to account for the impacts on cooling and heating loads.

Installation rates for the kits were derived from student survey data for the program with an additional 3% to offset the TRM in-service rate. The resultant installation rates for LEDs are 69% for the first LED, 59% for the second LED, and 52% 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 was 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.

Only 56% of kit recipients' homes were assumed to have an electric water heater. The only other upstream kit program in CPS Energy's portfolio which contains a possible gas vs. electric water heater population is the HEA kit program. The HEA kit program was therefore deemed the appropriate proxy to utilize in the Energy Savings Through Schools program to determine DHW fuel type distribution. In the HEA program, participants received either gas or electric water heater kits, and 56% is the FY 2022 proportion of electric water heater kits given out in that program. When these discounted per-unit savings are totaled, the aggregate is reflective of a situation in which 44% of homes have a gas water heater and 56% of homes have an electric water heater.

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.

4.7.3 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. The following are the gross energy and demand savings for the Energy Savings Through Schools program.

Table 4-7: 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	832,330	58.96	312.52	77.67

4.8 RESIDENTIAL RETAIL PARTNERS

4.8.1 Overview

The Residential Retail Partners program offers in-store rebates for ENERGY STAR® certified lighting. The retail program targets specific areas based on previous participation levels and focuses on fewer products for more common residential applications. This program was not offered in FY 2022.

4.9 RESIDENTIAL PROGRAM RECOMMENDATIONS

The updated Guidebook that will apply in FY 2022 contains updates that may impact savings. To ensure consistency of savings methodology between program tracking estimates and evaluation results for individual measures, we recommend revising input assumptions in program tracking systems to match the CPS Energy Guidebook. The evaluation team has identified and detailed specific inputs in a separate memo to program administrators, and included the following general items:

4.9.1 HVAC

- Window ACs:
    - Incorporate a 10% reduction in minimum CEER for units with connected functionality. This adjustment is detailed in the current CPS Energy Guidebook.

4.9.2 Home Efficiency

- Pool Pumps: Currently the highest savings tier available for units rated at 3 hp. This value previously coincided with the highest ENERGY STAR rating. Currently, the ENERGY STAR qualified product listing includes products greater than 3 hp. Until the CPS Energy Guidebook can be updated to reflect these higher tiers, the 3 hp savings tier should be used as a proxy for larger pumps rather than attempting to establish a new deemed savings tier using a ratio of rated hp.

4.9.3 Cool Roof

- The presence of very high realization rates for this program indicate that claimed savings are being underreported. CPS Energy should work with Frontier to evaluate current claimed savings methodologies to ensure alignment with the CPS Energy Guidebook.

4.9.4 New Home Construction

- Frontier anticipates revisions to the current New Home Construction modeling scheme will be necessary given the recent introduction of the IECC 2021 code base. Previously, it was found that IECC 2018 contained no overhauls to IECC 2015 that necessitated adjustments to the model. However, given the implementation vendor transition, the fact that IECC 2015 will be multiple iterations behind this next most-current code base, and how a temporary workaround was introduced in the FY 2020 evaluation to accommodate homes that are 30% more efficient than the IECC 2015 baseline[11], Frontier recommends that CPS Energy consider allowing Frontier to dedicate resources toward updating the current NHC model. In conjunction with such an update, Frontier also anticipates that a review of exactly how the 15%-better-than and 30%-better-than-IECC classification are determined will be needed, given

[11]That is, rather than 15% more efficient than the IECC 2015 baseline: Frontier algebraically estimated the incremental savings that occurred from a 15%-to-30%-more-efficient-than-IECC-2015 increase in FY 2021, with the procedure detailed in the New Home Construction section of this report.

how incentive payments and energy/demand savings differ between these categories. Documentation which explicitly indicates one project as belonging to one category or another will be requested for subsequent evaluations.

4.9.5 General Lighting (Various Programs)

- As of May 9, 2022, the Department of Energy published final rules pertaining to the definition and standards for general service lamps (GSLs). The Texas TRM and CPS Energy Guidebook have not yet been updated to reflect evaluator guidance related to the effective date of these updates. The previously published baseline wattages reduced for compliance with the EISA 2020 backstop should not be enforced until the Texas TRM addresses this topic. Continue to monitor the CPS Energy Guidebook for updates.

5. COMMERCIAL PROGRAMS

5.1 SUMMARY OF COMMERCIAL IMPACTS

CPS Energy's commercial programs portfolio addresses most markets and major commercial end uses. FY 2022 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 2022:

- Commercial & Industrial Solutions (C&I) – energy assessments to identify opportunities and rebates for measures including lighting, HVAC, and refrigeration.
- Schools & Institutions (S&I) – helps schools and government agencies reduce energy use through benchmarking, technical assistance, energy master planning, and rebate offerings.
- Small Business Solutions (SBS) – contractor-led incentive program for small business customers with less than 100 kW demand.

Commercial HVAC measures are no longer offered in a stand-alone program but are eligible to participate under the programs listed above. Projects were evaluated against the FY 2022 CPS Energy Guidebook. For programs or 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 2022 program participants as measured at the participant or end-user level and adjusted to account for net-to-gross ratios and line losses. These figures show program contributions to the commercial portfolio's energy and demand savings. Program names are abbreviated in chart labels.[12]

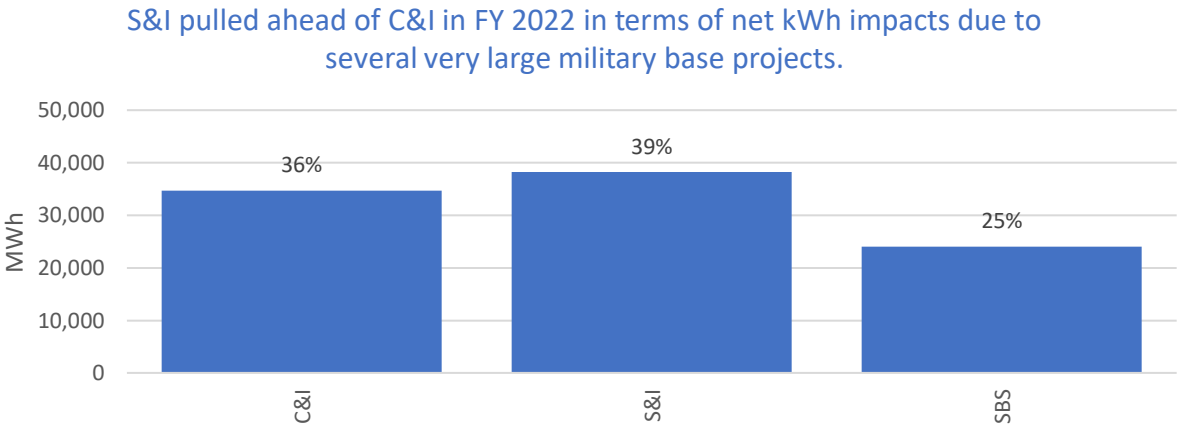


Figure 5-1: Summary of Commercial Impacts – Net Avoided Energy by Program

[12] C&I = Commercial and Industrial, S&I = Schools and Institutions, SBS = Small Business Solutions

Approximately 65% of NCP impacts come from C&I and S&I. SBS increased 5% in FY 2022.

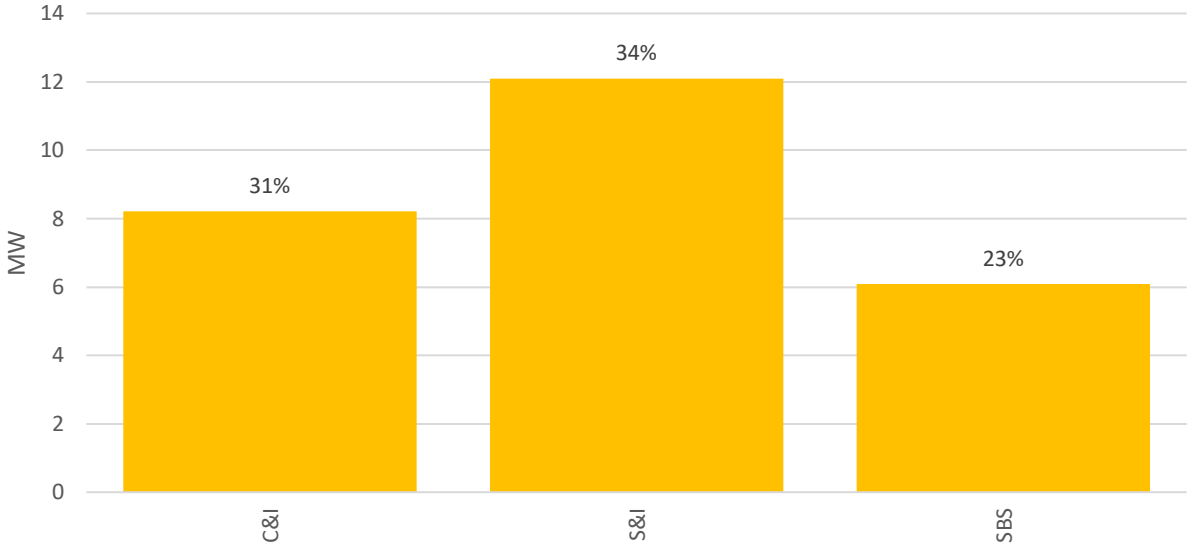


Figure 5-2: Summary of Commercial Impacts – Net Avoided NCP by Program

C&I CP impacts decreasd 10% in FY 2022 but still make up a majority of the overall portfolio. S&I CP impacts are limited due to minimal peak coincidence for schools and outdoor projects.

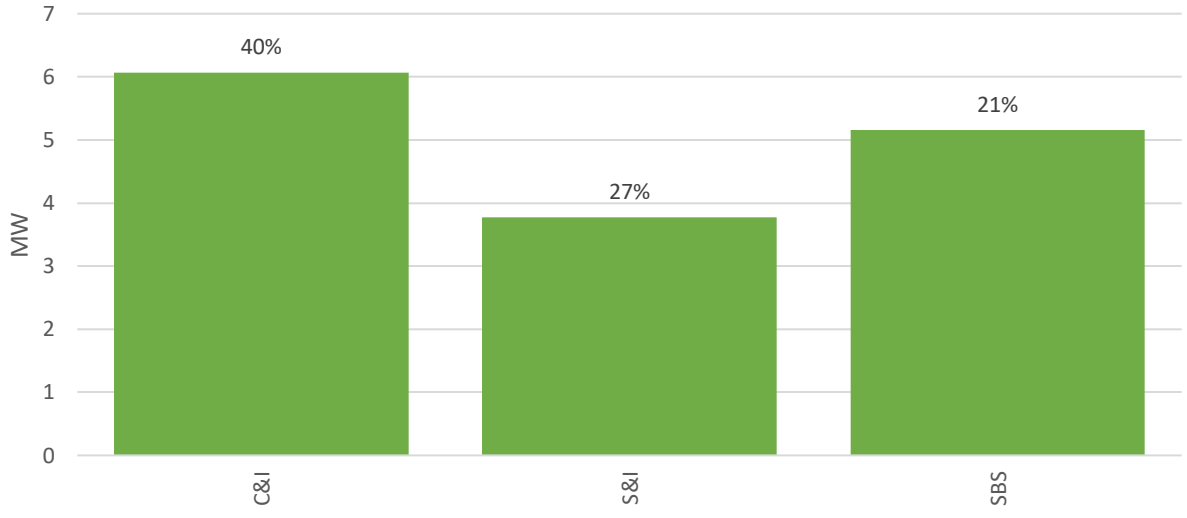


Figure 5-3: Summary of Commercial Impacts – Net Avoided CP by Program

5.2 COMMERCIAL & INDUSTRIAL SOLUTIONS

5.2.1 Overview

The C&I Solutions (C&I) program includes the installation of the following commercial energy efficiency measures: lighting, lighting controls, HVAC, HVAC tune-up (HPTU), custom, and several measures categorized as "Other" due to lower installation rates. In FY 2022, a total of 573 projects were incentivized through the C&I program, compared to 486 in FY 2021.

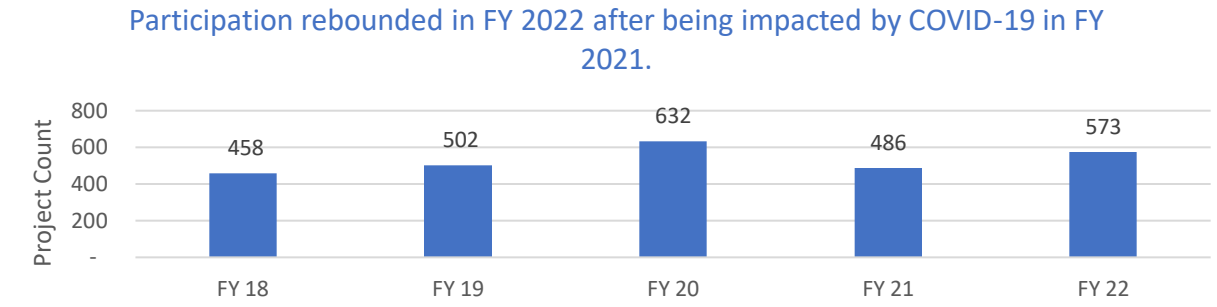


Figure 5-4: C&I Solutions – Participation Trends

The figures below present percentage breakdowns of kWh energy savings. Figure 5-5 shows percentage breakdowns of gross energy, CP, NCP, and 4CP demand impacts by measure.

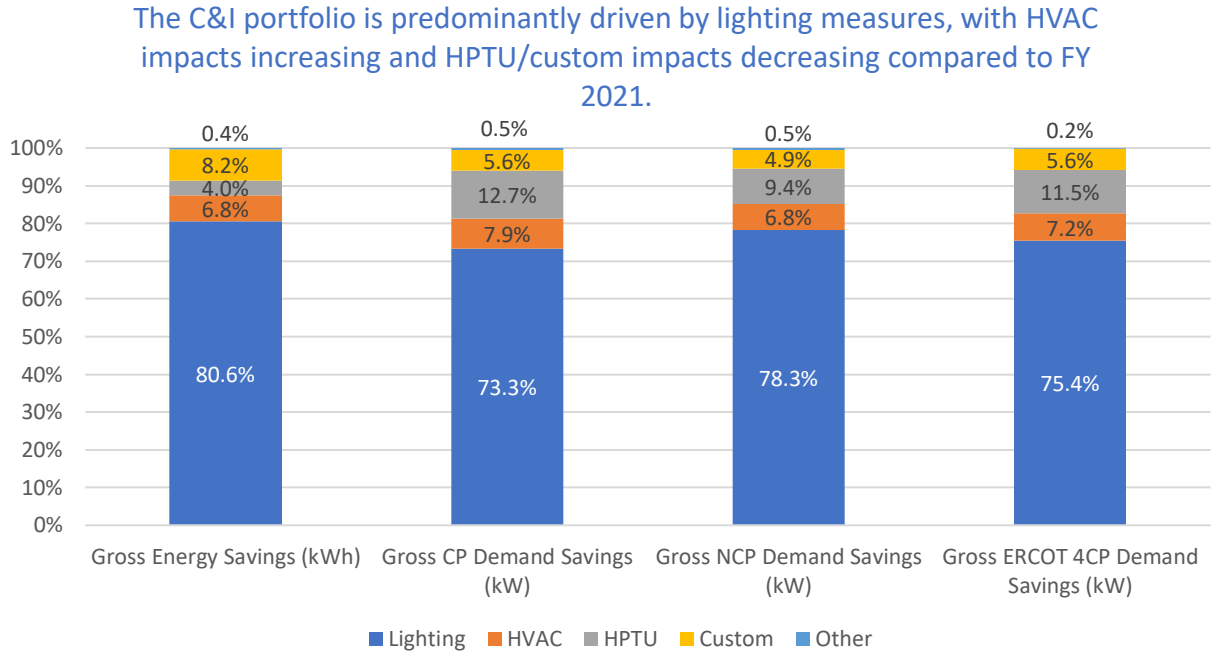


Figure 5-5: C&I Solutions – Gross Energy and Demand Impacts by Measure

5.2.2 Savings Calculation Method

Frontier performed a desk review of 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 were evaluated against the FY 2022 CPS Energy Guidebook.

5.2.2.1 Lighting and Lighting Controls

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.

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. Project documentation is supplemented by evaluator site inspections where applicable.

C&I lighting impacts are split relatively evenly across Mercantile, Office, Outdoor, and all other building types.

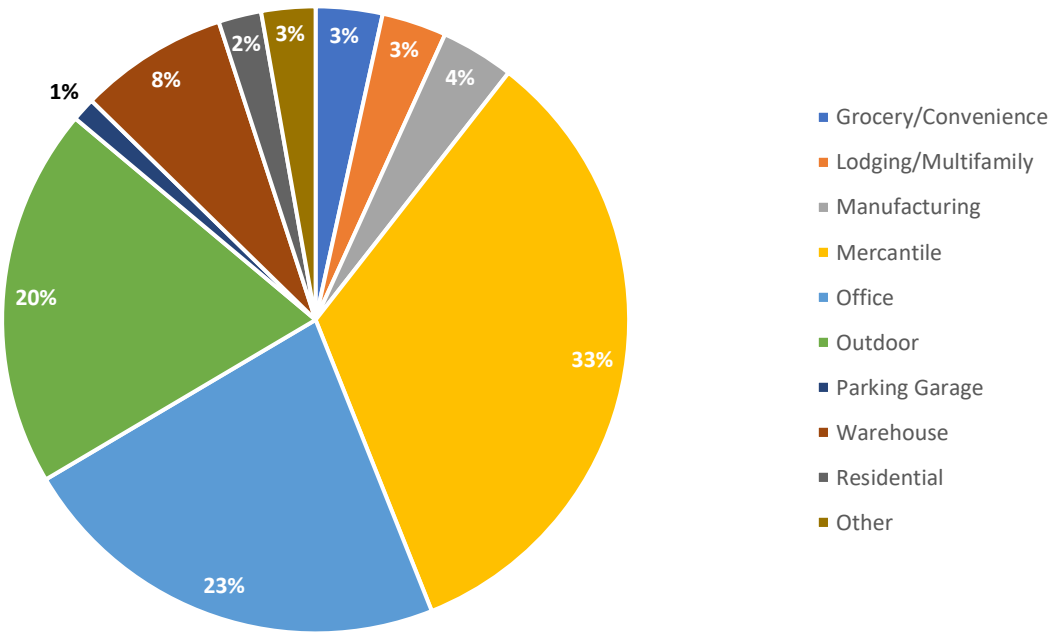


Figure 5-6: C&I Solutions – Percent of kWh Savings by Building Type for Sampled Lighting Projects

New construction projects use an alternate baseline that requires confirmation of several additional measure inputs. Frontier validated the reported IECC 2018 building or exterior space type and corresponding lighting power density (LPD) factor, IECC 2018 zone category (exterior lighting projects only), and treated interior/exterior square footage. IECC 2015 baselines were applied to new construction projects demonstrating a permit date prior to the October 1, 2018 effective date for San Antonio's adoption of IECC 2018.

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

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. After the inclusion of HVAC interactive effects, the CP or 4CP verified savings occasionally exceeded 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. The implementation vendor adopted the practice of claiming the highest calculated demand value (NCP or CP), but 4CP demand was not considered for claimed savings because it was not calculated by the implementation vendor.

Realization rates were calculated for NCP kW, CP kW, and kWh savings by weighting realization rates against the total claimed NCP kW, CP kW, and kWh savings from the FY 2021 evaluation periods. The resulting realization rates were then applied to each claimed savings value from the total FY 2022 measure population. Because the implementation vendor 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

Frontier randomly selected projects for desk review based on the overall HVAC project population. HVAC tune-up and 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. For chiller projects, savings are calculated against both Path A and Path B baselines from IECC 2018, 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. Project documentation is supplemented by evaluator site inspections where applicable.

FY 2022 C&I HVAC impacts are heavily weighted toward water cooled chillers after a relatively even split in FY 2021. However, the distrubution of DX vs. chillers remains consistent with the previous year.

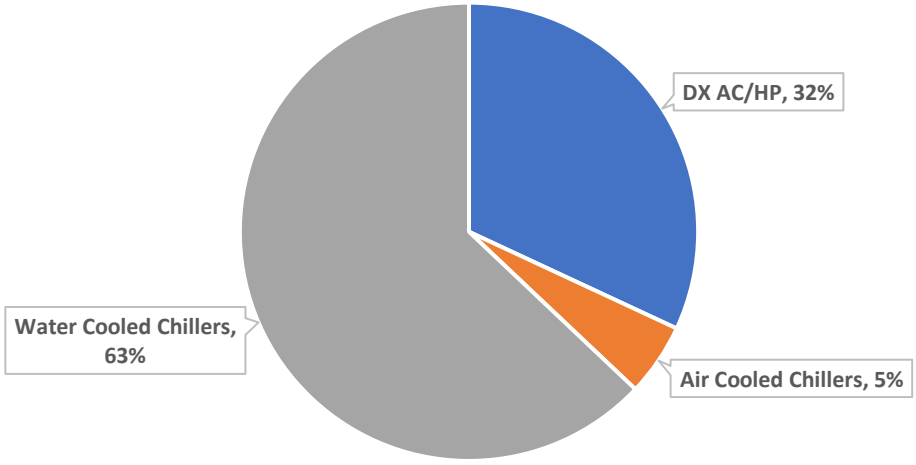


Figure 5-7: C&I Solutions – Percent of kWh Savings by System Type for HVAC Projects

IECC 2015 baselines were applied to new construction projects demonstrating a permit date prior to the October 1, 2018 effective date for San Antonio's adoption of IECC 2018.

Early retirement (ER) 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 (RUL) assumptions were incremented by a year to account for bulk installation during the 2021 calendar year. First and second-tier baselines were weighted using a net present value methodology applying CPS Energy's applicable discount rate, avoided capacity cost, and avoided energy cost factors.

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

Early retirement projects increased by 26% in FY 2022, rebounding after impacts related to COVID-19 led to a trend in customers being less likely to risk exposure in FY 2021. New construction projects also increased 7%.

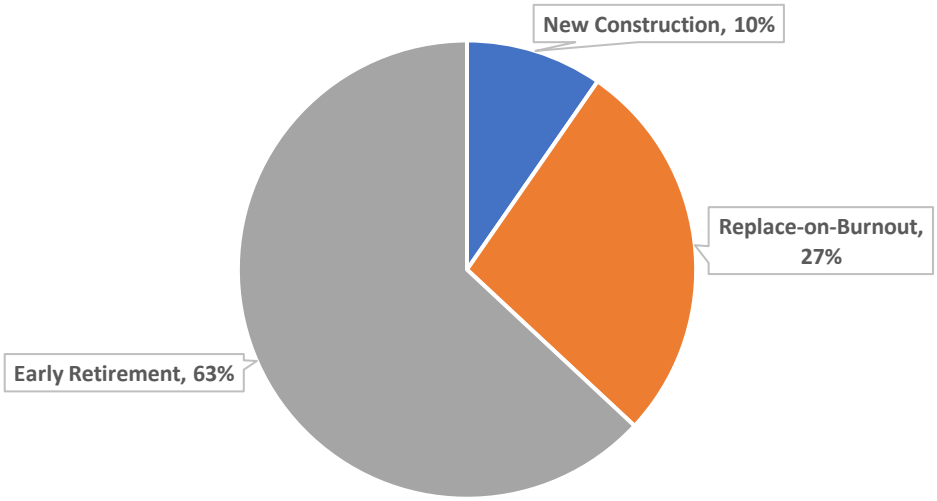


Figure 5-8: C&I Solutions – Percent of kWh Savings by Baseline Type for HVAC Projects

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 the implementation vendor 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 HVAC tune-up measure services air conditioners and heat pumps to improve operating efficiency. Service items may include cleaning the condenser, evaporator, and blower assembly, changing filters, adjusting airflow, and adjusting refrigerant charge as needed. There were 161 HVAC tune-up projects submitted in FY 2022. Frontier sampled 65 projects for desk review consisting of 220 individual HVAC system tune ups. More than 60% of sampled tune-ups were completed at retail strip mall or religious worship locations.

Table 5-1: C&I Solutions – HVAC Tune-up System Count and Capacity for Sampled Projects

Building Type	System Quantity	Average Tonnage
Full-Service Restaurant	18	5.2
Hospital	3	55.0
Large Office	1	7.5
Other	1	4.0
Outpatient Healthcare	6	5.2
Primary School	30	5.5
Quick-Service Restaurant	4	3.5
Religious Worship	65	5.2
Service	17	4.2
Small Hotel/Motel	2	4.5
Small Office	2	4.5
Stand-Alone Retail	3	5.5
Strip Mall	68	4.9
Total	**220**	**5.7**

The CPS Energy Guidebook contains a default efficiency loss factor to estimate savings impacts for tune-ups. Energy savings are calculated by estimating the efficiency of the cooling equipment before the tune-up using an efficiency loss factor because of dirty coils, blower, and filter, improper airflow, and/or incorrect refrigerant charge. The implementation vendor requested that the evaluation team apply an alternate efficiency loss factor obtained from field-measured performance data. This was not possible during the FY 2021 evaluation schedule and Frontier, at the time, opted to apply average realization rates from FY 2019 and FY 2020 to the total claimed impacts for the tune-up measure.

Following FY 2021, Frontier concluded it was appropriate to utilize the implementer's efficiency loss after conducting a thorough review of the variable, determining the calculations utilized to produce it were sound in their entirety. Final output between Frontier and the implementer was compared and found to be within one percent variability. This increased realization rates for the tune-up measure significantly.

5.2.2.4 Other Measures

Due to the small population of non-lighting or HVAC measure types, Frontier selected a higher percentage of the overall other measure population for desk review. Savings were validated using the savings methodologies outlined in the CPS Energy Guidebook.

Project documentation was reviewed to verify all relevant inputs, including but not limited to building type, cooling/heating type, and relative product specifications. Project documentation is supplemented by evaluator site inspections where applicable.

Other measures include, but are not limited to, the following: Solar LED lighting, VFDs, lodging lighting/HVAC occupancy controls, cool roofs, exterior door air infiltration, refrigeration, food service, and window treatments.

5.2.2.5 Custom

There were 25 custom projects completed in FY 2022, encompassing a variety of energy efficiency efforts that included HVAC schedule adjustments and system tune ups, building renovations[13], air compressor upgrades, and retro-commissioning. Frontier sampled 19 projects for desk review, each of which contained various magnitudes of individual measures associated with the project.

Certain individual measures classified as "custom" measures within the custom portfolio, such as commercial refrigeration and food service, follow deemed savings methodologies from the CPS Energy Guidebook. These types of measures were classified as "other" and were evaluated as deemed measures. This section covers non-deemed measures requiring non-standard calculation approaches. Frontier will recommend that a distinction is made between such measures in future evaluations.

Custom projects were predominantly HVAC-related and were validated individually during implementation by reviewing submitted M&V plans, confirming methodologies were statistically or methodologically sound, and ensuring that documentation was present, valid, and corresponded to the independent variables needed to compute savings for each individual measure.

[13] There was one "Building Renovations" project in FY 2022 at a major office building site. Main improvements included a new DDC control system, new VAV boxes throughout all floors, new 100- and 120-ton condensing units, a new packaged make-up air unit, and new LED lighting. This project derived claimed savings from the standard M&V approach for "Option C" (a utility building analysis), a regression-based method. To evaluate this project, Frontier assessed the statistical validity of the regression's coefficients and fit statistics, ensuring that goodness-of-fit variables were within thresholds commonly utilized in energy modeling.

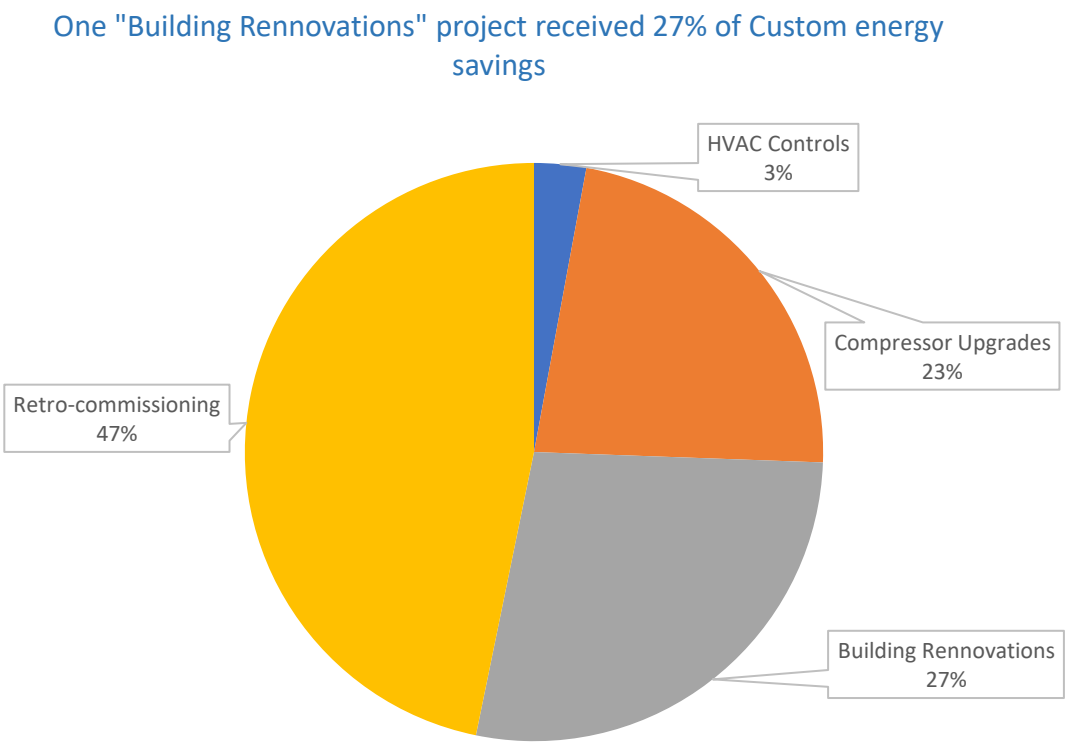


Figure 5-9: C&I Solutions – Energy Savings by Custom Project Type

C&I again saw an increase in retro-commissioning (RCx) projects as a proportional total of the Custom portfolio (from 23% to 47%, by approximately one quarter of savings for FY 2022 custom projects). Though RCx projects increased proportionally, their contributions to savings overall decreased by roughly half. These projects consist of building operation control measures such as air distribution supply temperature and static pressure reset, optimization of demand control ventilation systems, chiller tune-ups and chilled water reset, and schedule changes to align HVAC system operation with occupancy.

Due to COVID-19 restrictions limiting access to sites, no attempt was made to confirm that adjustments to building operation controls persisted. Instead, detailed project documentation including screenshots of building control systems schedules, system setpoints, and the associated calculations were submitted; these items were thoroughly reviewed and cross-referenced by Frontier. Combined with the fact that previous large-scale custom evaluations have produced realization rates of virtually 100%, Frontier concluded that the detail was sufficient for complete verification of the implemented measures for FY 2022.

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). Estimated useful life (EUL) was determined for each individual product based on the reported product type. This approach will continue as long as the reported EUL maintains a high level of consistency with the reported product type for desk review projects.

Table 5-2: 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	27,643,295	4,259.76	6,366.49	4,343.63
HVAC	2,336,577	455.98	555.80	414.99
HPTU	1,368,625	739.13	767.37	664.36
Custom	2,798,499	325.12	401.52	323.52
Other	151,922	28.45	38.26	12.56
Total*	**34,298,919**	**5,808.44**	**8,129.44**	**5,759.06**

* Note: 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 (HPTU), custom, and several measures categorized as "Other" due to lower installation rates. In FY 2022, a total of 137 projects were incentivized through the Schools & Institutions program, compared with 122 in FY 2021.

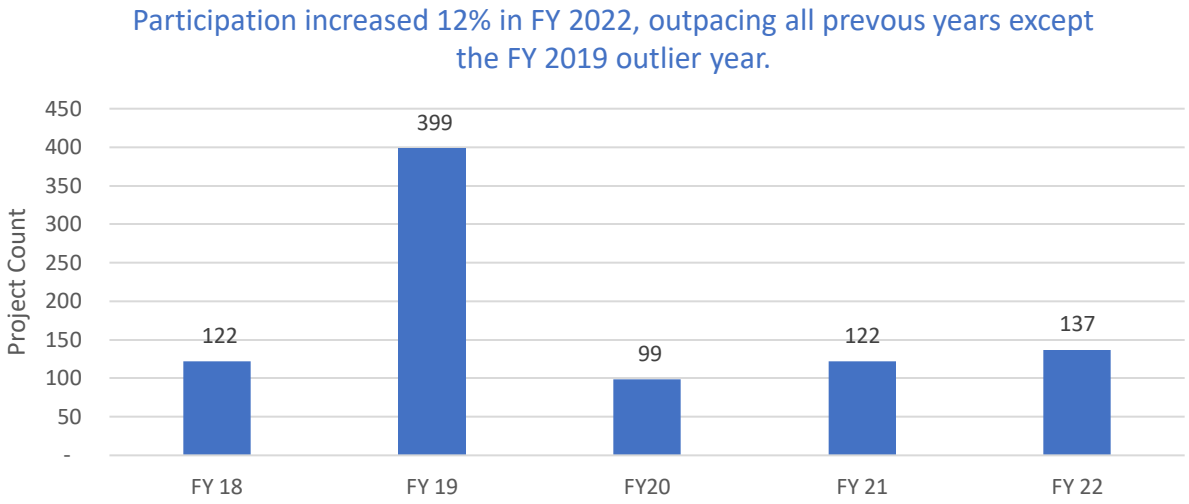


Figure 5-10: Schools & Institutions – Participation Trends

The figures below present percentage breakdowns of kWh energy savings. Figure 5-11 shows percentage breakdowns of gross energy, CP, NCP, and 4CP demand impacts by measure. The large custom contribution is made up of several measures, including Commercial Behavior-Operational Projects (CBOP) and retro-commissioning projects (RCx), that predominantly impact HVAC system operation. These measures have a low peak coincidence for schools. Therefore, those projects represent a lower share of CP and 4CP impacts.

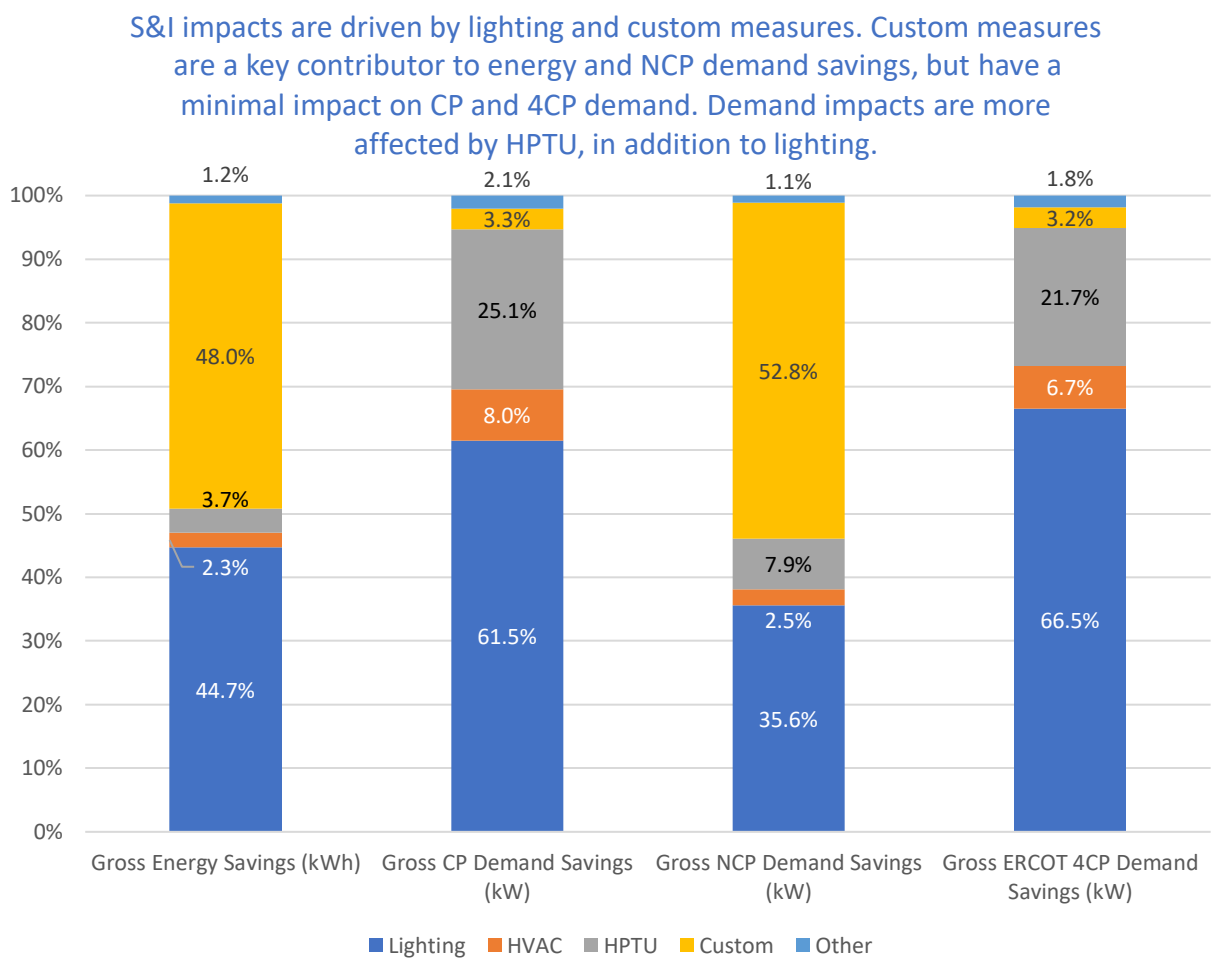


Figure 5-11: Schools & Institutions – Gross Energy and Demand Impacts by Measure

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, 2021 and January 31, 2022 were evaluated against the FY 2022 CPS Energy Guidebook.

5.3.2.1 Lighting and Lighting Controls

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.

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. Project documentation is supplemented by evaluator site inspections where applicable.

S&I lighting impacts were impacted by several large military projects. Outdoor lighting delivered approximately 90% of non-military project savings, with most occurring on educational campuses.

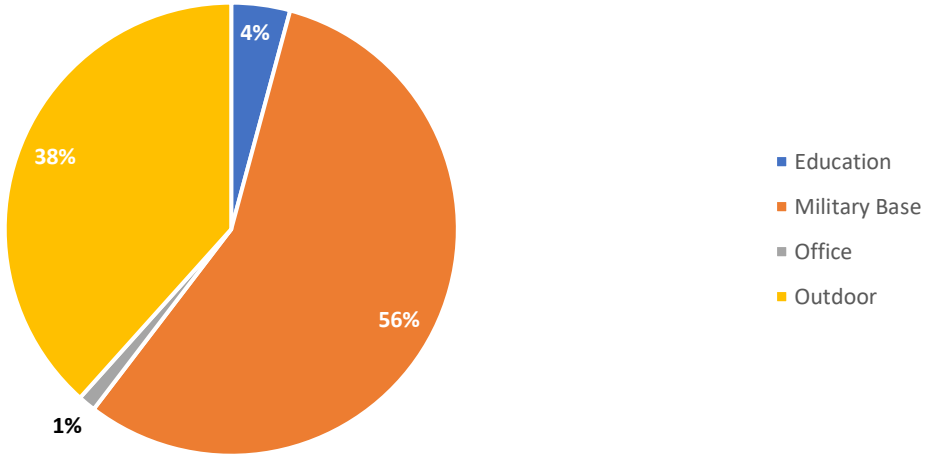


Figure 5-12: Schools & Institutions – Percent of kWh Savings by Building Type for Sampled Lighting Projects

New construction projects use an alternate baseline that requires confirmation of several additional measure inputs. Frontier validated the reported IECC 2018 building or exterior space type and corresponding lighting power density (LPD) factor, IECC 2018 zone category (exterior lighting projects only), and treated interior/exterior square footage. IECC 2015 baselines were applied to projects demonstrating a permit date prior to the October 1, 2018 effective date for San Antonio's adoption of IECC 2018.

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. After the inclusion of HVAC interactive effects, the CP or 4CP verified savings occasionally exceeded 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. The implementation vendor adopted the practice of claiming the highest calculated demand value (NCP or CP), but 4CP demand was not considered for claimed savings because it was not calculated by the implementation vendor.

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 the implementation vendor 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

Frontier randomly selected projects for desk review based on the overall HVAC project population. HVAC tune-up and 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. For chiller projects, savings are calculated against both Path A and Path B baselines from IECC 2018, 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. Project documentation is supplemented by evaluator site inspections where applicable.

S&I HVAC impacts are heavily weighted toward chillers. Water cooled chillers are missing from the desk review sample after accounting for 60% of FY 2021 impacts.

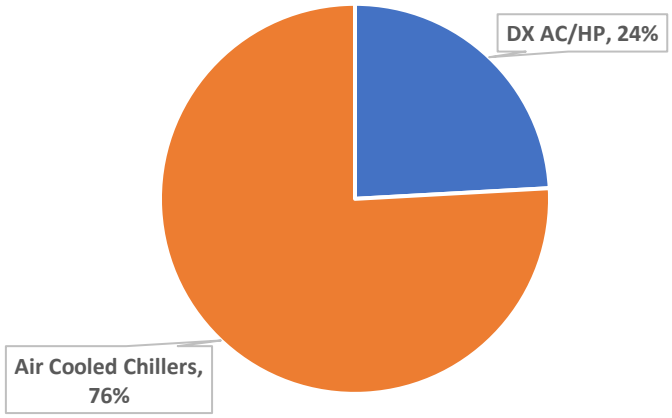


Figure 5-13: Schools & Institutions – Percent of kWh Savings by System Type for HVAC Projects

IECC 2015 baselines were applied to new construction projects demonstrating a permit date prior to the October 1, 2018 effective date for San Antonio's adoption of IECC 2018.

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 (RUL) assumptions were incremented by a year to account for bulk installation during the 2021 calendar year. First and second-tier baselines were weighted using a net present value methodology applying CPS Energy's applicable discount rate, avoided capacity cost, and avoided energy cost factors.

FY 2022 NC impacts approximately doubled compared to FY 2021. ER impacts decreased from 72% to 34%, and ROB increased from 1% to 9%.

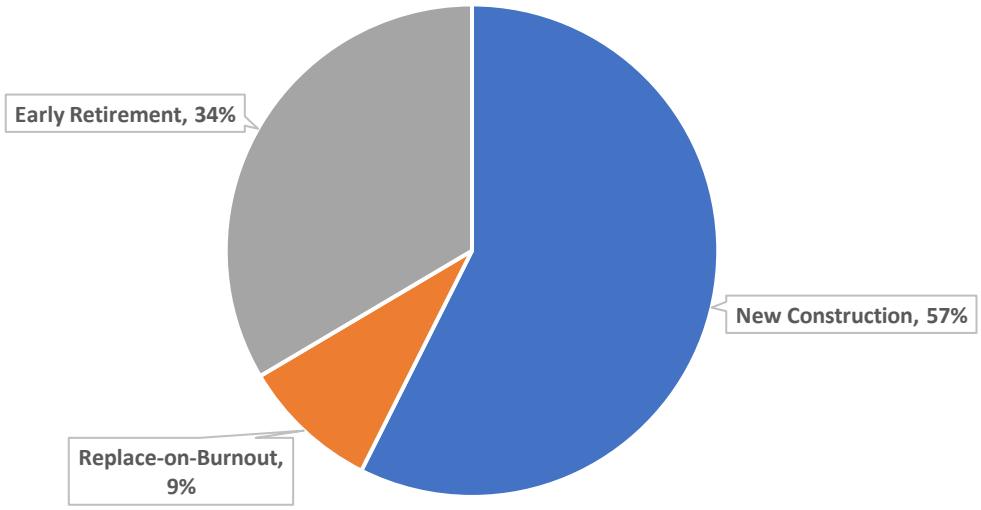


Figure 5-14: Schools & Institutions – Percent of kWh Savings by Baseline Type for HVAC Projects

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 the implementation vendor 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

The HVAC tune-up measure services air conditioners and heat pumps to improve operating efficiency. Service items may include cleaning the condenser, evaporator, and blower assembly, changing filters, adjusting airflow, and adjusting refrigerant charge as needed. There were 20 HVAC tune-up projects submitted in FY 2022. Frontier sampled 17 projects for desk review consisting of 454 individual HVAC system tune ups. Though this a decrease in projects overall (77 in FY 2021 to 20 in FY 2022), the amount of individual HVAC system tune ups sampled is roughly equivalent. Virtually all of sampled tune-ups were completed at primary school locations.

Table 5-3: Schools & Institutions – HVAC Tune-up System Count and Capacity for Sampled Projects

Building Type	System Quantity	Average Tonnage
Primary School	453	5.0
Religious Worship	1	5.0
Total	**454**	**5.0**

The CPS Energy Guidebook contains a default efficiency loss factor to estimate savings impacts for tune-ups. Energy savings are calculated by estimating the efficiency of the cooling equipment before the tune-up using an efficiency loss factor because of dirty coils, blower, and filter, improper airflow, and/or incorrect refrigerant charge. The implementation vendor requested that the evaluation team apply an alternate efficiency loss factor obtained from field-measured performance data. This was not possible during the FY 2021 evaluation schedule and Frontier, at the time, opted to apply average realization rates from FY 2019 and FY 2020 to the total claimed impacts for the tune-up measure.

Following FY 2021, Frontier concluded it was appropriate to utilize the implementer's efficiency loss after conducting a thorough review of the variable, determining the calculations utilized to produce it were sound in their entirety. Final output between Frontier and the implementer was compared and found to be within one percent variability. This increased realization rates for the tune-up measure significantly.

5.3.2.4 Other Measures

Due to the small population of non-lighting or HVAC measure types, Frontier selected a higher percentage of the overall other measure population for desk review. Savings were validated using the savings methodologies outlined in the CPS Energy Guidebook.

Project documentation was reviewed to verify all relevant inputs, including but not limited to building type, cooling/heating type, and relative product specifications. Project documentation is supplemented by evaluator site inspections where applicable.

Other measures include, but are not limited to, the following: Solar LED lighting, VFDs, lodging lighting/HVAC occupancy controls, cool roofs, exterior door air infiltration, refrigeration, food service, and window treatments.

5.3.2.5 Custom

There were eight custom and other projects completed in FY 2022, which consisted of four Retro-commissioning and four Resource Management Services (RMS) projects that achieve energy savings through operational and behavioral modification strategies. Each project itself contained various magnitudes of individual measures, which were HVAC or behavioral in nature. While COVID-19 restrictions prevented site access to verify installations, Frontier conducted a thorough documentation review for all projects. This review consisted of an assessment of project photos, verification of HVAC equipment parameters, and detailed discussions with the implementation team about methodologies (especially for behavioral measures). Given the population size, *all* projects were "sampled."

Certain individual measures classified as "custom" measures within the custom portfolio, such as window film/screens and commercial refrigeration, follow deemed savings methodologies from the CPS Energy Guidebook. These types of measures were classified as "other" and were evaluated as deemed measures. This section covers non-deemed measures requiring non-standard calculation approaches. Frontier will recommend that a distinction is made between such measures in future evaluations.

Custom projects were predominantly HVAC or behavioral-related energy efficiency efforts and were validated individually during implementation by reviewing submitted M&V plans, confirming methodologies were statistically or methodologically sound, and ensuring that documentation was present, valid, and corresponded to the independent variables needed to compute savings for each individual measure. School districts participating in FY 2022 included Judson Independent School District (ISD) and San Antonio ISD.

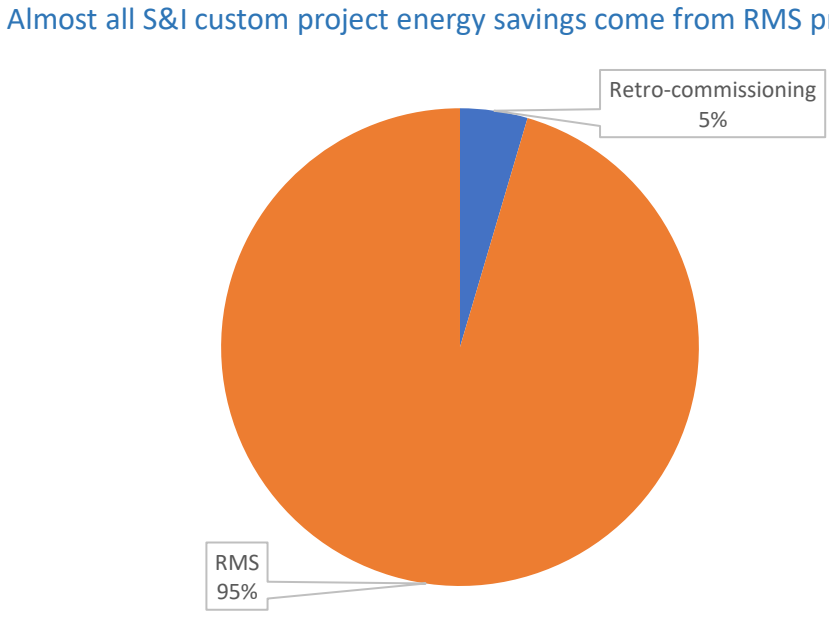


Figure 5-15: Schools & Institutions – Energy Savings by Custom Project Type

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). Estimated useful life (EUL) was determined for each individual product based on the reported product type. This approach will continue as long as the reported EUL maintains a high level of consistency with the reported product type for desk review projects.

Table 5-4: 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)
Lighting	16,884,599	2,218.36	4,261.26	2,393.05
HVAC	885,989	288.36	302.87	239.55
HPTU	1,409,267	905.92	948.69	780.82
Custom	18,148,563	118.59	6,318.87	116.72
Other	458,025	73.99	132.14	65.96
Total*	**37,786,443**	**3,605.22**	**11,963.84**	**3,596.11**

* Note: 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 direct-install (SBDI) measures: direct install lighting and lighting controls, direct install HVAC, and HVAC tune-ups (HPTU), as well as a separate midstream lighting component. In FY 2022, a total of 12 midstream batches and 517 SBDI projects were incentivized through the Small Business Solutions (SBS) program. After participation decreased approximately 58% in FY 2021, it rebounded by approximately 120% in FY 2022 as COVID-19 restrictions dissipated. Despite being the leading contributor for program savings, participation trends are less transparent for midstream lighting because each batch can vary significantly in terms of total lamps distributed.

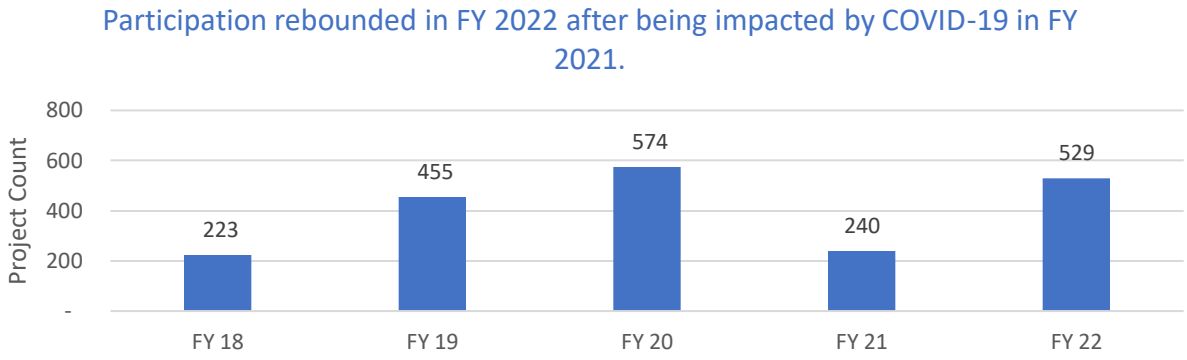


Figure 5-16: Small Business Solutions – Participation Trends

Figure 5-17 presents percentage breakdowns of gross energy, NCP, CP, and 4CP demand impacts by measure.

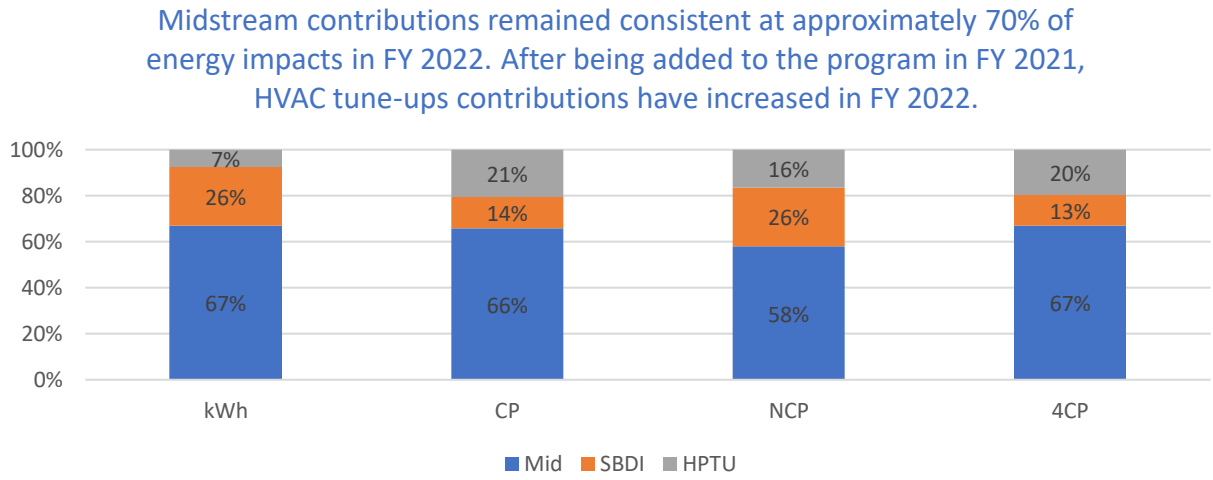


Figure 5-17: Small Business Solutions – Gross Energy and Demand Impacts by Measure

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, 2021 and January 31, 2022 were evaluated against the FY 2022 CPS Energy Guidebook.

5.4.2.1 Midstream Lighting Program

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 for the SBDI 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.

Because only randomly selected batches are selected for evaluation, lamp and fixture type is best analyzed on a percentage basis. Integral ballast screw-in and plug-in general service lamp and linear/tubular LED lamps (TLEDs) are more commonly included for several reasons, including lower cost, increased customer familiarity, and ease of installation, among others.

Screw-in or plug-in GSL and reflector lamps make up over 50% of desk review sample. TLEDs make up over 25%. These lamps are easier for customers to identify and install without the assistance of a contractor.

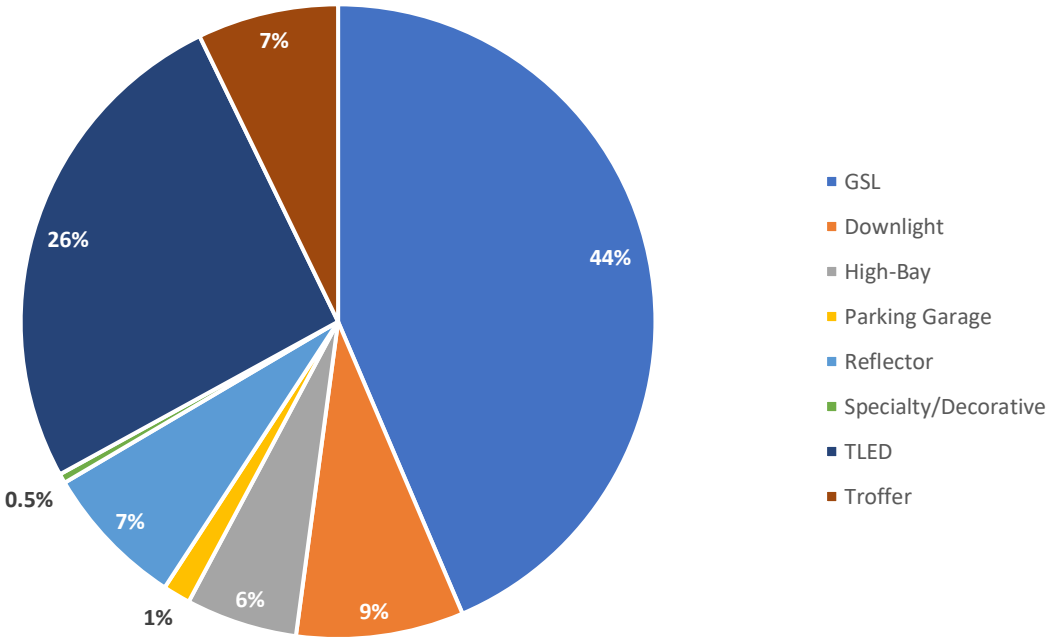


Figure 5-18: Small Business Solutions – Midstream Desk Review Lamp Type Distribution

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. Inspections are not applicable to this program design.

After the inclusion of HVAC interactive effects, the CP or 4CP verified savings occasionally exceeded 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. Unlike with the C&I Solutions and Schools & Institutions programs, the implementation vendor has not yet adopted the approach to substitute the higher value between calculated NCP and CP demand savings as the claimed NCP kW.

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 the implementation vendor 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 SBDI – Lighting Measures

Lighting measures make up the majority of SBDI installations. 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. Several lighting power density (LPD) factors were updated for compliance with IECC 2018. Most of these did not impact the FY 2022 evaluation, as sampled desk review projects were typically permitted under IECC 2015. Additionally, the SBS Direct program typically seems to focus on retrofit applications.

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. Savings are also adjusted to align with implementer and evaluator inspection results when available.

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. After the inclusion of HVAC interactive effects, the CP or 4CP verified savings occasionally exceeded 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. Unlike with the C&I Solutions and Schools & Institutions programs, the implementation vendor has not yet adopted the approach to substitute the higher value between calculated NCP and CP demand savings as the claimed NCP kW.

New construction projects use an alternate baseline that requires confirmation of several additional measure inputs. Frontier validated the reported IECC 2018 building or exterior space type and corresponding lighting power density (LPD) factor, IECC 2018 zone category (exterior lighting projects only), and treated interior/exterior square footage. IECC 2015 baselines were applied to projects demonstrating a permit date prior to the October 1, 2018 effective date for San Antonio's adoption of IECC 2018. However, this program focused almost exclusively on retrofit applications.

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.

Realization rates are applied in the same way as for the midstream lighting measures.

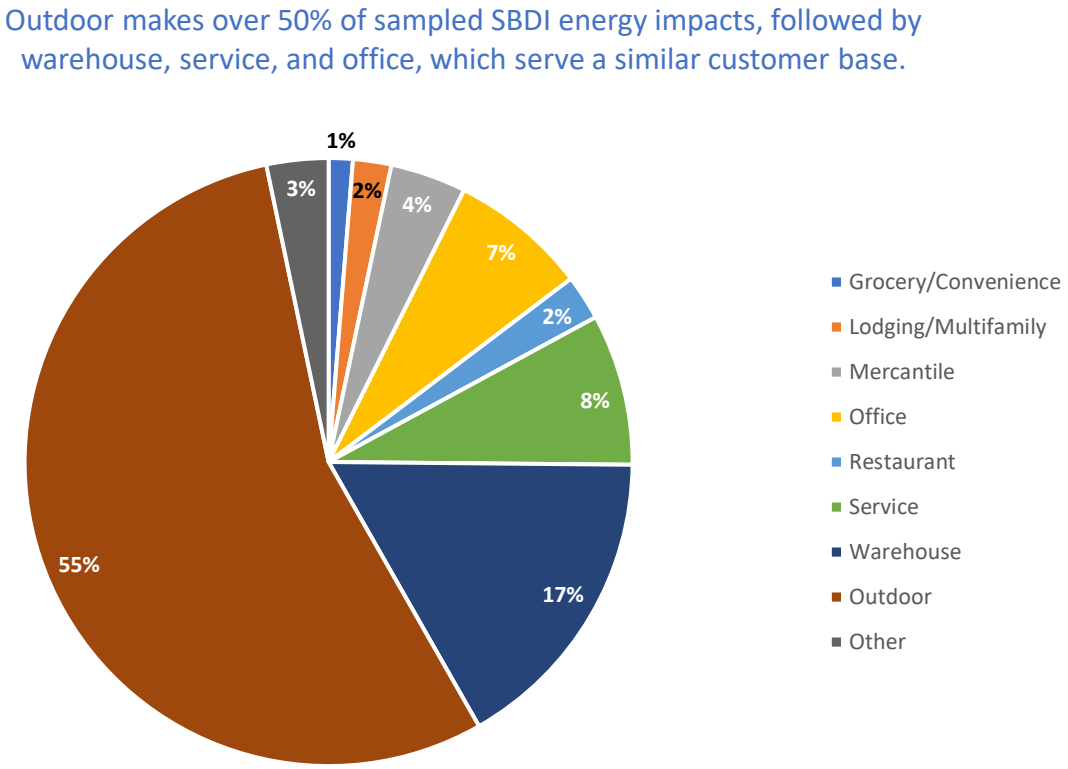


Figure 5-1919: Small Business Solutions – SBDI Desk Review Energy Impacts by Building Type

5.4.2.3 HVAC Tune-Ups

The HVAC tune-up measure services air conditioners and heat pumps to improve operating efficiency. Service items may include cleaning the condenser, evaporator, and blower assembly, changing filters, adjusting airflow, and adjusting refrigerant charge as needed. After being added to SBDI in FY 2021, participation increased to 246 during FY 2022 compared to only three in FY 2021. Frontier randomly selected projects for desk review based on the overall HPTU project population. Over one third of sampled tune-ups were completed at retail strip mall locations.

Table 5-5: Small Business Solutions – HVAC Tune-up System Count and Capacity for Sampled Projects

Building Type	System Quantity	Average Tonnage
Convenience	1	5.0
Full-Service Restaurant	13	5.3
Large Hotel	4	2.1
Other	2	4.0
Outpatient Healthcare	23	5.8
Primary School	5	14.8
Quick-Service Restaurant	13	4.8
Religious Worship	14	5.1
Service	5	5.6
Small Office	2	3.8
Stand-Alone Retail	5	4.9
Strip Mall	51	4.6
Total	**138**	**5.3**

The CPS Energy Guidebook contains a default efficiency loss factor to estimate savings impacts for tune-ups. Energy savings are calculated by estimating the efficiency of the cooling equipment before the tune-up using an efficiency loss factor because of dirty coils, blower, and filter, improper airflow, and/or incorrect refrigerant charge. The implementation vendor requested that the evaluation team apply an alternate efficiency loss factor obtained from field-measured performance data. This was not possible during the FY 2021 evaluation schedule and Frontier, at the time, opted to apply average realization rates from FY 2019 and FY 2020 to the total claimed impacts for the tune-up measure.

Following FY 2021, Frontier concluded it was appropriate to utilize the implementer's efficiency loss after conducting a thorough review of the variable, determining the calculations utilized to produce it were sound in their entirety. Final output between Frontier and the implementer was compared and found to be within one percent variability. This increased realization rates for the tune-up measure significantly.

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 realization rates were applied to the entire project population. EUL was determined for each individual product based on the reported product type. This approach will continue as long as the reported EUL maintains a high level of consistency with the reported product type for desk review projects.

Table 5-6: 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 Lighting	16,412,998	3,296.49	3,590.13	3,342.68
SBDI Lighting	6,248,546	678.75	1,585.75	671.74
SBDI HPTU	1,824,827	1,036.82	1,017.96	983.56
Total*	**24,486,370**	**5,012.06**	**6,193.84**	**4,997.97**

* Note: 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 COMMERCIAL PROGRAM RECOMMENDATIONS

To ensure consistency of savings methodology between program tracking estimates and evaluation results for individual measures, we recommend revising input assumptions in program tracking systems to match the CPS Energy Guidebook. The evaluation team has identified and detailed specific inputs in a separate memo to program administrators, and included the following general items:

5.5.1 Commercial & Industrial Solutions (C&I) and Schools & Institutions (S&I)

- Lighting and Lighting Controls:
    - Fixture codes:
        - Consider using the Texas TRM standard fixture wattage table, available for download at https://texasefficiency.com/index.php/regulatory-filings/lighting. This will resolve the previous recommendations and all other fixture code discrepancies. Specifically, most linear and compact fluorescent fixture wattages were updated in the most recent 9/2021 release.
- HVAC:
    - Update early retirement default age for systems where the manufacture year is unknown to set age equal to the measure estimated useful life (EUL). The FY 2022 CPS Energy Guidebook is inconsistent in this guidance because only the baseline section was updated to reflect this guidance. The RUL table still refers to outdated default EUL values and will be corrected in a future guidebook release.
- HPTU:
    - Efficiency loss variable utilized in HPTU savings calculations:
        - Prior to the FY 2022 evaluation, the variable was subject to a thorough vetting process by Frontier. The implementer's efficiency losses per project were found to be within one percent variability of Frontier's own calculated output. Calculations were therefore deemed sound and the implementer's variables were utilized for this evaluation.
        - However, the efficiency losses which are eventually utilized in computing final savings are subject to a process that averages those vetted as-calculated variables for a specific group of subsets of the tune-up population (currently, whether a refrigerant adjustment was made). The implementer's justification against further stratification prior to the averaging is that more granular or additional strata are statistically insignificant with respect to the differences in their efficiency losses. Frontier has found that more groupings are possible beyond what is currently utilized and that these exhibit statistically different average efficiency losses with viable population sizes. We anticipate a need to

examine whether the current groupings utilized in the averaging procedure represent sufficient stratification of the population.

- With respect to the current groupings utilized in the averaging, Frontier also requests that output be provided that demonstrates how the differences between the strata are statistically significant. Additionally, demonstrate that other logical grouping options have been exhausted, whether that be by way of a two-sample t test or otherwise.

- Custom:
  - Frontier recommends that CPS Energy consider allowing Frontier to dedicate resources toward vetting the calculators utilized to compute Retro-commissioning (RCxLite), RMS, and compressor-related savings. Though M&V Reports were provided by the implementer which allowed for a thorough theoretical review of the calculations contained therein, it has been multiple years (in some cases) since the associated programming has been reviewed. Doing so will expedite the custom evaluation process and allow Frontier to focus primarily on confirming the accuracy of input variables, as the procedures which generate output will have, at that point, been cleared.

5.5.2 Small Business Solutions (SBS)

- Midstream Lighting:
  - Investigate possible overlap for products distributed through this program and the expected Residential Retail Partners lighting program.

- SBDI Lighting:
  - Documentation for the Small Business Program has improved significantly in recent years. Frontier encourages program administrators to continue to educate contractors and refine data reporting for future program years. For a contractor-driven program design with minimal inspections, proper documentation should be emphasized until COVID-19 restrictions are lifted, and implementer and evaluator staff are able to perform field inspections.

- SBDI HPTU:
  - See recommendation from C&I/S&I section.

6. DEMAND RESPONSE PROGRAMS

6.1 SUMMARY OF DEMAND RESPONSE IMPACTS

CPS Energy offered the following demand response programs in FY 2022:

Commercial Demand Response

Commercial & Industrial (C&I) DR – 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 thermostats or WiFi thermostats to cycle off the compressors of participating air conditioners during periods of peak summer demand.

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

Google Nest Thermostat Programs – CPS Energy offers multiple Nest installation programs. These programs include free Nest thermostats and installation to enroll in the Nest RHR (Rush Hour Rewards). Google Nest 3rd generation thermostats are installed through Nest DI (Direct Install), and Google Nest-E thermostats are installed though Google Nest HEA (Home Energy Assessment), Nest MMAT (Mail Me a Thermostat) and Nest Wx (Weatherization).

Power Players Program (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 not participate in other CPS Energy DR programs.

*Flex*EV Smart Rewards Program – Newly launched in FY 2022, CPS Energy can make remote adjustments to participating EV chargers during the event period. EV chargers can either be turned off or reduced to level 1 charging (charging rate no higher than 1.8 kW). Events can be scheduled from 2pm to 9pm during weekdays throughout the year.

*Flex*EV Off-Peak Rewards Program - Newly launched in FY 2022, customers choose to only charge during off-peak hours (after 9pm and before 4pm), without any direct intervention from CPS Energy.

(Special Section) Winter DR - From February 13-17, 2021, a winter storm swept across Texas causing a major power crisis.[14] In response to surging demand and insufficient load, CPS Energy has deployed a

[14] Source: https://en.wikipedia.org/wiki/February_13%E2%80%9317,_2021_North_American_winter_storm

series of emergency DR events for both C&I DR customers and residential DR program participants. The savings incurred by winter DR special section were not included in FY 2022 overall DR portfolio savings.

For benefit-cost calculations, our approach focuses only on the incremental impacts of new participants added in FY 2022, 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 1-3 and Table 9-1, estimated savings are reported from all active participants to most accurately represent actual program capability at the end of FY 2022. These savings are adjusted to account for net-to-gross ratios and distribution line losses.

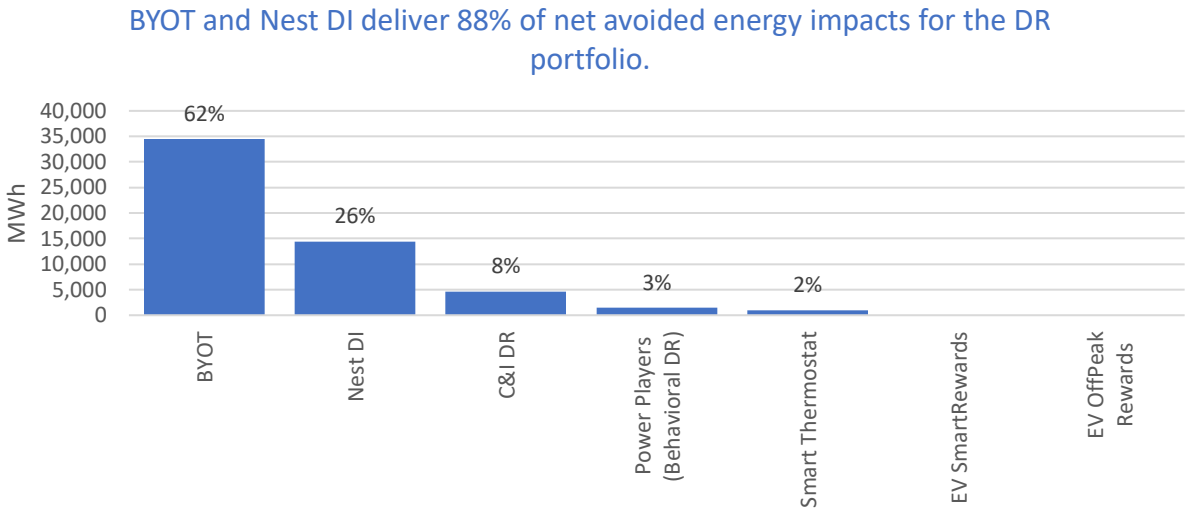


Figure 6-1: Summary of Demand Response Impacts – Energy (MWh) by Program

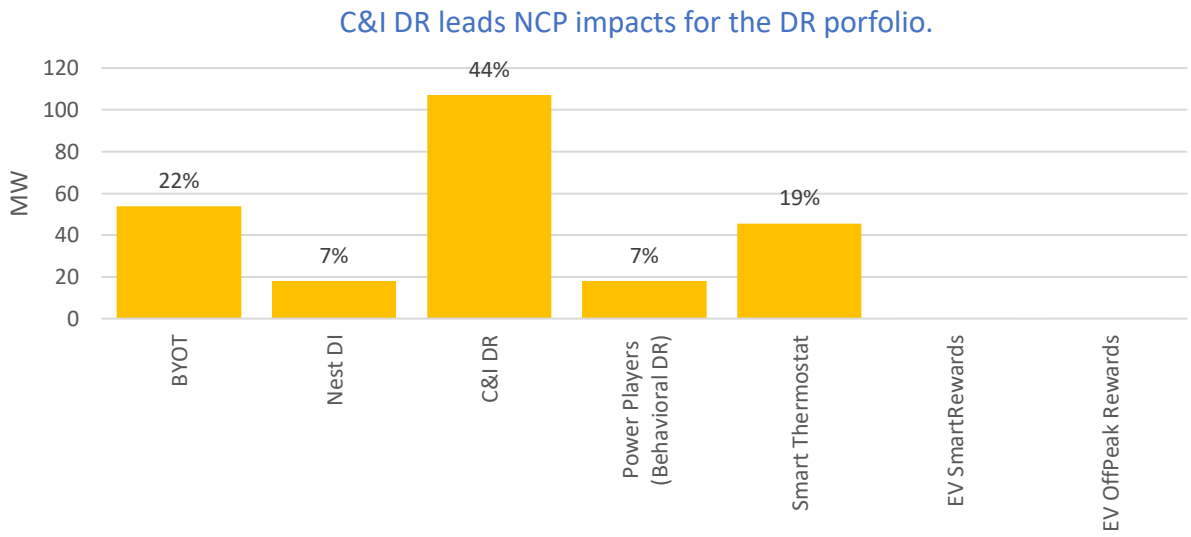


Figure 6-2: Summary of Demand Response Impacts – Non-Coincident Peak Demand (MW) by Program

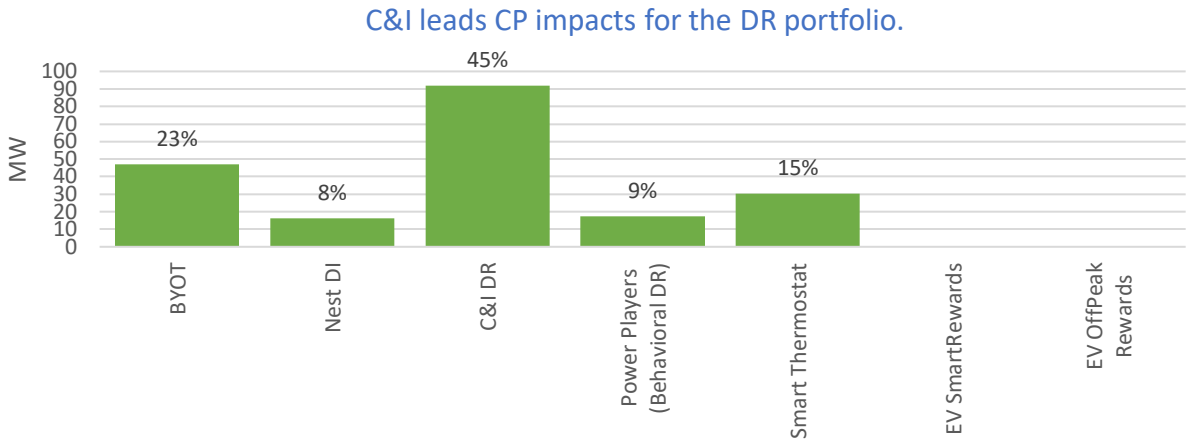


Figure 6-3: Summary of Demand Response Impacts – Coincident Peak Demand (MW) by Program

6.2 SMART THERMOSTAT PROGRAM

6.2.1 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 the customer's 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 (units are cycled off for 10 minutes during each half hour) or a 50% cycling rate (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 have an offset strategy..

In FY 2018, a small portion of single-family WiFi-enabled thermostats were selected as a pilot trial for a new thermostat offset strategy – a different load reduction pattern operated on the Resideo platform. The pilot trial showed that savings on the Resideo platform were higher than that of traditional cycling. In response to pilot trial results, as of FY 2021, all WiFi thermostats in the Smart Thermostat program have been migrated to the Resideo platform. For convenience, thermostats that are not on the Resideo platform are referred to as "traditional cycling thermostats."

6.2.2 Program Participation

The following figure shows overall participation in the Smart Thermostat program at the beginning and end of FY 2022 and at the time of DR events from June through September 2021.

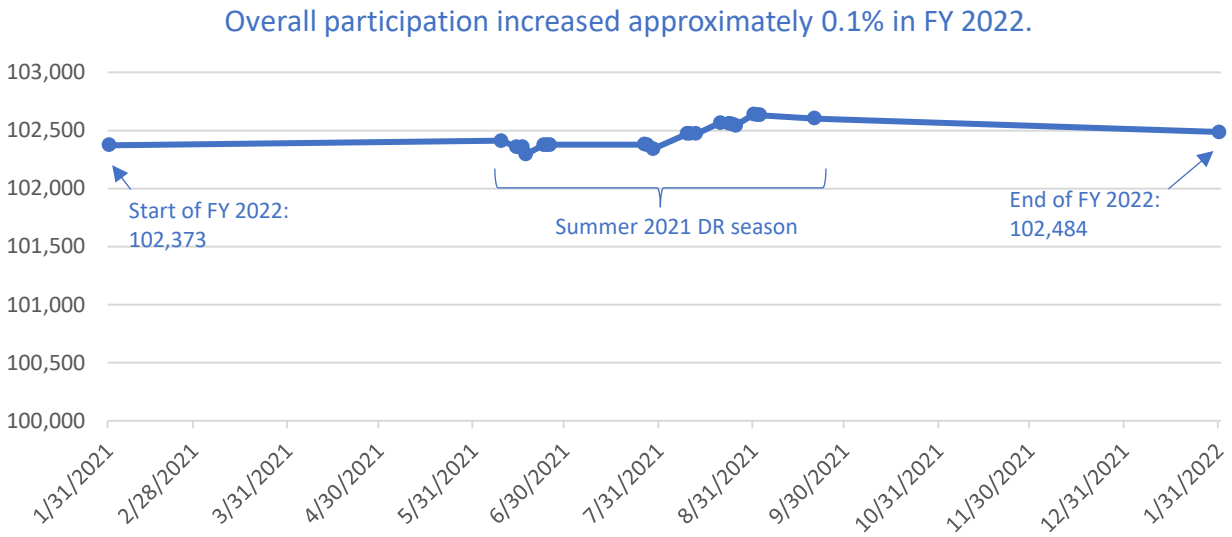


Figure 6-4: Smart Thermostat Participation Trend (FY 2022) – Total Thermostat Count[15]

There was a slight overall increase in participation by the end of FY 2022 compared with the start of FY 2022 (~0.1%). WiFi thermostat installations were the main contributor to the increase, while participation for traditional cycling thermostats experienced a slight drop.

Figure 6-5 shows participation trends by customer dwelling type over the past eight years. Device numbers were almost the same at the end of FY 2022 compared to the end of FY 2021, but has reversed the decrease trend in the past two years, with a slight increase in the residential sector (from 99,051 devices to 99,152 devices, as shown in Figure 6-5). Also, similar to the pattern in previous years, the majority of participating thermostats in the Smart Thermostat program are in the residential sector, with the commercial sector comprising approximately 3% of total devices.

[15]During the summer 2021 DR season, participating device numbers for WiFi thermostats (i.e., those on the Resideo platform) have been estimated, since only the number of participating accounts instead of the number of participating devices are available. Device to account ratio was estimated as follows: average total number of devices on the Resideo platform between start of FY 2022 and end of FY 2022 divided by the total number of participating accounts during the first event.

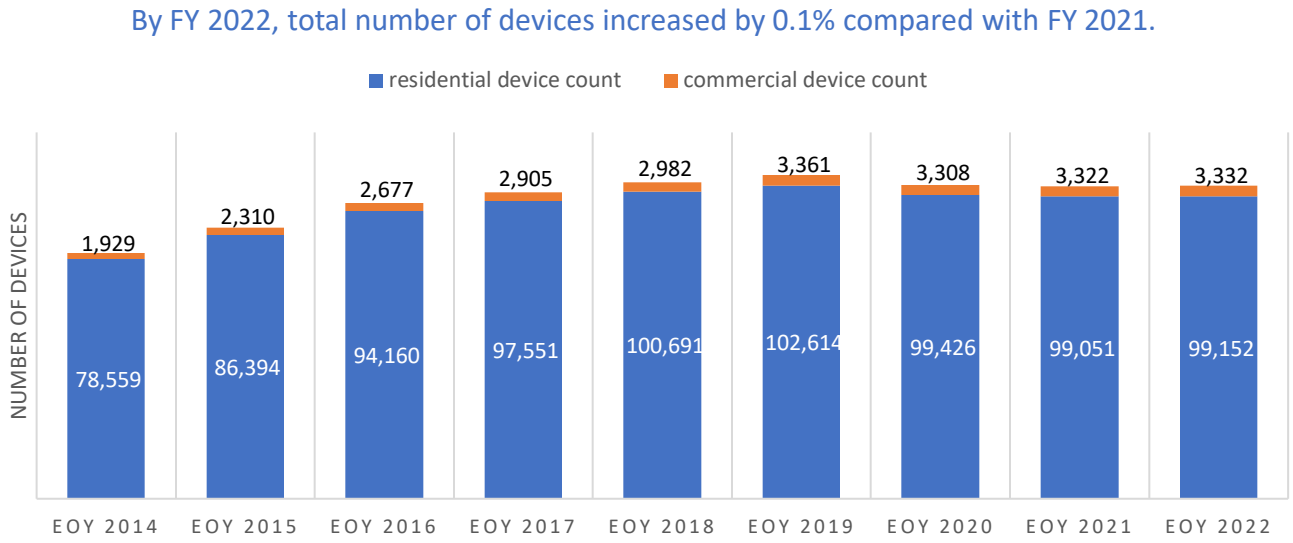


Figure 6-5: Smart Thermostat – FY 2014-2022 Participation Trends by Segment

Figure 6-6 shows the participation share by thermostat type (pager or WiFi) from FY 2017 to FY 2022. The percentage of WiFi thermostats increased slightly from 11.9% to 12.5% compared with end of FY 2021.

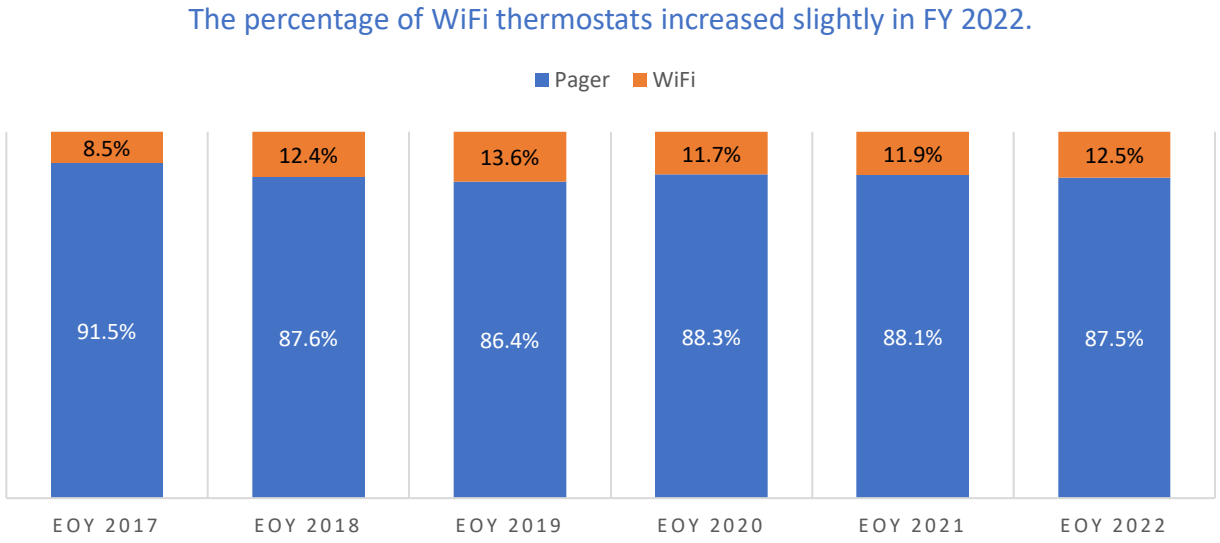


Figure 6-6: Smart Thermostat – FY 2017-2022 Participation Share by Thermostat Type

Figure 6-7 shows the breakdown by segment of all newly installed devices in FY 2022. All these devices are WiFi thermostats, with 638 installed in residential dwellings and 19 installed in commercial

dwellings. In comparison, there were only 81 newly installed thermostats in FY 2021 due to the pandemic; therefore, the installation process has significantly recovered in FY 2022.

97% of the newly installed devices are residential WiFi thermostats.

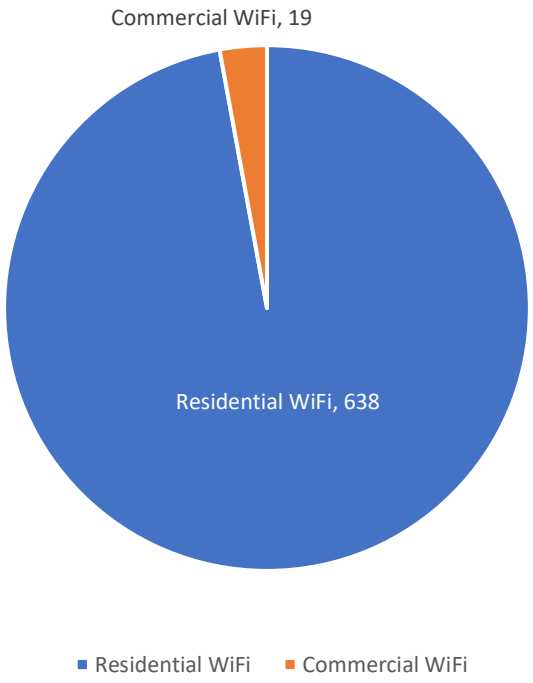


Figure 6-7: Smart Thermostat – New Install Breakdown by Thermostat Type

Table 6-1 summarizes end of FY 2022 participation levels by customer segment and cycling strategy.

Table 6-1: Smart Thermostat – EOFY Participation by Group

Thermostat Type	Dwelling Type	Cycling/Temperature Setback Strategy	Device Count Number
Pager	Residential	33% cycling	77,973
		50% cycling	9,465
	Commercial	33% cycling	2,232
		50% cycling	0
WiFi	Residential	WiFi	11,714
	Commercial	WiFi	1,100
		Total	**102,484**

Smart thermostats are run on two different kinds of platforms, and event schedules also differ slightly in FY 2022. Table 6-2 summarizes the total number of events called and the average event duration of traditional Smart Thermostat cycling and the Resideo platform:

Table 6-2: Smart Thermostat – Traditional Cycling vs. Resideo Platform: Number of Events and Average Duration

Event Metric	Traditional Cycling	Resideo Platform
Total Number of Events Called	23	22
Average Event Duration	2.05	2.09

6.2.3 Savings Calculation Methods

6.2.3.1 Per Device/Account kW and kWh Savings

In FY 2017 and FY 2018, Frontier used raw interval consumption data and developed temperature bins for estimating savings for both traditional cycling thermostats and thermostats on the Resideo platform (i.e., WiFi thermostats). Those temperature bins were designed to expedite the savings estimation process, so that raw interval consumption data is not needed every year.

However, several studies[16] have shown that residential load profiles may have changed due to the COVID-19 pandemic beginning in 2020, as more people have tended to stay at home. Given that the pre-pandemic data (temperature bins developed in FY 2017 and FY 2018) certainly cannot cover this issue, we have been using the actual interval consumption data to estimate kW and kWh savings instead of applying the pre-pandemic temperature bins starting FY 2021.

There were two separate data sources of FY 2022 raw consumption interval data:

- CPS Energy residential DR dashboard: This data source only contains 15-minute interval data for thermostats in residential dwellings. CPS Energy developed the residential DR dashboard and put it into use starting in FY 2021. The DR dashboard records 15-minute interval aggregated kW load along with the daily number of thermostats included in the DR dashboard by thermostat platform or cycling category. The categories that are pertinent to the Smart Thermostat program are: Smart Thermostat 33% cycling, Smart Thermostat 50% cycling, and Resideo.[17]

[16] Example studies regarding possible changes of residential load profiles due to COVID-19 include but are not limited to the following: (1) Pecan Street, <COVID-19 is Changing Residential Electricity Demand>, source: https://www.pecanstreet.org/2020/05/covid/; (2) A.Smith et al., <Changes in Electricity Load Profiles Under COVID-19: Implications of "The New Normal" for Electricity Demand>, source: https://www.researchgate.net/publication/343216276_Changes_in_Electricity_Load_Profiles_Under_COVID-19_Implications_of_The_New_Normal_for_Electricity_Demand.

[17] The Resideo platform hosted thermostats from both Smart Thermostat and BYOT programs. Thus, savings results generated from the "Resideo" category on the CPS residential DR dashboard not only apply to residential WiFi thermostats from the Smart Thermostat program, but also to the thermostats on residential Resideo platform from BYOT program as well.

- 15-minute interval kWh AMI data: This data source is used for analyzing savings of small commercial thermostats, which are not covered in the CPS Energy residential DR dashboard. This includes per AMI account raw meter data from all Smart Thermostat small commercial customers.

Savings analyses are conducted in the following steps:

Step 1: Converting CPS Energy residential DR dashboard interval consumption data into average per-device basis and converting AMI raw interval data into average per-account basis by each category. Specifically, for each category on the residential DR dashboard (Smart Thermostat 33% cycling, Smart Thermostat 50% cycling and Resideo), dividing aggregated interval kW by the corresponding device count yields average per device kW. Taking the mean kWh of each interval and multiplying by 4 for each category yields average per-account kW for small commercial AMI data customers.

Step 2: For each event, using two methodologies—temperature-based regression and CPS Energy's "top 3 of 10" analysis—and selecting the methodology that has the lowest RMSE during the "test period."

Specifically, for each event, we take the event day along with the previous 10 eligible days[18] and use those 11 days to conduct the following procedures:

(1) Regression: Average per device/account kW is modeled as a function of an *event* dummy variable indicating whether a time period is within the event period, a *precool* dummy variable indicating whether a time period is within the 1-hour precool period before each event,[19] a *snapback* dummy variable indicating whether a time period is within the 2-hour snapback period right after each event, a *cdh* variable (cooling degree hours, with balance point set as 65°F), a *cdh-squared* variable (cooling degree hours squared, to account for the non-linear relationship between temperature an load to some extent), 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:

$$kW_t = \beta_0 + \beta_1 * event_t + \beta_2 * precool_t + \beta_3 * snapback_t + \beta_4 * cdh_t + \beta_5 * cdh\_squared_t + \sum_{i=6}^{8} \beta_i * time\text{-}of\text{-}day_t$$

$-\beta_1$ is the estimated kW load reduction per device/account during a certain event with regression method. Similarly, β_2 is the estimated kW precool and β_3 is the estimate kW snapback per device during a certain event. Net energy (kWh) savings per device/account is calculated as $-\beta_1$ * event duration - β_2 – β_3 * 2 hours.

[18] For the first 5 events for traditional cycling and the first 4 events for WiFi thermostats on the Resideo platform, there were less than 10 previous eligible days due to the fact that the available interval data started from 6/1/2021.

[19] *Precool* dummy variable only existed in the regression model for Resideo platform WiFi thermostats. There was no obvious precooling consumption pattern for traditional 33% cycling thermostats and this dummy variable was therefore not included. Regarding traditional 50% cycling thermostats, there were slightly inconsistencies between scheduled event time and actual event time for some of the DR programs. As a result, 12 of the 23 events were treated as if there were a 1-hour precool period while there was no precool period included in the other 11 events.

(2) CPS Energy's high 3-of-10 baseline analysis. This methodology ranks the last ten eligible days based on total kWh during the event period. The three days with the highest kWh during the event period are selected. These three days are then averaged for each interval to create a calculated baseline. An adjustment ratio to the calculated baseline is applied to factor in weather effects and customer operation levels on the event day. In this case, adjustment ratio is calculated as the ratio between the average kW of the event day versus the three baseline days during the 1-hour adjustment window right before the precool period or event period (if there is no precool period). The average kW difference during the event period is the kW savings estimate; and the kWh difference during the combination of 1-hour precool period, event period and 2-hour snapback period is the estimated net kWh savings under "high 3-of-10 baseline" analysis.

(3) Compare the RMSE (root mean square error) of these two analyses during the test period and select the results generated by the methodology that has the lower RMSE. Here, the "test period" consists of four separate periods: the first three periods are the event time periods during the "top previous 3 days" (i.e., the three baseline days illustrated in the "high 3-of-10 baseline analysis" section above); and the last period is 10:00 am – 2:00 pm during event day. For example, if an event period is 6/9/2021 4:00 - 6:30 pm, and the "top previous 3 days" are 6/2/2020, 6/7/2021 and 6/8/2021, the test period would therefore be: 6/2/2021 4:00 - 6:30 pm, 6/7/2021 4:00 - 6:30 pm, 6/8/2021 4:00 - 6:30 pm and 6/9/2021 10:00 - 2:00 pm combined.

Take residential WiFi customers on the Resideo platform during the 8/9/2021 15:30 – 17:30 event as an example. Table 6-3 shows savings estimates using the two methodologies – regression and CPS Energy "high 3-of-10" baseline analysis:

Table 6-3: Smart Thermostat – Example kW and kWh Savings Per Device Analysis Process

Methodology	kW savings per device estimate	1-hour precool kW per device estimate	2-hour snapback kW pre device estimate	Net energy kWh savings per device estimate[20]	RMSE
Regression	0.93	0.68	0.42	0.33	0.26
High 3-of-10	1.11	0.69	0.29	0.97	0.03

As shown, the RMSE of "high 3-of-10" methodology is obviously lower than that of regression methodology (0.03 vs 0.26), indicating a better fit during the test period. As a result, the savings from "high 3-of-10" were selected, yielding final per-device savings of 1.11 kW and 0.97 kWh.

[20] Numbers may not sum up exactly due to rounding.

Figure 6-8 shows the residential Resideo event day versus baseline load profile on 8/9/2021 event day:

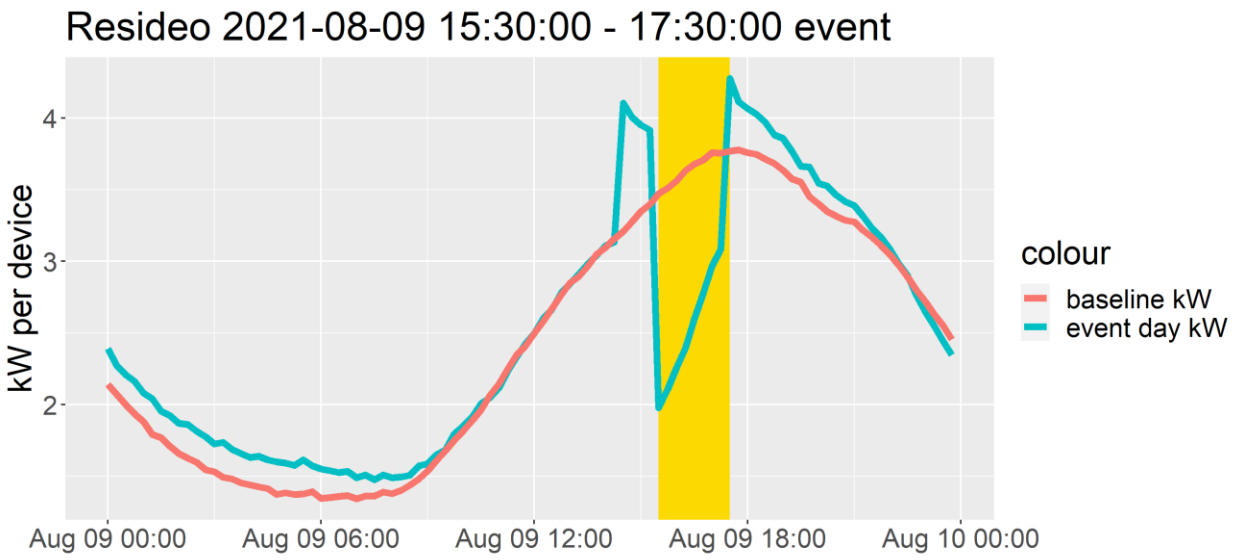


Figure 6-8: Smart Thermostat – Example Resideo per-device Load Profile vs. Baseline Profile – 8/9/2021 Event

Other categories and events are calculated in a similar manner.

6.2.3.2 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 [21] in summer 2021 were then calculated. To estimate program capability based on end-of-year and incremental enrollment, the result was scaled to the number of Smart Thermostats at the end of FY 2022 and to the number of new thermostats installed in FY 2022, respectively.

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

Delivered non-coincident peak savings for residential DR programs (Smart Thermostat, BYOT and Nest DI/HEA/MMAT/Wx) are the savings on the day when maximum demand savings of all residential DR programs occurred among all FY 2022 events. In summer 2021, all residential DR programs reached maximum program level demand reduction during the 6/15/2021 event, so the kW savings value from 6/15/2021 is used as NCP demand savings for the Smart Thermostat program. 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 2022.

[21] The high temperature threshold is set as 95°F for the event period.

6.2.3.4 ERCOT 4CP Demand Savings (kW)

During summer 2021, both traditional cycling and WiFi thermostats on the Resideo platform hit all four of the four ERCOT 4CP events, with a success rate of 100% program wide. To estimate ERCOT 4CP demand savings, we estimated the 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 2022 and to the number of newly installed thermostats throughout FY 2022.

6.2.4 Results

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

1) Estimated per-device kW and kWh savings during summer 2021 DR events.
2) Estimated program impacts during summer 2021 DR events.
3) End-of-year program capability based on program enrollment at the end of FY 2022. This information is useful for planning purposes.
4) End-of-year program capability based on incremental enrollment during FY 2022. This information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

6.2.4.1 Estimated per-device kW and kWh Savings During Summer 2021 DR Events

The table below summarizes average per-device kW and kWh savings for each category across all summer 2021 DR events:

Table 6-4: Smart Thermostat – Summer 2021 Average per device kW and Net kWh Savings

Thermostat Type	Dwelling Type	Cycling/Temperature Setback Strategy	Average kW savings per device	Average net kWh savings per device per event
Pager	Residential	33% cycling	0.16	0.28
		50% cycling	0.21	0.40
	Commercial	33% cycling	0.40	0.78
		50% cycling	--	--
WiFi	Residential	Resideo	1.06	1.27
	Commercial	Resideo	0.44	0.65

6.2.4.2 Estimated Impacts During Summer 2021 DR Events

During summer 2021, there were 23 events called for thermostats with traditional cycling and 22 events called for WiFi thermostats on the Resideo platform. Both traditional cycling and Resideo WiFi thermostats hit all four of the four ERCOT 4CP events, with a success rate of 100% program wide. These demand reduction estimates are shown in the figure below. For summer 2021, total kW reduction ranged from 9,756 kW (6/9/2021) to 41,284 kW (6/15/2021).

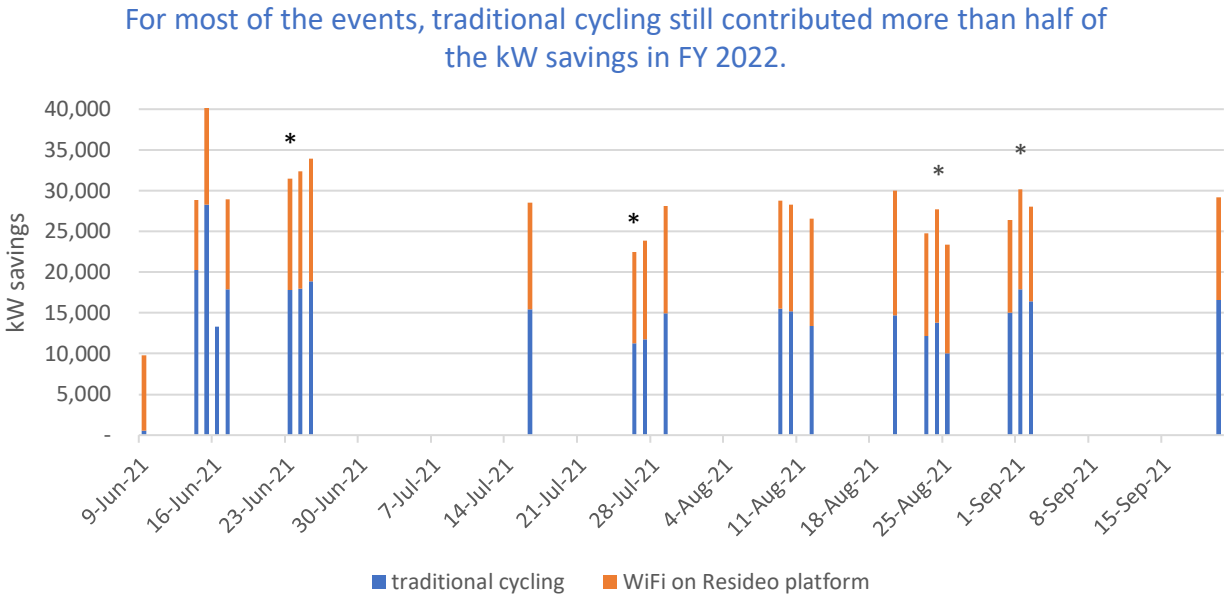


Figure 6-9: Smart Thermostat – Summer 2021 Achieved Demand Reduction

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

The following table shows estimated energy, peak demand, non-coincident peak demand, and ERCOT 4CP demand savings delivered by the program in FY 2022. 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 savings achieved on 6/15/2021, which is the day when maximum demand savings of all residential DR programs occurred among all FY 2022 events. Given the differences in schedule between traditional cycling and Resideo 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 6-5: Smart Thermostat – Delivered 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)
Traditional Cycling	637,885	15,113	28,261	15,190
Resideo Cycling	332,432	12,746	13,023	12,784
Total*	**970,317**	**27,859**	**41,284**	**27,974**

* Note: 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.

6.2.4.3 End-of-Year Program Capability

End-of-year program capability is based on end-of-year enrollment. The table below shows the end of FY 2022 program capability values.

Table 6-6: Smart Thermostat – EOY Gross Energy and Demand Savings

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	89,670	636,120	15,071	28,241	15,138
Resideo Cycling	12,814	336,046	12,883	13,650	13,101
Total*	**102,484**	**972,167**	**27,954**	**41,891**	**28,239**

* Note: 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.

6.2.4.4 Incremental Impacts

For traditional cycling thermostats, incremental impacts used for cost-effectiveness analysis are based on gross incremental enrollment. Results of both cycling types are shown below.

Table 6-7: Smart Thermostat – Incremental Gross Energy and Demand Savings

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	0	0	0	0	0
Resideo Cycling	657	17,713	681	728	697
Total*	**657**	**17,713**	**681**	**728**	**697**

* Note: 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.

6.3 BRING YOUR OWN THERMOSTAT (BYOT) PROGRAM

6.3.1 Overview

Bring Your Own Thermostat (BYOT) is a program that integrates customers' own thermostats with load curtailment events. The program began in FY 2015 when CPS Energy partnered with Google Nest to implement the Rush Hour Rewards (RHR) pilot program for customers with Google Nest thermostats. RHR 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 RHR program is available from the Google Nest website.[22]

Starting in FY 2016, CPS Energy began incorporating existing Nest RHR customers into a more broadly defined BYOT program,[23] 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 Resideo platform, which also includes single family and commercial WiFi thermostats in the Smart Thermostat platform.

Starting in May 2020, ecobee thermostats on the EnergyHub platform were incorporated in the eco+ program, which can automatically adjust temperature settings of ecobee thermostats and help save energy year-round.

To summarize, the FY 2022 BYOT program included several types of thermostats that operate as follows:

- WiFi thermostats, including Google Nest, Honeywell and Emerson run on the Resideo platform;
- ecobee thermostats run on the EnergyHub platform; and
- Other brands (apart from ecobee) thermostats run on the EnergyHub platform.

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

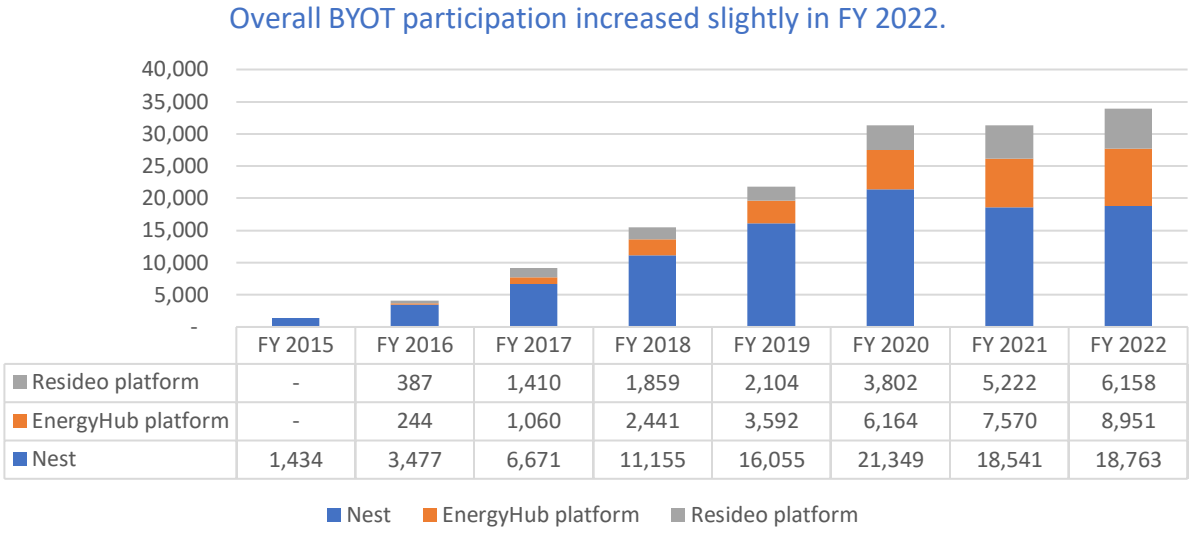
Similar to the previous year, in FY 2022 CPS Energy passed these savings on to the customer via a $85 one-time bill credit per thermostat device upon enrollment in the program. The customer also received an annual$30 bill credit at the end of the summer for participating in the program.

[22] Google Nest Support. *Learn more about Rush Hour Rewards.* Online. Available: https://support.google.com/googlenest/answer/9244031?hl=en.
[23] CPS Energy has marketed this program as the My Thermostat Rewards program, and most recently, WiFi Thermostat Rewards: https://cpsenergy.com/wifithermostatrewards.

6.3.2 Program Participation

6.3.2.1 BYOT Program Level Overall Participation Trends

Figure 6-10 shows the number of enrolled BYOT devices by thermostat brand/platform from FY 2015 to FY 2022.



	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Resideo platform	-	387	1,410	1,859	2,104	3,802	5,222	6,158
EnergyHub platform	-	244	1,060	2,441	3,592	6,164	7,570	8,951
Nest	1,434	3,477	6,671	11,155	16,055	21,349	18,541	18,763

Figure 6-10: BYOT – FY 2015-2022 Participation Trends

The total number of BYOT devices increased slightly in FY 2022, with participation increases from all three platforms (Resideo, EnergyHub and Google Nest), respectively. The stalled growth in FY 2021 was mainly due to account cleaning for Google Nest thermostats in November 2020. In FY 2022, all Google Nest thermostats were subject to a platform migration from Google Nest to Resideo. The below figure further breaks down end of FY 2022 participating BYOT thermostat counts by category. Residential thermostats account for 99% of the total end of FY 2022 BYOT thermostats.

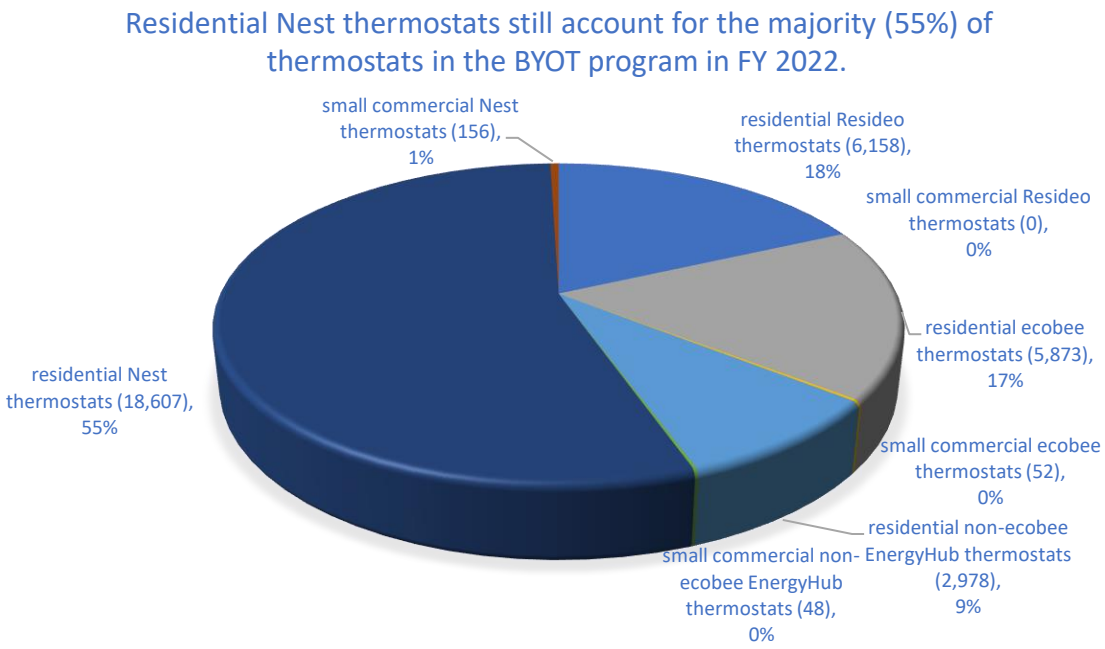


Figure 6-11: BYOT – EOY Participating Thermostats by Category

The figure below shows incremental BYOT thermostat counts in FY 2022, with ecobee BYOT thermostats contributing the largest proportion of incremental counts at 45%.

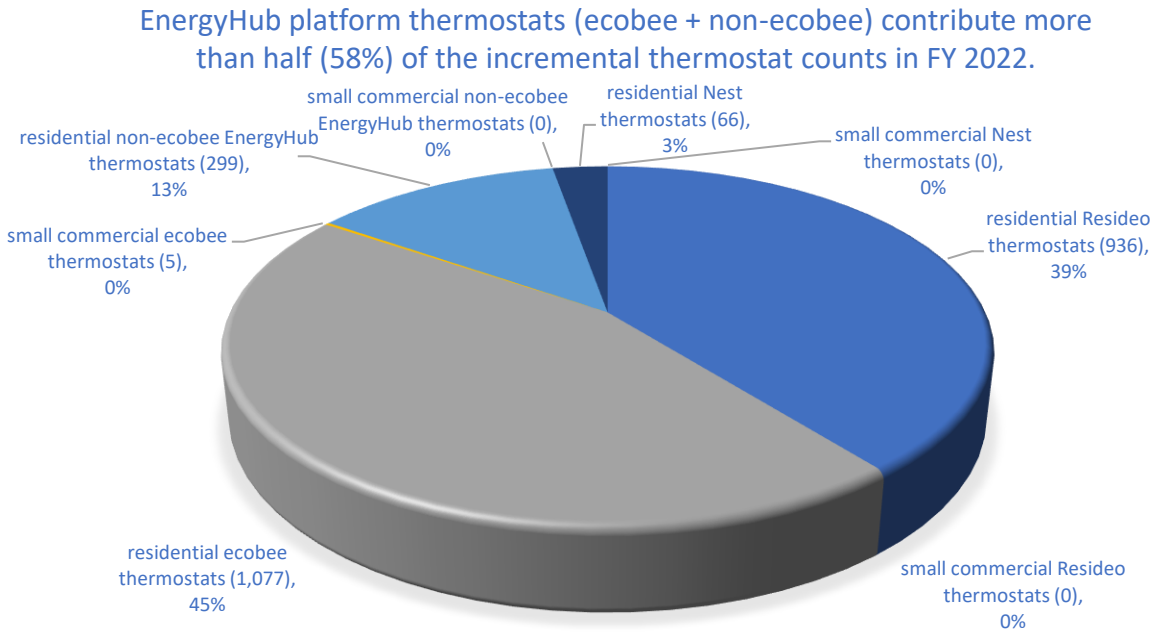


Figure 6-12: BYOT – Incremental Participating Thermostats by Category

6.3.3 Savings Calculation Method

6.3.3.1 Per-Device kW and kWh Savings

In FY 2017, Frontier developed a time temperature matrix (TTM) for Google Nest customers using per AMI account 15-minute interval data in that year. In FY 2018, temperature bins were developed for Honeywell and Emerson BYOT WiFi thermostats on the Resideo platform, along with thermostats on the EnergyHub platform. Both TTM and temperature bins serve as an expedited method for estimating kW savings by omitting the steps of calculating savings using raw interval consumption data.

However, for the same reasons illustrated in the Smart Thermostat program section (6.2.3.1), BYOT program kW and kWh savings were estimated using actual interval consumption data starting in FY 2021 instead of applying pre-pandemic TTM and temperature bins.

Similar to the Smart Thermostat program, there were also two separate sources of FY 2022 raw consumption interval data for the BYOT program: one source is aggregated 15-minute interval data for residential BYOT customers by category; the other source is 15-minute interval kWh AMI data for small commercial BYOT customers by category. Thermostat categories on the BYOT platform include the following: residential/small commercial ecobee thermostats on the EnergyHub platform, other brands of residential/small commercial thermostats on the EnergyHub platform, residential/small commercial Google Nest thermostats, and residential/small commercial thermostats on the Resideo platform.[24]

Also, per-device/AMI account kW savings analyses of all BYOT categories are performed in the same manner as Smart Thermostat savings analyses, which have already been illustrated step by step in section 6.2.3 of this report. Per device/AMI account kWh savings analyses of most BYOT categories are performed in the same manner as Smart Thermostat savings analyses, except for the ecobee and Google Nest thermostats. The unique algorithms of these two brands of thermostats can help save energy year-round, so deemed annual savings of 1,274[25] kWh per thermostat were applied for these two brands of thermostats.

6.3.3.2 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 (>=95^{o}F during event period) events. Scaling the average kW savings by the EOY customer count and newly installed customer count yield EOY and incremental CP demand savings.

[24] The Resideo platform hosted thermostats from both Smart Thermostat and BYOT programs in summer 2021. Thus, savings results generated from the Resideo category on CPS's residential DR dashboard not only apply to residential WiFi thermostats from the Smart Thermostat program, but also to the residential thermostats on the Resideo platform from the BYOT program.
[25] CPS Energy Technical Guidebook for Energy Efficiency and Demand Response - section 5.7 - Smart Thermostats.

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

Delivered non-coincident peak savings for residential DR programs (Smart Thermostat, BYOT and Google Nest DI/HEA/MMAT/Wx) are the savings during the day when maximum demand savings of all residential DR programs occurred among all FY 2022 events. In summer 2021, all residential DR programs reached maximum program level demand reduction during the 6/15/2021 event, so the kW savings on 6/15/2021 is used as the NCP demand savings for BYOT program. 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.

6.3.3.4 ERCOT 4CP Demand Savings (kW)

In summer 2021, thermostats on the Resideo and EnergyHub platforms successfully hit all four of the four 4CP intervals, with a success rate of 100%. Google Nest Thermostats hit three of the four, with a success rate of 75%.[26] 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 2022 and to the number of newly installed devices added during FY 2022, respectively.

6.3.4 Results

For the BYOT DR program, we present impacts in four sections:

1) Estimated per device kW and net kWh savings by thermostat type during summer 2021.
2) Estimated program impacts during summer 2021 DR events.
3) End-of-year program capability based on program enrollment at the end of FY 2022.
4) End-of-year program capability based on incremental enrollment during FY 2022. 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 Net kWh Savings by Thermostat Category

The following table summarizes achieved average per device kW and net kWh savings by thermostat category in the summer 2021 BYOT program.

[26] It is noted that although the DR event was called on June 4CP day (6/23/2021) on Google Nest platform, it did not hit the 4CP interval because the event started at 5pm, while the 15-minute 4CP interval was 4:45pm – 5pm.

Table 6-8: BYOT – Estimated Average per Device kW and Net kWh Savings by Thermostat Category

Platform	Dwelling Type/Brand	Average kW Savings per Device	Average net kWh Savings per Device per Event
EnergyHub	Residential non-ecobee	1.03	1.59
	Small commercial non-ecobee	0.86	1.11
	Residential ecobee	1.22	1.68
	Small commercial ecobee	1.11	1.68
Google Nest (on Resideo platform)	Residential	1.44	1.60
	Small commercial	0.59	0.61
Resideo	Residential	1.06	1.27
	Small commercial	0.44	0.65

6.3.4.2 Estimated Impacts during Summer 2021 DR Events

Event schedules vary under different platforms. The table below summarizes the number of events called and the average event duration in summer 2021 for Google Nest, EnergyHub and the Resideo platform.

Table 6-9: BYOT – Event Number and Duration Summary by Platform

Platform	# of Events Called	Average Event Duration
Google Nest (on Resideo platform)	20	2.20
EnergyHub	22	2.30
Resideo	22	2.09

BYOT program-level total achieved impacts of FY 2022 events ranged from 4,723 kW (6/9/2021 event) to 47,962 kW (6/15/2021), with the Google Nest thermostats group contributing most of the kW savings across all events except for events when no Google Nest DR events were called. These demand reduction estimates are shown below.

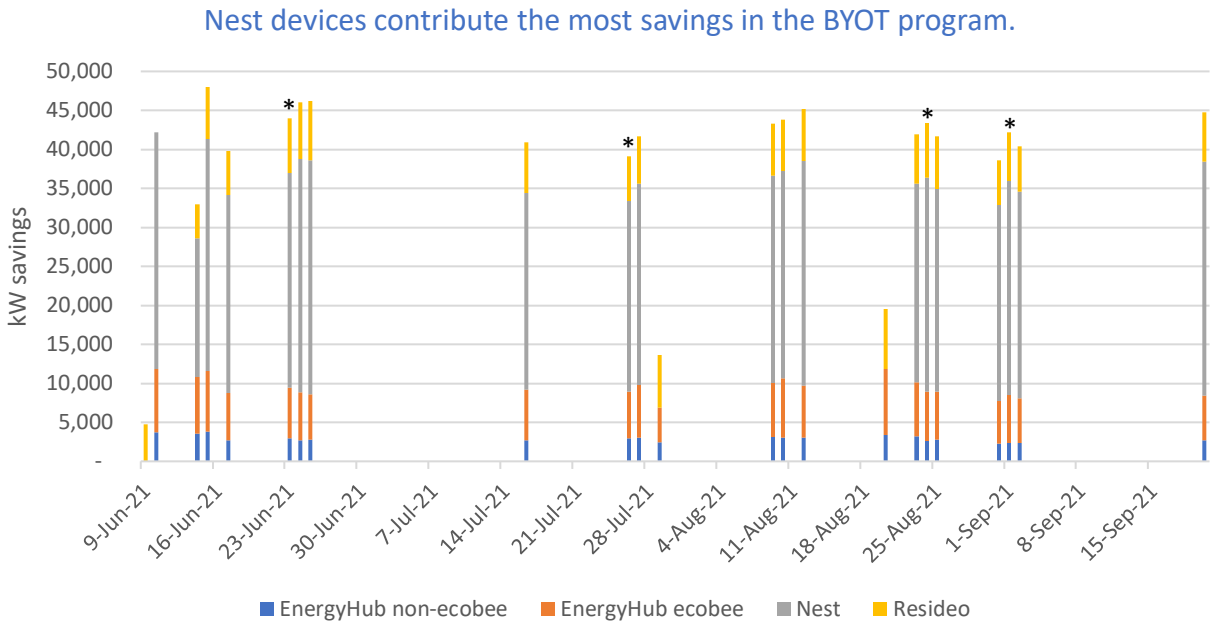


Figure 6-13: BYOT – Summer 2021 Achieved Demand Reduction

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

The below table shows estimated energy, peak demand, non-coincident peak demand, and ERCOT 4CP demand savings delivered by the program in FY 2022. 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 savings that occurred on 6/15/2021, which is the maximum demand savings day for all residential DR programs combined among all FY 2022 events. 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 thermostat types.

Table 6-10: BYOT – Delivered 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)
Google Nest	23,890,048	27,028	29,730	19,818
EnergyHub (non-ecobee)	100,102	2,680	3,880	2,784
ecobee	6,859,216	6,325	7,819	6,279
Resideo	166,739	6,422	6,637	6,492
Total*	**31,016,105**	**42,455**	**48,065**	**35,373**

* Note: 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.

6.3.4.3 End-of-Year Program Capability

End-of-year program capability is based on end-of-year enrollment and is shown in the table below.

Table 6-11: BYOT – EOY Gross Energy and Demand Savings

Measure	EOY Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Google Nest	18,763	23,904,062	27,063	29,768	19,842
EnergyHub (Non-ecobee)	3,026	105,312	2,819	4,082	2,928
ecobee	5,925	7,544,628	6,957	8,601	6,906
Resideo	6,158	168,329	6,484	6,957	6,653
Total*	**33,872**	**31,722,331**	**43,323**	**49,408**	**36,329**

* Note: 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.

6.3.4.4 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 6-12.

Table 6-12: BYOT – Incremental Gross Energy and Demand Savings

Measure	Gross Incremental Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Google Nest	62	84,084	96	105	70
EnergyHub (non-ecobee)	299	10,456	278	405	289
ecobee	1,082	1,378,468	1,272	1,573	1,261
Resideo	936	25,586	985	1,057	1,011
Total	**2,379**	**1,498,593**	**2,631**	**3,140**	**2,632**

* Note: 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.

6.4 GOOGLE NEST THERMOSTATS

6.4.1 Overview

The Nest DI (Direct Install) program was 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 one or more free Google Nest(s) (3rd generation) and free installation to replace the older Home Manager Consert devices in their homes.

Nest HEA (Home Energy Assessment), Nest MMAT (Mail Me a Thermostat) and Nest Wx (Weatherization) are three programs that launched in FY 2020. For HEA and Wx program customers (see section 4.4 and section 3.1 respectively for details), CPS Energy offers one or more free Google Nest Thermostat E devices and free installation to provide opportunity for further kW and energy savings. As for MMAT, CPS Energy mailed selected customers one or more pre-enrolled Google Nest Thermostat E devices instead.

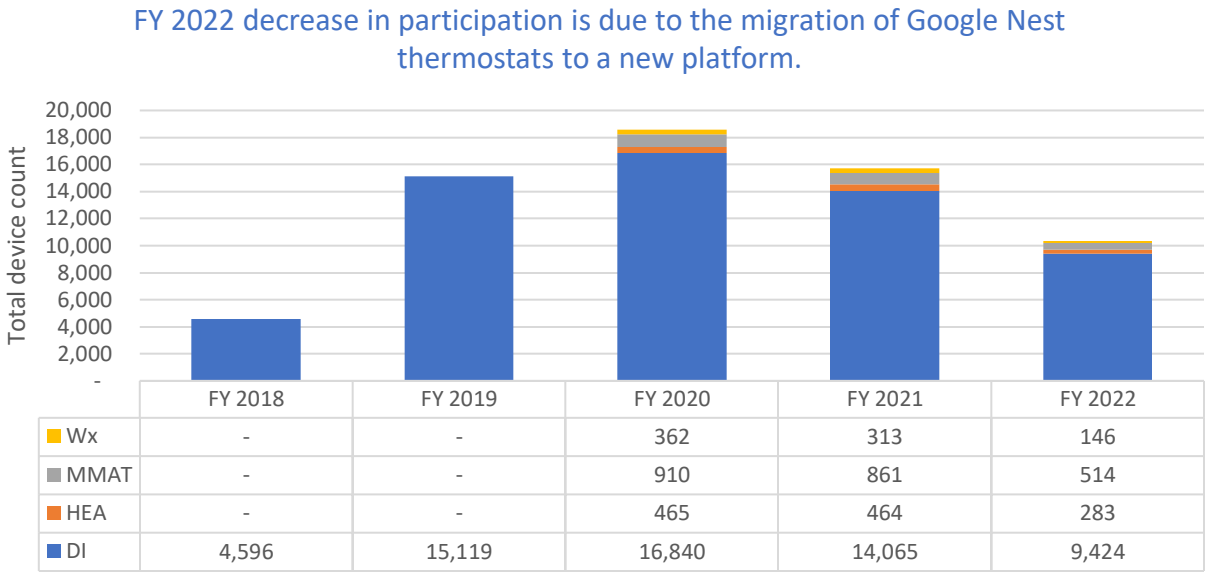
After the customers have installed the Nest(s), they are automatically enrolled in Google Nest RHR (Rush Hour Rewards) in synchronization with all the other Google Nest thermostats on the Google Nest platform. As with Google Nests in the BYOT program, at the end of each DR season, a $30 bill credit is applied to customers' bills.

In FY 2021, DI, HEA, MMAT and Wx were combined into one single Nest program due to the homogenous characteristics of these four programs. They all had residential Google Nest devices run by the Nest platform, which arranged the identical event schedule.

6.4.2 Program Participation

The following figure shows Google Nest participation trends from FY 2018 to FY 2022. Also, there were no newly installed Google Nest thermostats in this program throughout FY 2022. The drop in total participation in FY 2022 as seen in the bar chart is mainly due to two reasons:

- In FY 2022, for all Google Nest thermostats, there was a platform migration from Google Nest to Resideo. During this migration, all customers had to accept new terms and conditions from Google in order to stay in the program. The drop in participation was mainly caused by this reason.
- All potential Home Manager customers had been converted to Nest DI in FY 2020. As a result, there was no room for new installs in the Nest DI category.



	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Wx	-	-	362	313	146
MMAT	-	-	910	861	514
HEA	-	-	465	464	283
DI	4,596	15,119	16,840	14,065	9,424

Figure 6-14: Google Nest – FY 2018-2022 Participation Trends

6.4.3 Savings Calculation Method

6.4.3.1 Per-Device kW and kWh Savings

Since Google Nest thermostats are incorporated in the same platform along with other Google Nest thermostats in BYOT programs, savings from this program are calculated the same way. Section 6.3.3 6.3.3explained 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 program:

Table 6-13: Google Nest – DI/HEA/MMAT/Wx per Device Savings

Category	Savings per Device
CP/Average per device demand savings	1.45 kW
NCP per device demand savings	1.59 kW
4CP per device demand savings	1.06 kW
Annual energy per device savings	1,274 kWh

6.4.3.2 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 (>=95^{o}F during event period) events. Scaling the average kW savings by the EOY customer count and newly installed customer count yields EOY and incremental CP demand savings.

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

Achieved non-coincident peak savings is based on the maximum event demand savings of all residential programs combined (Smart Thermostat, BYOT, Nest DI/HEA/MMAT/Wx) among FY 2022 events, and it occurred on June 15, 2021 in FY 2022. Multiplying the NCP per-device demand savings from the previous table by the total number of devices in the summer of 2021 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.

6.4.3.4 ERCOT 4CP Demand Savings (kW)

During the summer of 2021, three of the Google Nest DI events coincided with ERCOT 4CP events, yielding a 75% success rate in hitting the 4CPs.[27] 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. In this case, 4CP savings can also be generated simply by multiplying the 4CP per device demand savings from the previous table by the total number of devices in the summer of 2021. For the year-end capability and incremental calculations, we scaled the result to the number of devices at the end of FY 2022 and to the number of new devices added during FY 2022.

6.4.4 Results

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

1) Estimated program impacts during summer 2021 DR events.

2) End-of-year program capability based on program enrollment at the end of FY 2022.

3) End-of-year program capability based on incremental enrollment during FY 2022.
   This information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

6.4.4.1 Estimated Impacts During Summer 2021 DR Events

As in other Google Nest-related DR programs, 20 events were called in summer 2021 for the Nest DI program. Event impacts ranged from 12,431 kW (6/14/2021 event) to 21,284 kW (6/10/2021 event). These demand reduction estimates are shown below.

[27] Although a DR event was called on June 4CP day (6/23/2021) on the Google Nest platform, it did not hit the 4CP interval because the event started at 5pm while the 15-minute 4CP interval was 4:45pm – 5pm.

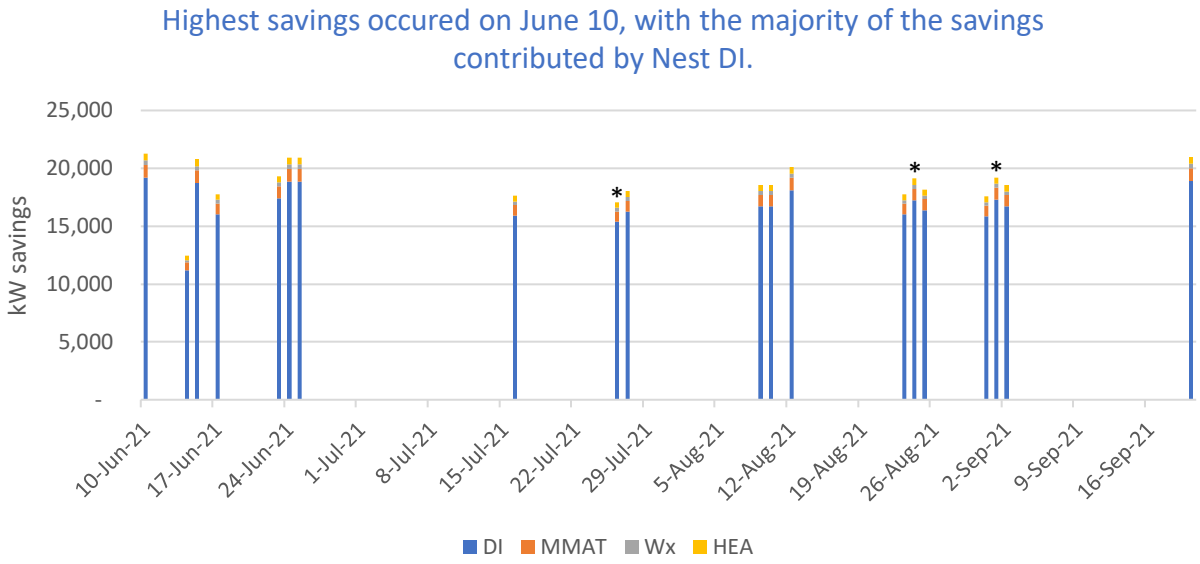


Figure 6-15: Google Nest – DI/HEA/MMAT/Wx – Achieved Demand Reduction during Summer 2021 DR Events

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

The following table shows estimated energy, peak demand, non-coincident peak demand, and ERCOT 4CP demand savings delivered by the program in FY 2022.

Table 6-14: Google Nest – Delivered 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)
Google Nest DI	14,963,130	17,025	18,728	12,478
Google Nest MMAT	876,512	997	1,097	731
Google Nest Wx	293,020	333	367	244
Google Nest HEA	476,476	542	596	397
Total*	**16,609,138**	**18,898**	**20,788**	**13,850**

* Note: 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.

6.4.4.2 End-of-Year Program Capability

End-of-year program capability is based on end-of-year enrollment and is shown in the following table.

Table 6-15: Google Nest – EOY Gross Energy and Demand Savings

Measure	EOY Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Google Nest DI	9,424	12,006,176	13,661	15,027	10,012
Google Nest MMAT	514	654,836	745	820	546
Google Nest Wx	146	186,004	212	233	155
Google Nest HEA	283	360,542	410	451	301
Total*	**10,367**	**13,207,558**	**15,028**	**16,530**	**11,014**

* Note: 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.

6.4.4.3 Incremental Impacts

Incremental impacts used in benefit-cost analysis are based on gross incremental enrollment during the program year. FY 2022 Nest DI/HEA/MMAT/Wx incremental savings are shown in the following table. Because there were no newly installed Google Nest thermostats in this program during FY 2022, there are no incremental savings to report. The below table is provided to illustrate this fact and maintain consistency across annual evaluation reports.

6.5 POWER PLAYERS (BEHAVIORAL DEMAND RESPONSE)

6.5.1 Overview

CPS Energy partnered with Oracle to implement a program called "Power Players"[28] for residential customers beginning in summer 2017.The Power Players program deploys messaging to encourage customers to make minor adjustments in their home's energy use on peak energy days. This program was implemented as an opt-out randomized controlled trial (RCT). In order to be eligible for the program, households/accounts were all equipped with AMI meters and were not participating in other CPS Energy DR programs.

Participants receive a welcome letter before the annual program starts. Either one day before each event or in the morning of the event day, participants receive a notification message through an email and/or a phone call message. These notifications also contain information explaining what a peak day is and personalized energy conservation tips. After each event, customers receive a follow-up call and/or email containing personalized customer performance feedback is also provided to participants within three days after the event.

Throughout the summer of 2021, eight events were called. The first three events lasted from 4:00pm to 7:00pm, while the last five events lasted from 3:00pm to 7:00pm.

6.5.2 Program Participation

Participation in FY 2022 was a combination of participants enrolled in summer 2017, 2018, 2019, 2020, and 2021 separately. Participation of each year is described as a "wave." For example, participants enrolled in the summer of 2017 are called the "2017 wave."

During the RCT selection process in early 2019, most of the control group participants from the 2017 and 2018 waves were accidentally selected into the 2019 wave treatment group and therefore received "treatment," causing the original control group from the 2017 and 2018 waves to become partially unusable. Only around 25% of control group participants were left in the 2017 wave and 13% in the 2018 wave.

In summer 2020, the control group participants who were accidentally selected into the treatment group in 2019 were then put back into their respective control groups, and therefore were still regarded as valid control group members in summer 2020 and summer 2021.

The following table shows the number of active customers throughout summer 2021 by waves.

[28] The "Power Players" program was originally known as BDR (behavioral demand response) in previous fiscal years. The program name changed to "Power Players" in FY 2021.

Table 6-16: Power Players (BDR) – Summer 2021 Participation

Wave	Treatment Group # of Households	Control Group # of Households
2017 Wave	72,752	16,475
2018 Wave	12,631	3,674
2019 Wave	136,332	17,134
2020 Wave	60,907	15,072
2021 Wave	52,690	12,730
Total	**335,312**	**65,085**

In the summer of 2021, there were 52,690 additional households participating who remained active in the Power Players program as the treatment group of the 2021 wave. However, the biggest share of treatment group participation was contributed by 2019 participants (136,332 remained active in summer 2021).

6.5.3 Savings Calculation Method

6.5.3.1 Per Household kW and kWh Savings

CPS Energy provided Frontier with aggregated 15-minute interval AMI meter level data from 06/01/2021 to 09/30/2021 for almost all participants[29] by group and wave. A simple difference of the mean values of the two groups was calculated to estimate savings.

For each event, kW savings per household is simply the average household consumption difference between the treatment and control groups during the event period; 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 either the previous day or early in the morning of the event day, so it is likely that participants took conservation actions in advance of the start (3 p.m. or 4 p.m.) of each of the events. To calculate energy savings, we assume that treatment group participants start taking conservation actions as early at 9 a.m. on the event day. In other words, the energy savings is the consumption difference between the treatment and control groups during the event period and pre-event period, combined.

Take the first event (6/14/2021) of the 2021 wave as an example. The load per account by group and time period is tabulated below.

[29] Around 88% of all active customers were included in the aggregated 15-minute interval AMI data for analysis.

Table 6-17: Power Players (BDR) – Example: 2021 Wave Average Load by Group, Wave, and Time Period for 6/14/2021

Event period (4 p.m. – 7 p.m.) (kW per household)		Pre-event period (9 a.m. – 4 p.m.) (kW per household)	
Treatment Group	Control Group	Treatment Group	Control Group
3.174	3.209	2.415	2.439

For the 6/14/2021 event, per household kW savings for the 2021 wave is estimated at 3.209 – 3.174 = 0.035 kW. Total kW savings for the 2021 wave is 0.035 x 52,690 = 1,842 kW.[30] Energy savings during the event period is calculated as 1,842 kW x 3 hours = 5,525 kWh.[31]

kW savings during the pre-event period can be calculated in the same manner: (2.439 kW – 2.415 kW) x 52,690 = 1,232 kW.[32]

Energy savings during the pre-event period is calculated as 1,232 kW x 7 = 8,622 kWh.

Total energy savings for the 2021 wave during 6/14/2021 event is the combination of savings from the pre-event period and event period: 5,525 + 8,622 = 14,147 kWh.

Savings from the other three waves can be calculated in the same manner.

6.5.3.2 Coincident Peak (CP) Demand Savings (kW)

Coincident peak demand savings are estimated by the average kW savings across all high temperature events.[33] Since participants are recruited each year, the EOY and incremental savings are identical to the FY 2022 achieved savings.

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

Achieved non-coincident peak savings represent the maximum event demand savings among FY 2022 events. Similar to CP savings, EOY and incremental NCP savings are equivalent to achieved maximum savings in FY 2022.

6.5.3.4 ERCOT 4CP Demand Savings (kW)

During the summer of 2021, two of the Power Players events coincided with the four ERCOT 4CP events (i.e., success rate of 50%). 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

[30] Numbers do not sum up exactly due to rounding.
[31] Numbers do not sum up exactly due to rounding.
[32] Numbers do not sum up exactly due to rounding.
[33] Here "high temperature events" are defined as events with average temperature no lower than 95°F.

success rate. Year-end capability and incremental calculations are also the same as achieved 4CP savings.

6.5.4 Results

For the Power Players program, we present impacts in three ways:

1) Estimated program impacts during summer 2021 DR events.
2) End-of-year program capability based on program enrollment at the end of FY 2022.
3) End-of-year program capability based on incremental enrollment during FY 2022.
   This information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

6.5.4.1 Estimated Impacts During Summer 2021 DR Events

In FY 2022, kW savings per account by wave is tabulated below.

Table 6-18: Power Players (BDR) – kW Savings per Household by Wave

Wave	Average kW savings per household
2017 wave	0.030
2018 wave	0.083
2019 wave	0.048
2020 wave	0.053
2021 wave	0.043

There were 8 events called in summer 2021 for the Power Players program. Event impacts ranged from 12,676 kW (7/27/2021 event) to 16,636 kW (9/1/2021 event). These demand reduction estimates are shown in the following figure.

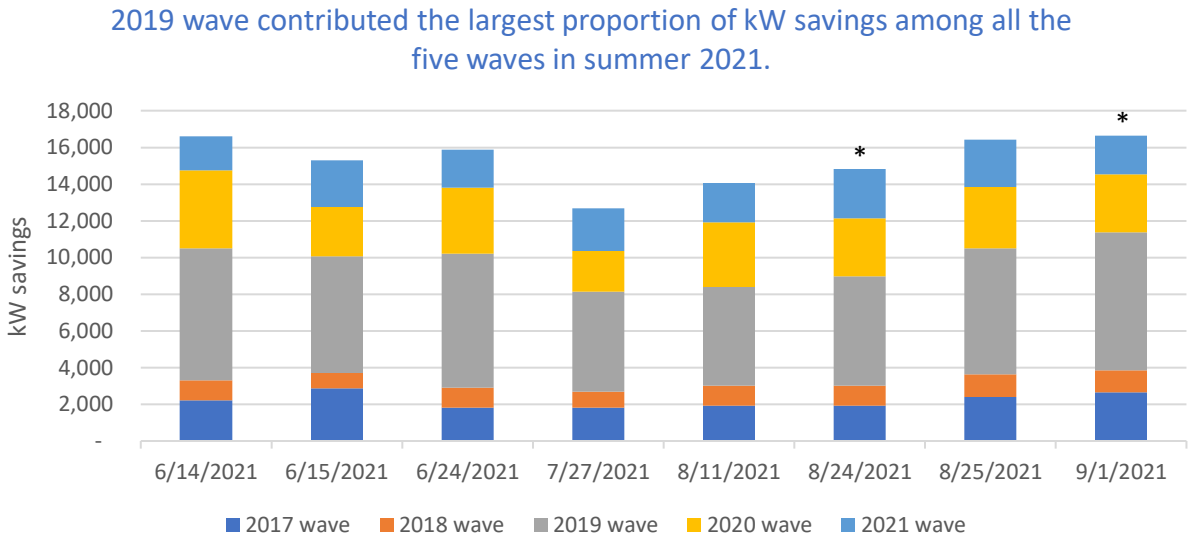


Figure 6-16: Power Players (BDR) – kW Reduction by Event

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 2022.

Table 6-19: Power Players (BDR) – Delivered Program 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)
Power Players	857,429	16,108	16,636	7,866

6.5.4.2 End-of-Year Program Capability

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

Table 6-20: Power Players (BDR) – EOY Program Energy and Demand Savings

Measure	EOY Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Power Players	335,312	857,429	16,108	16,636	7,866

6.5.4.3 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 6-21: Power Players (BDR) – Incremental Program Energy and Demand Savings

Measure	Gross Incremental Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Power Players	335,312	857,429	16,108	16,636	7,866

6.6 COMMERCIAL AND AUTO DEMAND RESPONSE PROGRAMS

6.6.1 Overview

CPS Energy's Commercial and Auto DR (CADR) programs 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.[34]

Before FY 2019, the Commercial DR programs consisted of Options 1, 2, and 3, and Automated DR (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. The below table summarizes these differences.

Table 6-22: CADR – Program Characteristics

Measure	Performance Period	Time Period	Event Days	Max Events	Total Hours Available	Advance Notice (Hours)
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[35]	Jun 1 – Sep 30	24/7	All Days	--	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.

6.6.2 Program Participation

As can be seen in the following figures, total number of sponsors (i.e., participating entities), participating sites and contracted kW all dropped slightly in FY 2022. Compared with the previous year, the number of sponsors dropped slightly from 155 to 154, the number of sites went from 754 to 722, and contracted kW dropped from 96.3 MW to 91.8 MW.

The total number of sponsors, sites, and contracted kW are shown in the graphs below.

[34] Except ADR program, which is introduced in the following paragraphs.
[35] There is also a non-summer ADR program offering that runs for the rest of the year, but its impacts are not evaluated here.

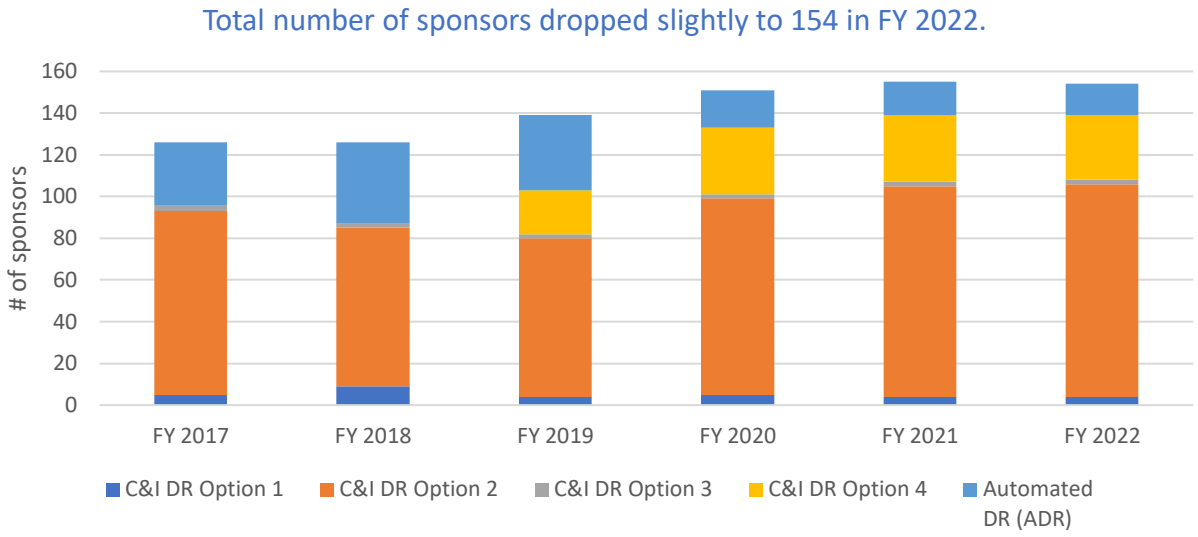


Figure 6-17: CADR – FY 2017-2022 Sponsor Counts

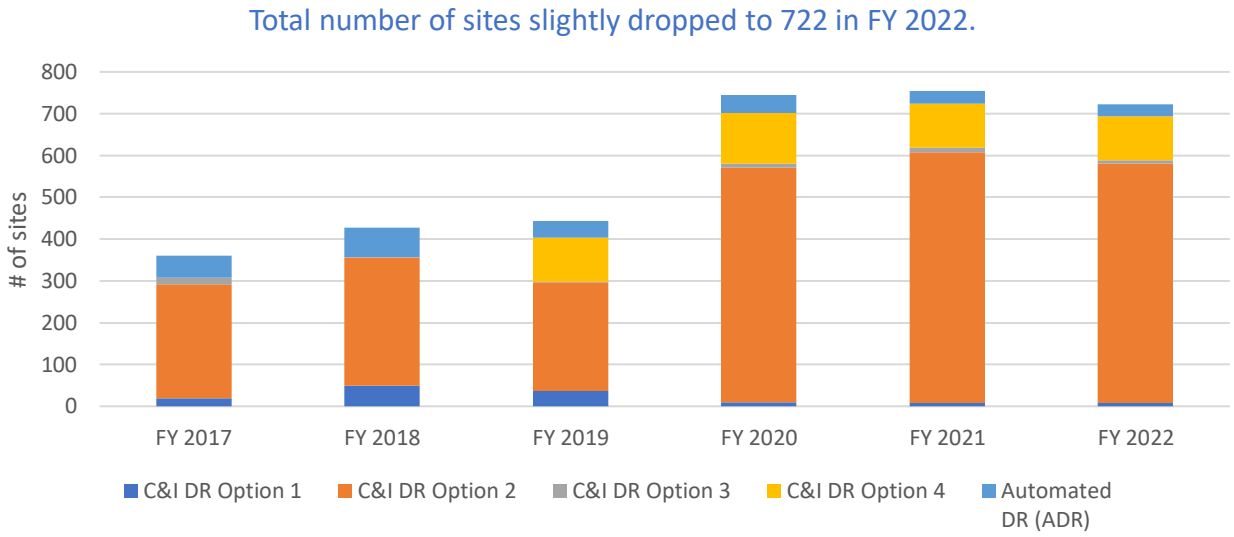


Figure 6-18: CADR – FY 2017-2022 Site Counts

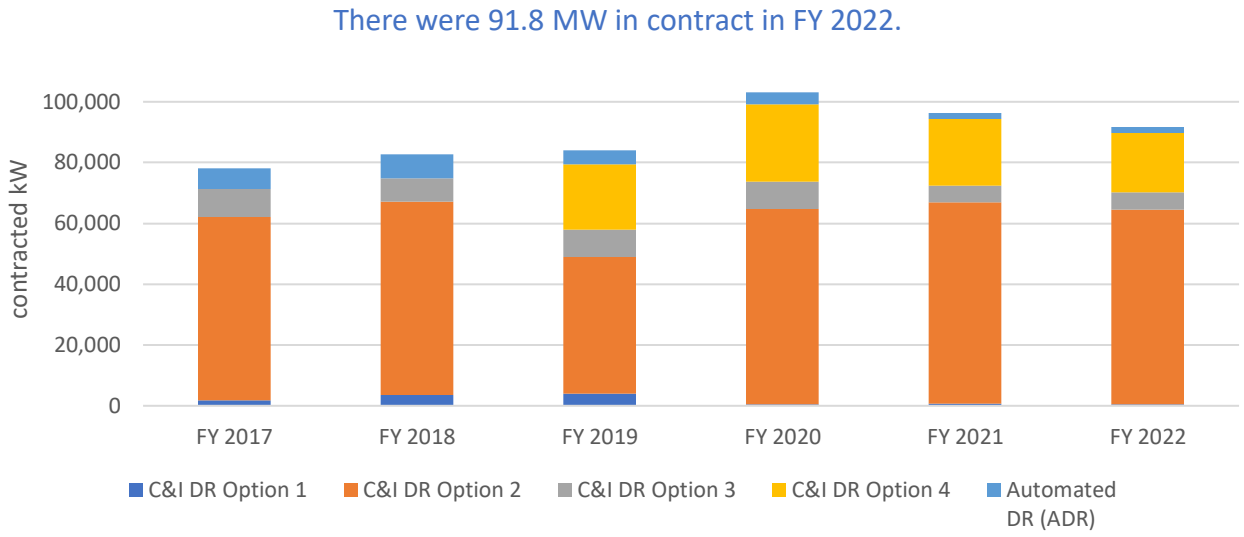


Figure 6-19: CADR – FY 2017-2022 Contracted kW

CPS Energy deployed its Commercial DR programs on 27 days in FY 2022. As can be seen in the table below, Option 2, 4, and the ADR programs were called most frequently, while Option 3 was called only six times due to a limit on the maximum number of events that could be called under that program.

The four days highlighted in yellow are 4CP days in FY 2022. On July 26th and August 24th, all the C&I DR programs hit the 4CP event. On September 1st, four of the C&I DR programs (option 2, 3, 4 and ADR) hit the 4CP event. Two of the C&I DR programs (option 4 and ADR) called DR events on June 23rd, which is also a 4CP day.

Table 6-23: CADR – Event Date Distribution

Event Date	Option 1	Option 2	Option 3	Option 4	ADR
6/9/2021					X
6/10/2021					X
6/13/2021					X
6/14/2021		X	X	X	X
6/15/2021		X		X	X
6/16/2021					X
6/17/2021		X		X	X
6/23/2021				X	X
6/24/2021		X		X	X
6/25/2021		X		X	X
7/16/2021	X	X		X	X
7/19/2021	X	X			
7/26/2021	X	X	X	X	X
7/27/2021	X	X		X	X
7/29/2021	X	X		X	
7/30/2021	X	X			
8/9/2021	X	X		X	
8/10/2021	X	X		X	X
8/12/2021	X	X		X	X
8/20/2021				X	X
8/23/2021	X	X	X	X	X
8/24/2021	X	X	X	X	X
8/25/2021	X	X		X	X
8/31/2021	X	X		X	X
9/1/2021		X	X	X	X
9/2/2021		X		X	X
9/20/2021		X	X	X	X

The following table shows the total number of events called for the past 6 years with a breakdown by program.

Table 6-24: CADR – FY 2017-2022 Total Number of Events Called

C&I DR Program/ Option	FY 2022	FY 2021	FY 2020	FY 2019	FY 2018	FY 2017
Option 1	13	12	11	14	12	11
Option 2	21	16	19	19	22	19
Option 3	6	5	6	6	6	6
Option 4	21	16	17	19	--	--
ADR	23	16	16	19	19	18
Total number of days that C&I DR program(s) occurred	**27**	**19**	**22**	**22**	**23**	**21**

The following figure compares the average event duration from FY 2017 to FY 2022. Event durations for all the programs are longer in FY 2022 compared with previous years. The average event duration for all C&I programs in FY 2022 was 2.34 hours.

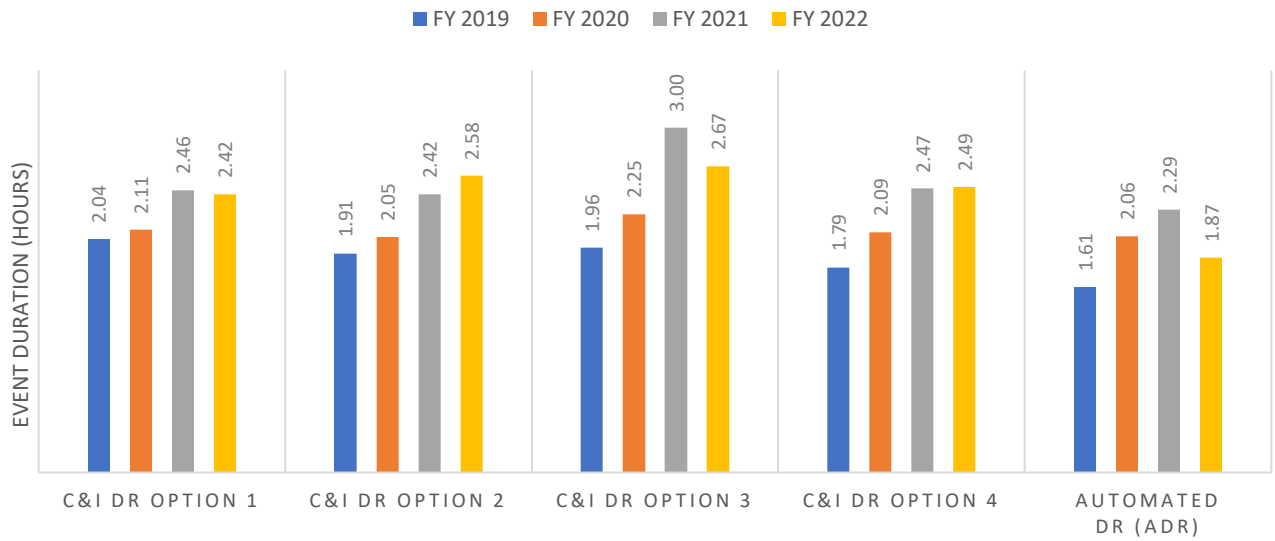


Figure 6-20: CADR – FY 2019-2022 Average Event Duration

6.6.3 Savings Calculation Methods

For most cases in summer 2021, CPS Energy adopted the following methodologies to estimate savings for C&I DR programs:

- High 3 of 10
- Middle 8 of 10
- Matching Day Pair[36]

The "best fit" baseline was selected based on statistical criteria that determined how well each estimation method aligned with the 10:00-13:00 time frame for the event day.

Consistent with the methodology adopted in the past three fiscal years, Frontier has employed a "multiple-baselining method" to verify CPS Energy's savings estimates in FY 2022. 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 this "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), a *notify period* dummy variable indicating whether a time period is within the notification period, an *event* dummy variable indicating whether a time period is within the event period, 10 day-dummy variables indicating date, and three *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.

[36] The Matching Day Pair methodology uses a deterministic algorithm similar to the X of Y methodology. The algorithm looks for pairs of days that match a reference pair associated with the forecasted day. The similarity between two pairs of days is assessed using the mean squared error (MSE) between the two pairs. The 10 best pairs are then selected and averaged to obtain the baseline for the forecasted day.

- 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 a rather amorphous and irregular load.

Step 3: Evaluation. For the testing data period,[37] three measures including accuracy (root mean square error, RMSE), bias (difference), and variability (standard deviation) are calculated. This step measures how well-fit the model results are when 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.[38] The method with the top ranking (lowest score) is selected.

6.6.3.1 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), pre-cooling, or snapback.

6.6.3.2 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 2021 was then calculated. This is the number used to report achieved CP savings.

6.6.3.3 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.

6.6.3.4 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 the 4CP success rate[39] for each program in FY 2022.

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[37] 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 9:00 am – 1:00 pm on the event day.

[38] General rule for "pairwise comparison using ranking": if the difference for a pair of baselines is greater than 2%, the baseline with the higher one gets one point. Otherwise, both baselines get 0.5 point. At the end of this process, for each method respectively, the RMSE, bias, and standard deviation score are added together.

[39] 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%.

6.6.4 Results

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

1) Estimated program impacts during summer 2021 DR events.

2) End-of-year (EOY) program capability based on program enrollment at the end of FY 2022; this information is useful for planning purposes.

3) End-of-year (EOY) program capability based on incremental enrollment during FY 2022; this information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

For C&I DR programs, 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.

6.6.4.1 Estimated Impacts During Summer 2021 DR Events

During summer 2021, C&I DR events were called on 27 days. The aggregated kW savings estimates are shown in the following figure.

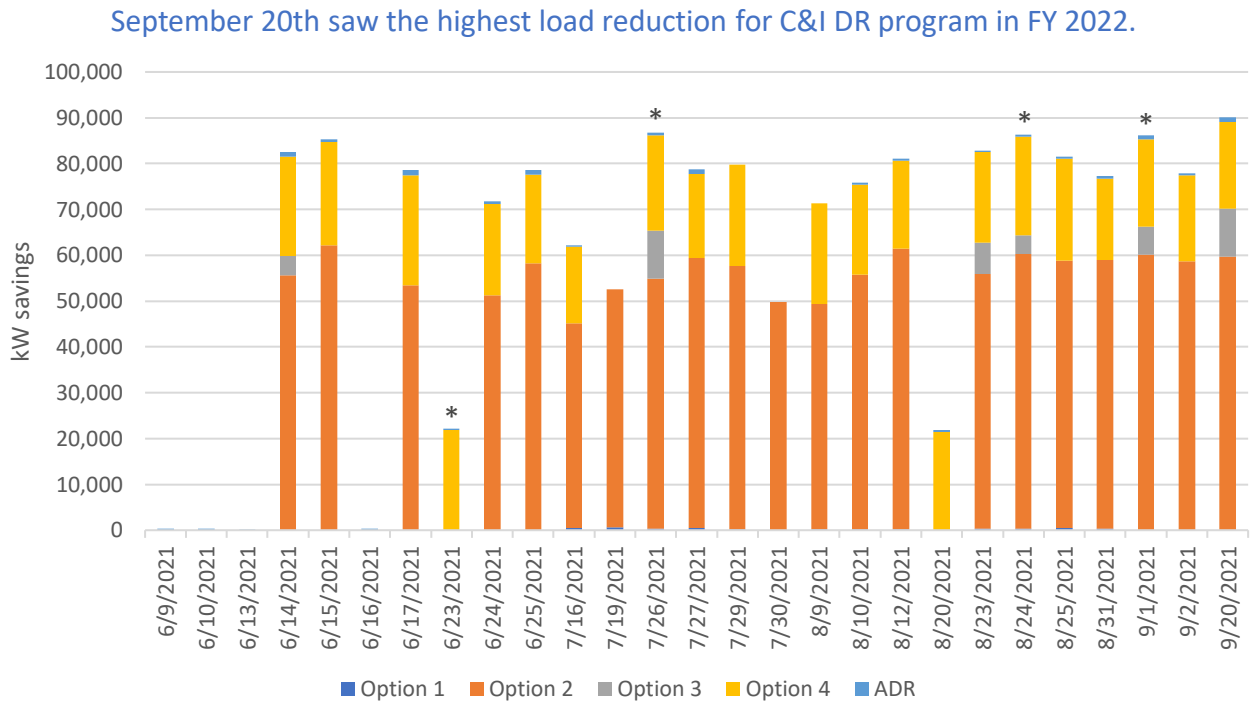

Figure 6-21: CADR – Summer 2021 Delivered Demand Savings

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

Maximum total demand reduction was achieved on the last event day, September 20th. The total demand reduction on this day from all C&I DR programs was 90.1 MW. 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 the following five figures.

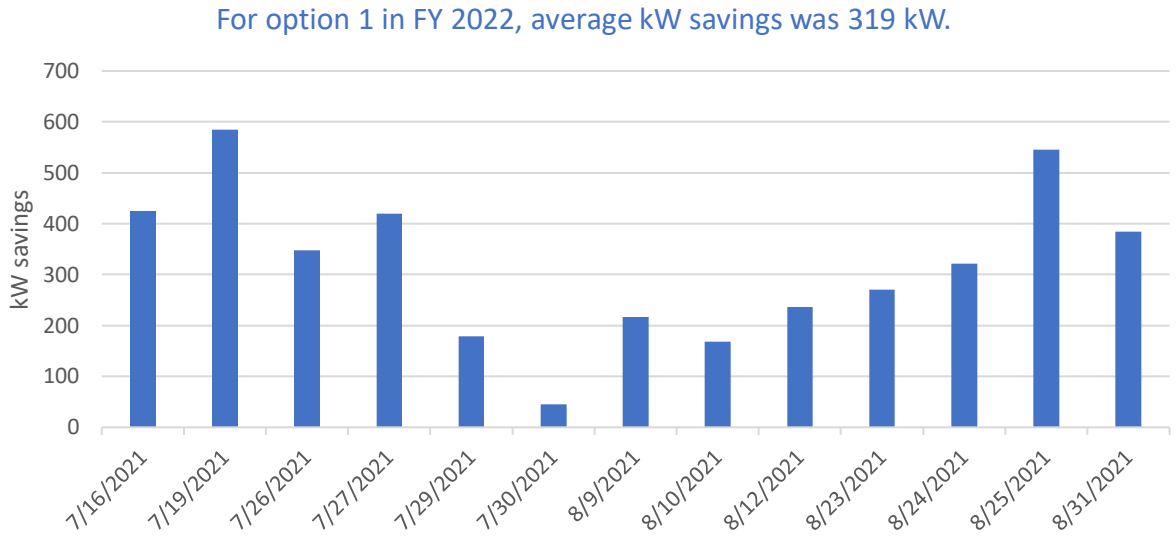

Figure 6-22: CADR – Option 1 Demand Savings by Event

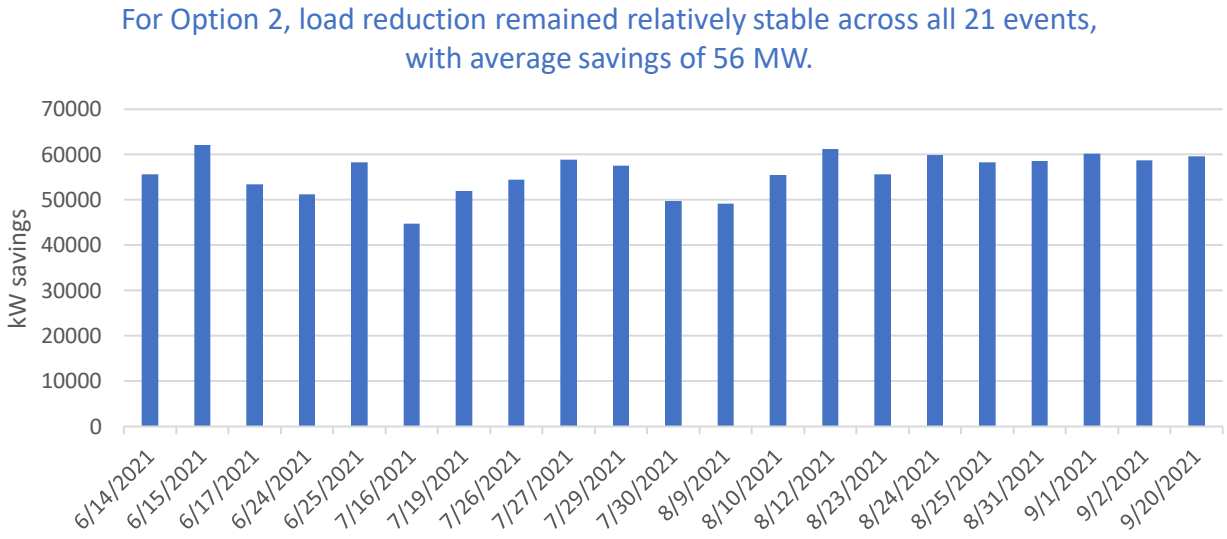

Figure 6-23: CADR – Option 2 Demand Savings by Event

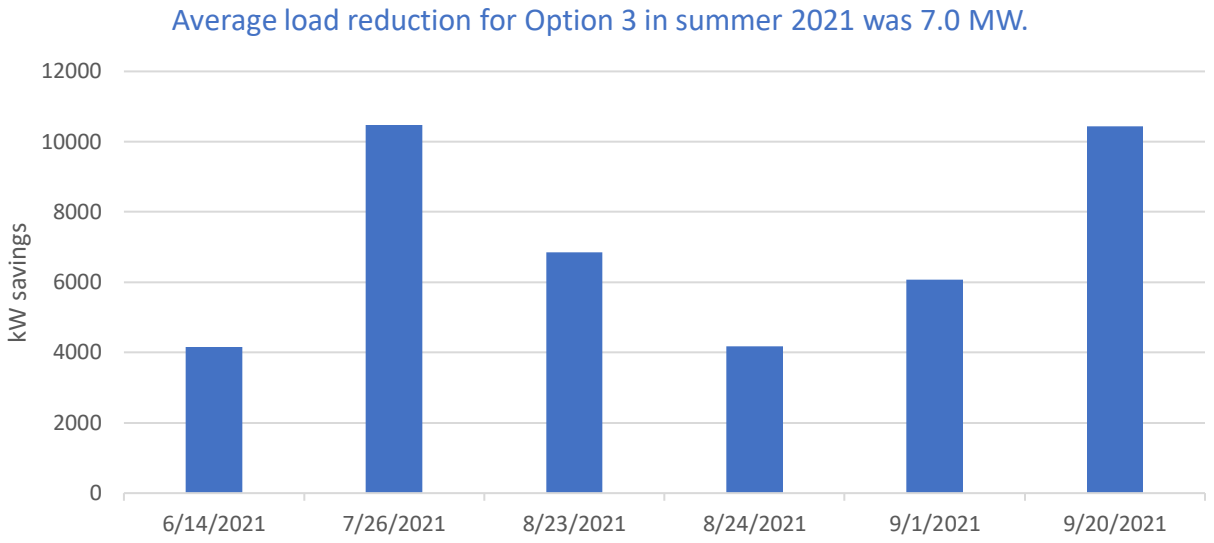

Figure 6-24: CADR – Option 3 Demand Savings by Event

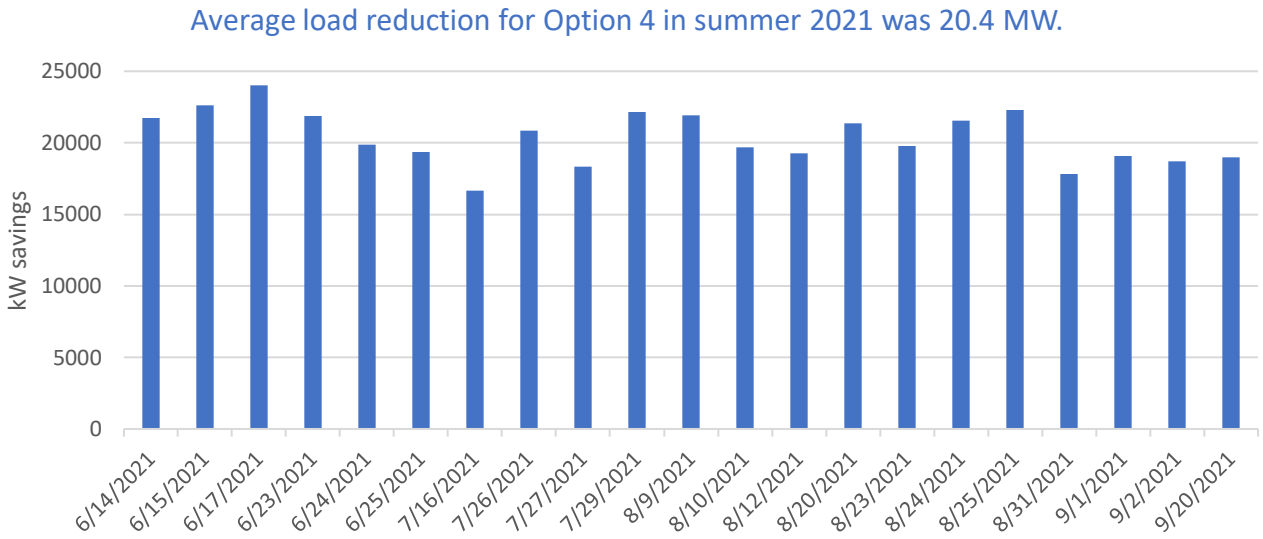

Figure 6-25: CADR – Option 4 Demand Savings by Event

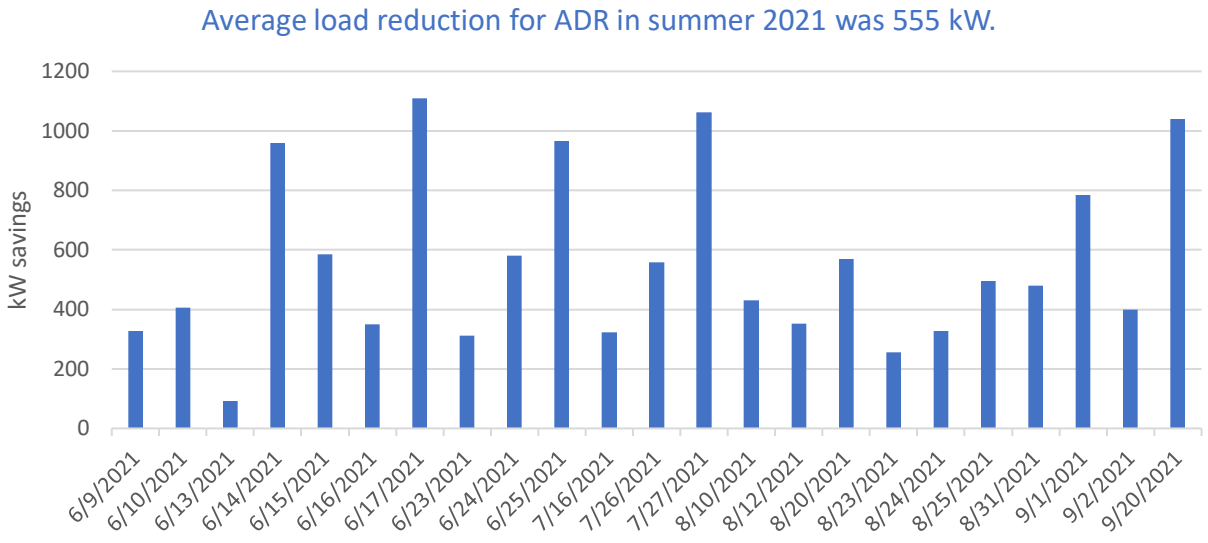

Figure 6-26: CADR – Automated DR Demand Savings by Event

A comparison of the estimated impacts from FY 2017 to FY 2022 is shown below:

Table 6-25: CADR – FY 2017-2022 Estimated Achieved kW Impacts Comparison

C&I DR Program/ Option	FY 2017 Average Savings (kW)	FY 2018 Average Savings (kW)	FY 2019 Average Savings (kW)	FY 2020 Average Savings (kW)	FY 2021 Average Savings (kW)	FY 2022 Average Savings (kW)
Option 1	994	5,373	3,900	964	726	319
Option 2	66,010	56,103	43,216	57,302	65,746	55,955
Option 3	7,860	4,265	4,998	5,016	5,240	7,028
Option 4	--	--	20,647	22,877	20,671	20,377
ADR	5,684	7,239	3,662	2,510	637	555
Sum of Average Savings	**80,548**	**72,980**	**76,423**	**88,669**	**93,020**	**84,234**

* Note: 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.

FY 2022 Delivered Savings

The following table presents the estimates of savings delivered by the Commercial DR programs for FY 2022.

Table 6-26: CADR – Delivered 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)
Option 1	9,843	319	585	167
Option 2	3,026,750	55,955	62,163	43,658
Option 3	111,830	7,028	10,473	5,178
Option 4	1,059,930	20,377	24,012	20,838
ADR	25,363	555	1,110	495
Total*	**4,233,716**	**84,234**	**98,343**	**70,335**

* Note: 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.

6.6.4.2 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 one to two 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 2021 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 eight fiscal years[40] to estimate end-of-year program capability for ERCOT 4CP demand savings. For example, the average success rate for Option 1 in the past eight fiscal years was 41%, as shown in the table below. With success rate in 50%, converting achieved 4CP demand savings to EOY demand savings yields 167 kW/ 50% * 41% = 136 kW[41].

[40] For option 4, we average the success rate of past four fiscal years since it was launched four fiscal years ago.
[41] Number may not exactly match due to rounding.

Table 6-27: CADR – EOY ERCOT 4CP Demand Savings

Measure	Success Rate								Average Success Rate	Achieved ERCOT 4CP Demand Savings (kW)	EOY ERCOT 4CP Demand Savings (kW)
	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22			
Option 1	25%	50%	50%	25%	50%	25%	50%	50%	41%	167	136
Option 2	75%	75%	100%	75%	100%	75%	75%	100%	84%	43,658	36,836
Option 3	50%	75%	25%	75%	50%	50%	50%	75%	56%	5,178	3,884
Option 4	--	--	--	--	100%	100%	75%	100%	94%	20,838	19,535
ADR	75%	100%	100%	100%	100%	100%	75%	100%	94%	495	464
									Total*	**70,335**	**60,855**

* Note: 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.

Option 1 participants are not available in June or September, meaning at least two 4CP events will always be missed with that program option and the maximum success rate for hitting 4CP would therefore be 50%. 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 6-28: CADR – EOY 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)
Option 1	9,843	319	585	136
Option 2	3,026,750	55,955	62,163	36,836
Option 3	111,830	7,028	10,473	3,884
Option 4	1,059,930	20,377	24,012	19,535
ADR	25,363	555	1,110	464
Total*	**4,233,716**	**84,234**	**98,343**	**60,855**

* Note: 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.

6.6.4.3 Incremental Impacts

For all the C&I DR programs, there is no distinction between total participation and incremental participation – all participants are treated as new for FY 2022. As such, the analysis of incremental impacts of these programs is no different from the analysis of total impacts.

6.7 RESPONSE TO 2021 FEBRUARY WINTER STORM – WINTER DR EVENTS

6.7.1 Overview

Between February 13 and 17, 2021, Winter Storm Uri swept across Texas and caused a major power crisis.[42] In response to surging demand and insufficient load, CPS Energy deployed a series of emergency DR events for both C&I DR customers and residential DR program participants.

For both C&I and residential DR participants, it is very difficult to isolate the impacts of the DR programs from the impacts of the service outages which were either unplanned or implemented by CPS Energy in response to ERCOT's EEA-3 directives. In addition, compared with residential DR participants, C&I DR participants have seen unusual load shapes and lack a valid control group. Due to these factors, Frontier did not quantify winter DR savings for C&I DR customers and focused only on the savings contributed by residential thermostats.

From February 14 to 19, winter DR events were deployed to the following categories of thermostats[43]:

(1) Traditional cycling thermostats participating in Smart Thermostats DR program.
(2) WiFi thermostats on the Resideo platform. They either participated in Smart Thermostats DR program or BYOT DR program. Participating thermostat brands include Honeywell and Emerson.
(3) ecoBee thermostats on the EnergyHub platform. They participated in BYOT DR program in summer.
(4) Nest thermostats. They either participated in BYOT DR program or Google Nest DR program in summer.

Unlike summer DR events, there were no strict limits on the total number of DR events called, the duration of each event, or the time period when the events should be called. Table 6-29 through Table 6-32 tabulate winter DR event schedule and participation by event on different deployment platforms.

Table 6-29 Winter DR – Event Schedule – Smart Thermostat Traditional 33%/50% Cycling Thermostats

Event ID Number	33% Cycling Participating AMI Accounts Quantity	50% Cycling Participating AMI Accounts Quantity	Event Date	Start Time	End Time
Event #1	48,151	7,540	2/14/2021	6:00:00 PM	9:00:00 PM
Event #2-3	28,604	7,934	2/15/2021	12:32:00 AM	12:57 AM (Canceled)
			2/15/2021	1:03:00 AM	3:30:00 AM
Event #4-5	29,631	3,637	2/15/2021	5:45:00 AM	10:00:00 AM
			2/15/2021	10:04:00 AM	11:59:00 PM

[42] Source: https://en.wikipedia.org/wiki/February_13%E2%80%9317,_2021_North_American_winter_storm
[43] Not all of the thermostats which participated in summer DR programs in the following categories participated in the winter DR program.

Event ID Number	33% Cycling Participating AMI Accounts Quantity	50% Cycling Participating AMI Accounts Quantity	Event Date	Start Time	End Time
Event #6-9	21,870	2,503	2/16/2021	1:49:00 AM	11:59:00 PM
			2/17/2021	12:00:00 AM	11:59:00 PM
			2/18/2021	12:00:00 AM	11:59:00 PM
			2/19/2021	12:00:00 AM	11:00:00 AM

Table 6-30 Winter DR – Event Schedule – Honeywell & Emerson Thermostat on Resideo Platform

Event ID Number	Honeywell Participating AMI Accounts Quantity	Emerson Participating AMI Accounts Quantity	Event Date	Start Time	End Time
Event #1	4,492	517	2/15/2021	1:15:00 AM	3:15:00 AM
Event #2-6	3,867	441	2/15/2021	7:05:00 AM	10:05:00 AM
			2/15/2021	10:00:00 AM	5:00:00 PM
			2/15/2021	5:00:00 PM	8:00:00 PM
			2/15/2021	8:00:00 PM	12:00:00 AM
			2/16/2021	12:00:00 AM	11:00:00 AM
Event #7-10	4,080	468	2/16/2021	12:00:00 PM	4:00:00 PM
			2/16/2021	4:00:00 PM	8:00:00 PM
			2/16/2021	8:00:00 PM	12:00:00 AM
			2/17/2021	12:00:00 AM	11:00:00 AM
Event #11	5,700	656	2/17/2021	12:00:00 PM	4:00:00 PM
Event #12	6,389	729	2/17/2021	5:00:00 PM	9:00:00 PM
Event #13-14	8,118	922	2/17/2021	10:00:00 PM	12:00:00 AM
			2/18/2021	12:00:00 AM	11:00:00 AM
Event #15	9,329	1,049	2/18/2021	12:00:00 PM	4:00:00 PM
Event #16	9,252	1,050	2/18/2021	5:00:00 PM	9:00:00 PM
Event #17-18	9,208	1,048	2/18/2021	10:00:00 PM	12:00:00 AM
			2/19/2021	12:00:00 AM	11:00:00 AM

Table 6-31 Winter DR – Event Schedule – ecobee Thermostats on EnergyHub Platform

Event ID Number	Participating AMI Accounts Quantity	Event Date	Start Time	End Time
Event #1	1,749	2/15/2021	1:00:00 PM	11:59:00 PM
Event #2	1,730	2/16/2021	12:00:00 PM	11:59:00 PM
Event #3-6	1,580	2/17/2021	1:00:00 AM	11:00:00 AM
		2/17/2021	11:01:00 AM	11:59:00 PM
		2/18/2021	12:00:00 AM	11:00:00 AM
		2/18/2021	11:01:00 AM	11:59:00 PM
Event #7	3,244	2/19/2021	1:00:00 AM	11:00:00 AM

Table 6-32 Winter DR – Event Schedule – Nest Thermostats

Event ID Number	Participating AMI Accounts Quantity	Event Date	Start Time	End Time
Event #1	8,556	2/15/2021	9:40:00 PM	11:55:00 PM
Event #2	6,556	2/16/2021	8:45:00 AM	12:45:00 PM
Event #3	7,620	2/17/2021	7:00:00 AM	11:00:00 AM
Event #4	13,811	2/18/2021	7:00:00 AM	11:00:00 AM
Event #5	13,767	2/19/2021	7:00:00 AM	11:00:00 AM

As can be seen from event schedule tables above, winter DR events could last as long as 24 hours, and there were situations when there was no “pause time” between two events. In those cases, savings were analyzed together instead of on an event-by-event basis.

Because Winter DR is a one-time program deployed specifically for the winter storm in February 2021, we will not incorporate winter DR savings into the overall STEP program portfolio savings summary.

6.7.2 Savings Calculation Methods

Winter DR was a one-time, emergency program implemented for emergency load shed during the power crisis. Although residential thermostats from summer DR programs were deployed in winter DR, methodologies developed for quantifying summer DR savings did not apply to winter DR analysis due to the following reasons:

(1) Unlike summer DR events, we need to isolate the impacts of the DR programs from the impacts of the outages of service to residential customers, which were due either to unplanned outages (such as falling tree limbs causing line failure) or implemented by CPS Energy in response to ERCOT’s EEA-3 directives.

(2) There is little a priori information available regarding the expected performance of the residential DR programs during winter events, while for summer DR events, aggregated load profile pattern usually exists for residential dwellings.
(3) Some of the winter DR events lasted as long as 24 hours with another DR event following immediately, while summer DR events rarely occur more than once a day, usually lasting no more than 3 hours per event.

As a result, for all the deployment platforms, a single static control group was developed for quantifying the savings. The customers in this group did not participate in CPS Energy winter residential DR programs and did not have their power shut off by CPS Energy during the week of rolling blackouts.[44] Specifically, savings per AMI account was calculated in the following manner:

Step 1: Before each event (or a group of consecutive events), set a one-hour adjustment window[45] to develop a calibration ratio to force average consumption level between participant group and control group to be the same. For example, if an event begins at 4pm, the adjustment window is set as 3pm – 4pm. Control group and participant group aggregated kW per AMI account is 4 kW and 5 kW respectively during this 1-hour period. The calibration ratio is calculated as 5 kW/4 kW = 1.25.

Step 2: Apply the calibration ratio to the control group throughout the whole event period (or combination of a set of consecutive events) to generate an adjusted baseline.

Step 3: kW savings per AMI account is calculated as the difference between adjusted baseline and actual participant load profile. Multiplying number of participants during that event (or that set of consecutive events) yields total kW savings.

6.7.2.1 Energy Savings (kWh)

For each event or each set of consecutive events, multiplying total kW savings by event duration yields total kWh savings.

6.7.2.2 Coincident Peak (CP) Demand Savings (kW), Non-Coincident Peak (NCP) Demand Savings (kW), ERCOT 4CP Demand Savings (kW)

CP, NCP and 4CP savings only apply to summer DR programs and are therefore not reported in the winter DR program.

6.7.3 Results

The figures below summarize aggregated kW savings for each of the deployment platforms:

[44] This analysis did not consider potential local problems with distribution lines affected by falling tree limbs or similar events.
[45] For WiFi Emerson and WiFi Honeywell events #15 and #16, along with WiFi Emerson events #13-#14 (consecutive events), a 15-minute instead of a 1-hour adjustment window prior to the start of the event was applied. For those events, the gaps between the previous events were only one hour, which would have caused obvious "bounce-back" problems if a full 1-hour adjustment window was applied.

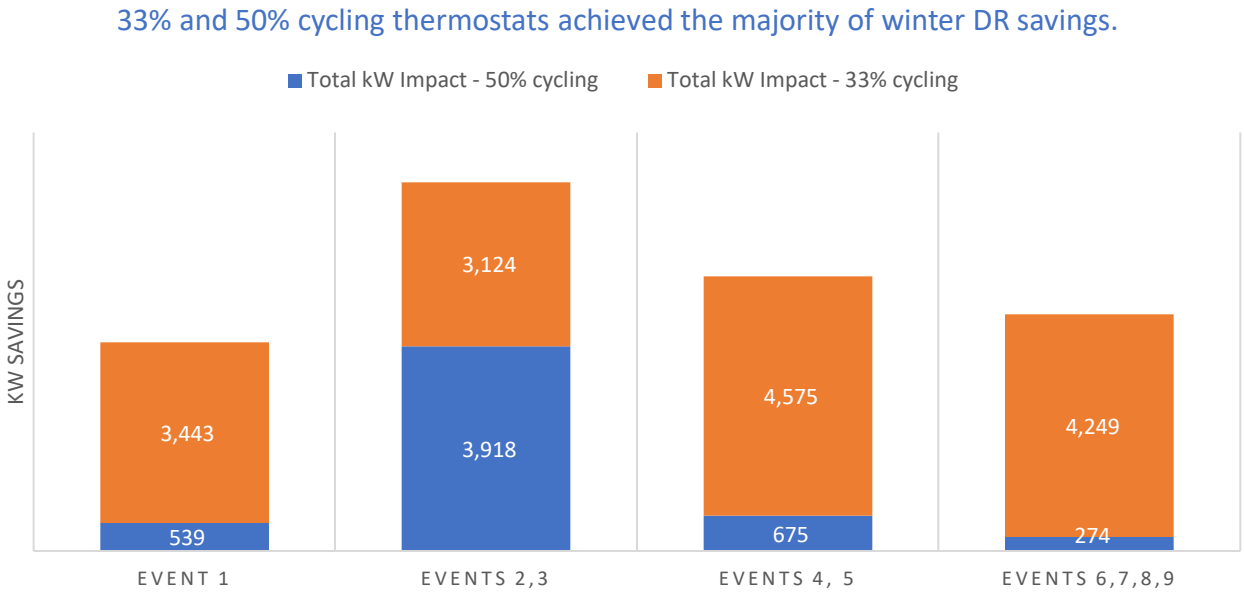

Figure 6-27: Winter DR – kW Savings by Event - 33% and 50% Cycling Thermostats

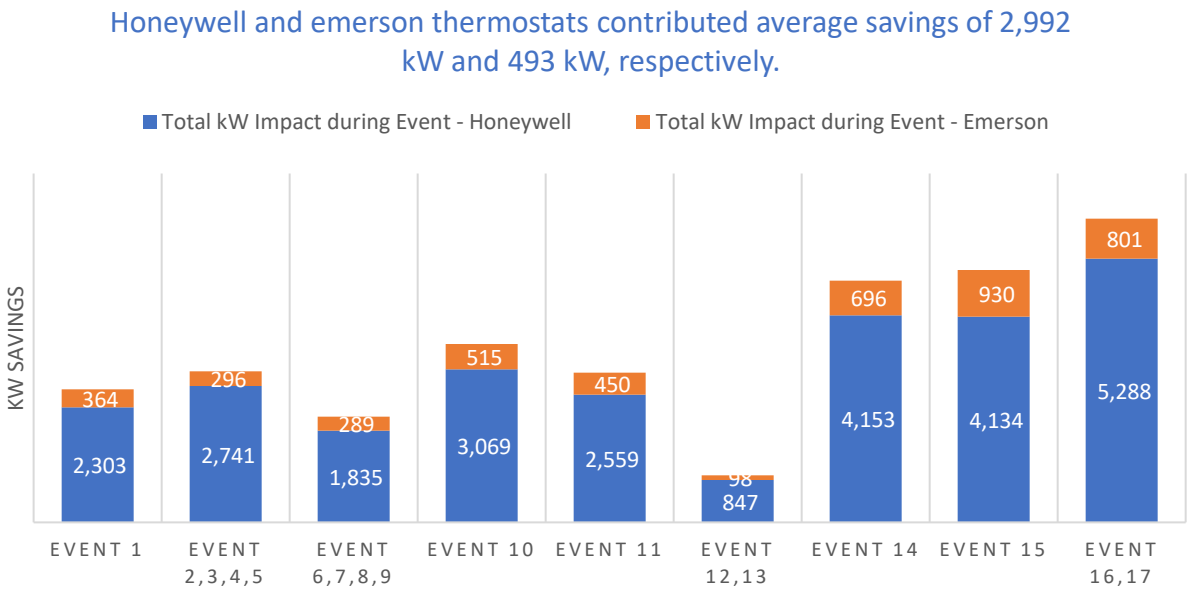

Figure 6-28: Winter DR – kW Savings by Event – Honeywell and Emerson Thermostats

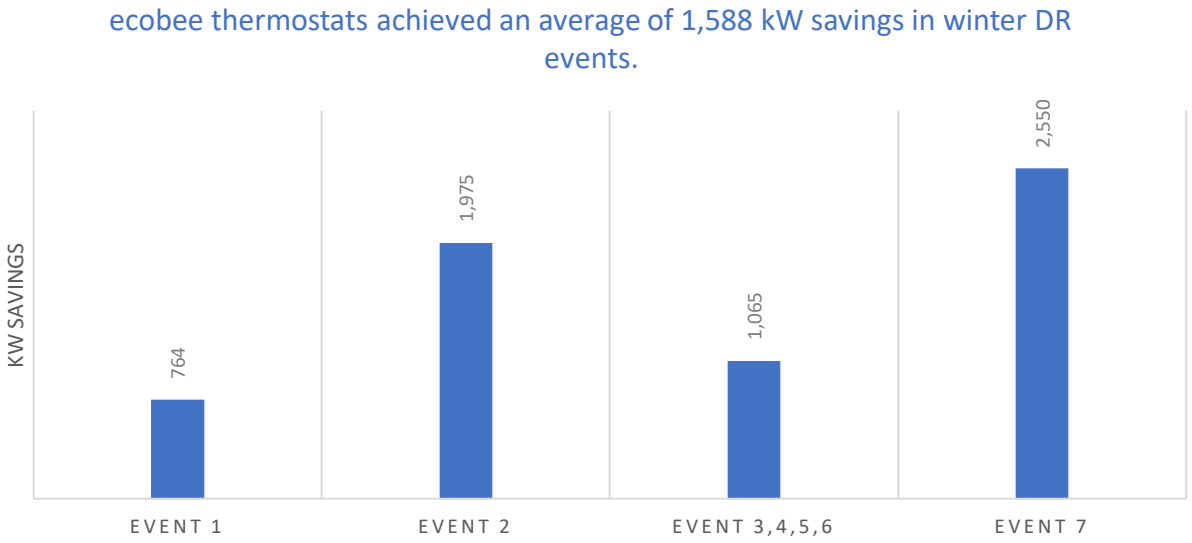

Figure 6-29: Winter DR – kW Savings by Event - ecobee Thermostats

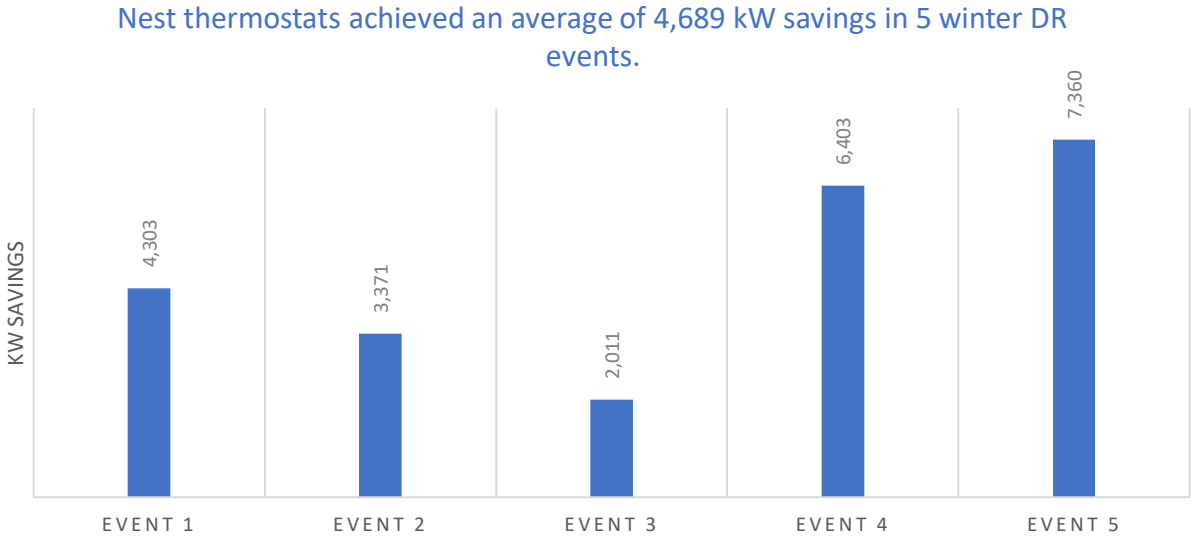

Figure 6-30: Winter DR – kW Savings by Event - Nest Thermostats

The table below summarizes average kW savings per AMI account, average total kW savings and total energy savings achieved in winter DR. Approximately 14,963 kW of load reduction and 990 MWh in energy savings were achieved during these winter storm days.

Table 6-33 Winter DR – Program Savings Summary

Platform/Cycling Type	Thermostat Types	Average kW Savings per AMI Account	Average Total kW Savings	Total Energy (MWh) Savings
Traditional cycling	33% cycling	0.13	3,848	448
	50% cycling	0.22	1,352	48
Resideo	WiFi Honeywell	0.46	2,992	262
	WiFi Emerson	0.65	493	38
EnergyHub	ecobee	0.76	1,588	108
Nest	Nest	0.46	4,689	86
		Total*	**14,963**	**990**

* Note: 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.

6.8 DEMAND RESPONSE PROGRAM RECOMMENDATIONS

6.8.1 General Comments for All DR Programs

Compared with DR program portfolio performance in FY 2021, there was an approximate 23 MW decrease[46] in NCP kW savings in FY 2022. The following factors may explain the drop in savings:

1. **Much cooler temperatures in summer 2021 compared to 2020:** Temperature is the main reason behind the savings drop in FY 2022. In summer 2021, the temperature during residential DR events was 5-6 degrees Fahrenheit lower than summer 2020 events. The temperature difference between two adjacent years has generally not been this large. For residential DR programs (Smart Thermostat, BYOT and Google Nest Thermostat) alone, this drastic temperature change has contributed to around 16 MW CP, 14 MW 4CP, and 17 MW NCP savings loss,[47] as shown in the scenario analysis below:

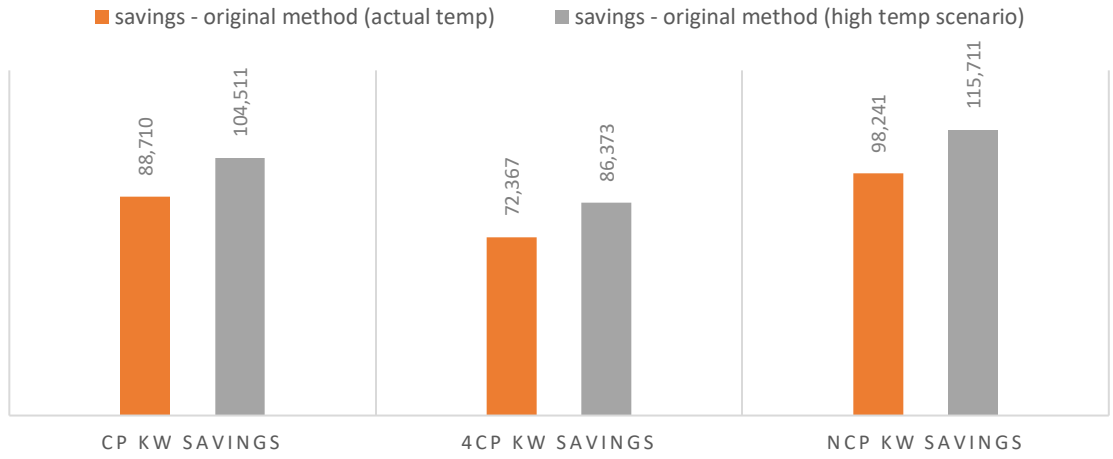

Figure 6-31: Residential DR EOY kW Savings Comparison – Actual vs. Higher Temperature Scenario[48]

2. **Lower participation in the Google Nest Thermostat program**: Due to Google closing down their thermostat management system and requiring utilities to move all devices to another platform and required all customers to sign new terms, there were approximately 1/3 fewer participants in Nest thermostat programs by EOY FY 2022 (approximately 10,000) compared with EOY FY 2021 (approximately 15,000).
3. **Long event duration**: The longest residential DR event in Summer 2021 lasted five hours (Nest thermostats 6/14/2021 2-7pm event), which was longer than the 2020 events.
4. **Possible behavior change in summer 2020 due to the pandemic**: Compared with summer 2021, more people stayed at home in summer 2020 due to the COVID-19 pandemic.

[46] End-user level, i.e., before scaling for net-to-gross ratios.
[47] These numbers are all end-user level, i.e., before scaling for net-to-gross ratios.
[48] This scenario analysis was conducted using the originally developed time-temperature matrix (adopted two years ago) instead of actual interval data since different temperature scenarios can be simulated more easily using this methodology. In fact, overall DR portfolio level savings generated by actual data vs time-temperature matrix is very small in FY 2022.

In addition, Frontier provides the following recommendations by program type:

6.8.2 General Recommendations for All DR Programs

- To balance the multiple goals of DR programs, we continue our recommendation of calling events with more creativity and flexibility, potentially more than once within a single day. The goals of DR programs are to reduce 4CP transmission cost, cost from high Real-Time Market (RTM) prices, and CPS Energy load zone peak. With the launching of two fast-growing EV programs that allow load reduction to occur till as late as 9pm, Frontier recommends CPS Energy design weather sensitive DR programs with non-weather sensitive EV programs where maximum event duration can be reduced while total kW savings is optimized.

6.8.3 Smart Thermostat Program

- The Smart Thermostat program has been offered since 2003. Because WiFi thermostats yield much higher per-device level savings than traditional cycling thermostats and indoor installations have resumed post-pandemic, we recommend continuing to replace early traditional cycling thermostats with WiFi thermostats.

6.8.4 Google Nest Thermostat Program

- In FY 2022, participation in this program decreased about 1/3 compared to FY 2021. The participation drop is primarily due to a platform migration where all customers had to accept new terms and conditions from Google to stay in the program. Most of these lost savings can likely be recovered by re-inviting these 1/3 participants to join certain DR program(s) in some way, as they already have the device to be able to participate in load shedding events.

7. SOLAR ENERGY PROGRAMS

7.1 SUMMARY OF SOLAR ENERGY IMPACTS

The following CPS Energy solar energy programs resulted in new onsite solar energy generating capacity being installed during FY 2022:

- Residential Solar – Offers incentives for the installation of solar photovoltaic (PV) systems.
- Commercial and Schools Solar – Offers incentives for the installation of solar PV systems.
- 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 new generating capacity added via each solar energy program to energy savings, non-coincident peak demand (NCP), and coincident peak demand (CP) are shown in Figure 7-1, Figure 7-2, and Figure 7-3.

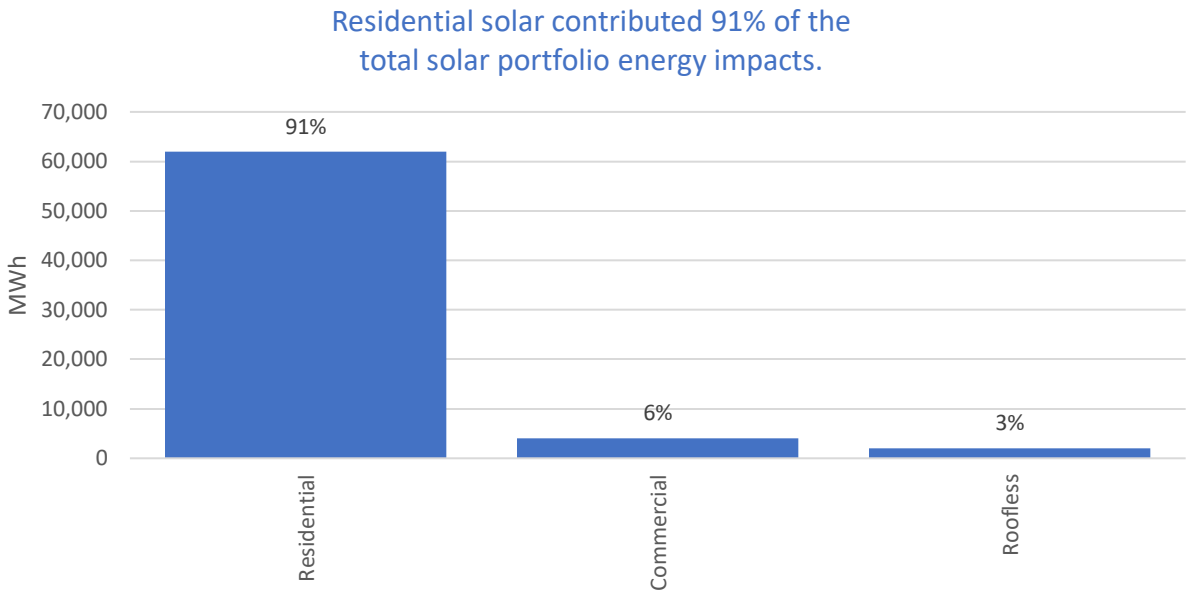

Figure 7-1: Summary of Solar Energy Impacts – Energy (MWh) by Program

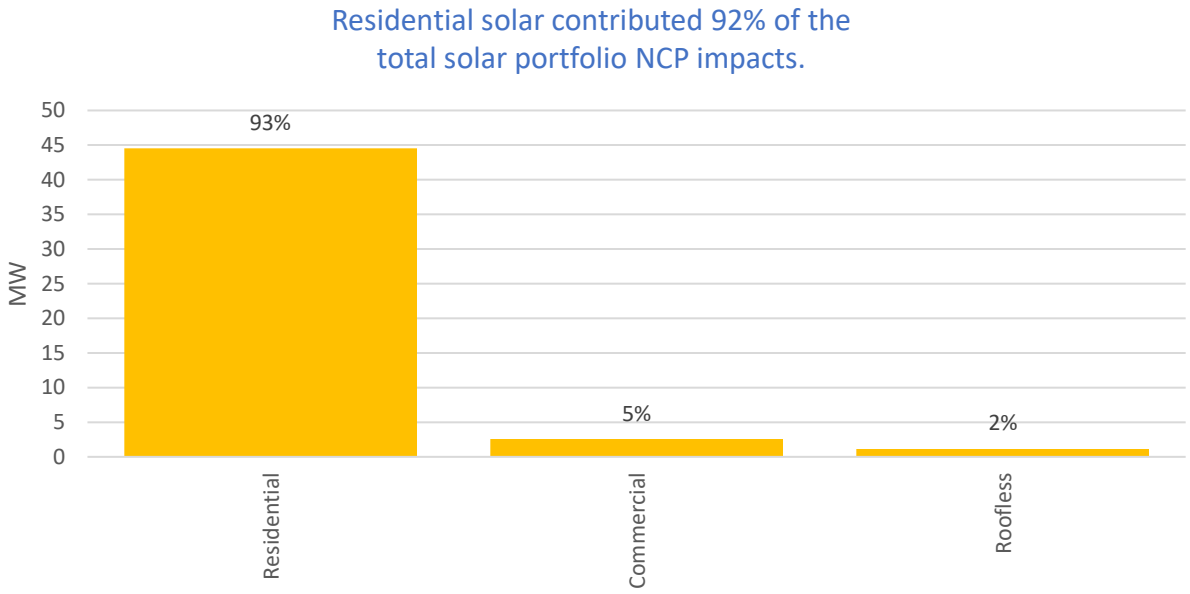

Figure 7-2: Summary of Solar Energy Impacts – Non-Coincident Peak Demand (MW) by Program

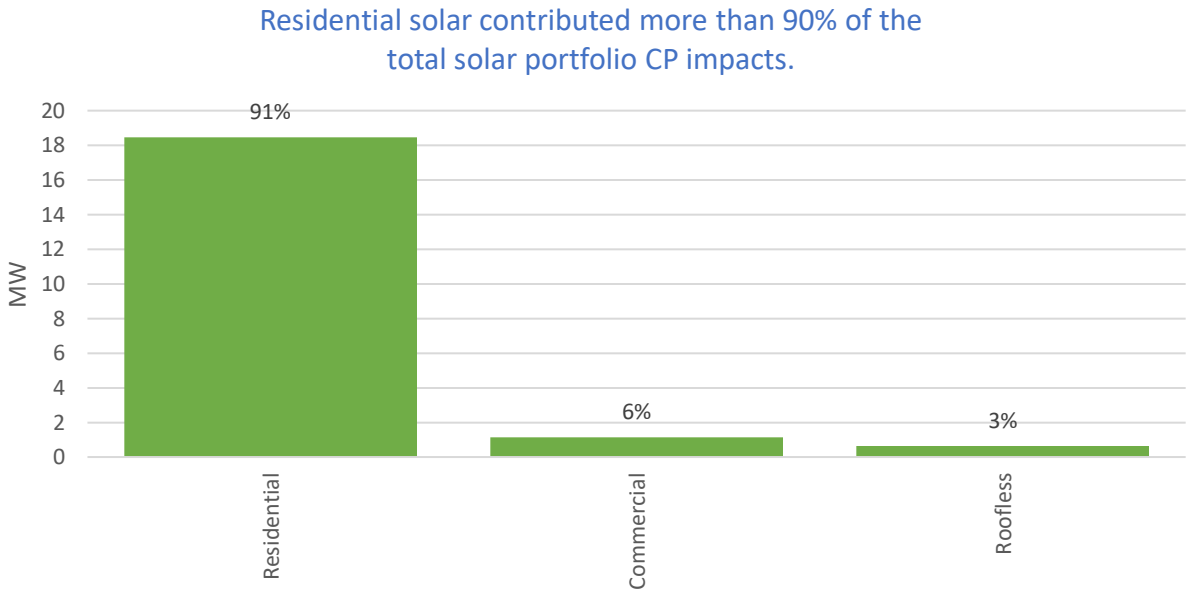

Figure 7-3: Summary of Solar Energy Impacts – Coincident Peak Demand (MW) by Program

7.2 RESIDENTIAL SOLAR PROGRAM

7.2.1 Overview

CPS Energy has offered rebates for residential solar PV systems for more than 15 years. During that time, rebate levels have been gradually reduced as the local and global solar markets have matured, and market prices for installed solar have declined dramatically.

All residential solar projects completed during FY 2022 were paid under a rebate design that offered a fixed rebate amount ranging from $1,875 to $3,000 per customer-owned project. Incentives were dependent on the use of local installers and locally manufactured components. This resulted in an effective average rebate level of $0.31/$W_{DC}$, representing a slight decrease from FY 2021's $0.32/$W_{DC}$. Residential solar rebates are further limited to 50% of the project cost, and all PV systems are required to be installed by a CPS Energy-registered contractor.

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

In FY 2022, 4,974 residential solar PV systems were installed through the program, totaling 42,611 kW_{DC} and $13.1 million in rebates distributed. Each of these metrics represent program records despite slightly rising installation costs over the past three years. The average residential solar PV system size was 8.6 kW_{DC}, and the median system size was 8.1 kW_{DC}.[49] Figure 7-4 summarizes the Residential Solar program history in terms of annual capacity installed, average installed system prices, and average rebate levels.

[49] The average value tends to skew high due to the presence of a relatively small number of very large residential systems.

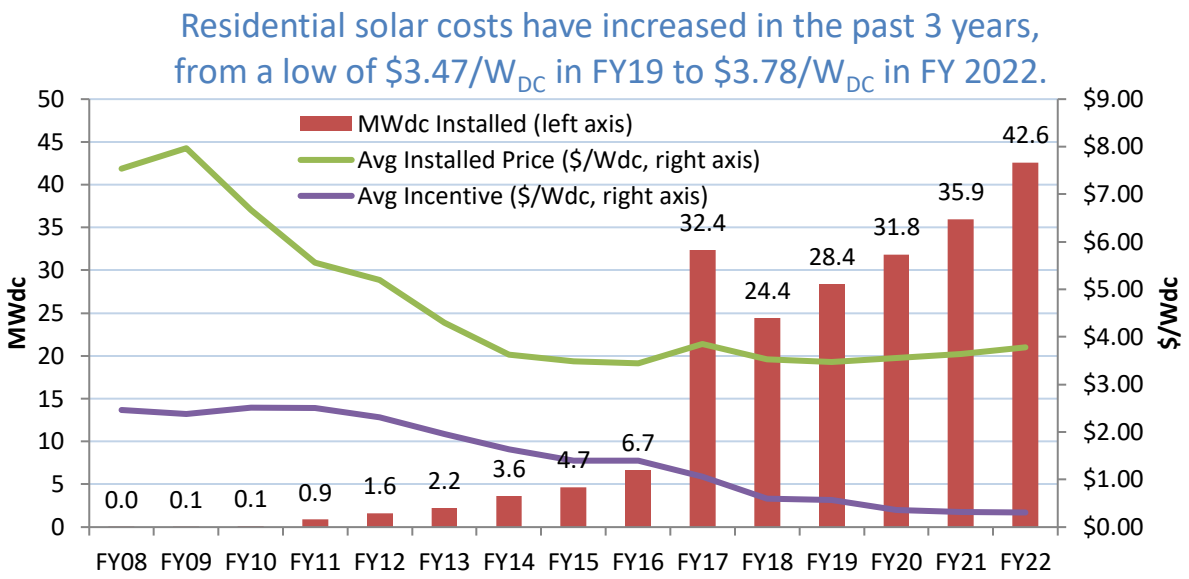

Figure 7-4: Residential Solar – Program History: Annual Capacity Installed, Average System Price, and Average Rebate Levels

CPS Energy's contribution to the total installation costs of residential solar has diminished over the program life. Utility rebates currently cover only 8% of installed costs, a record low in the program's history.

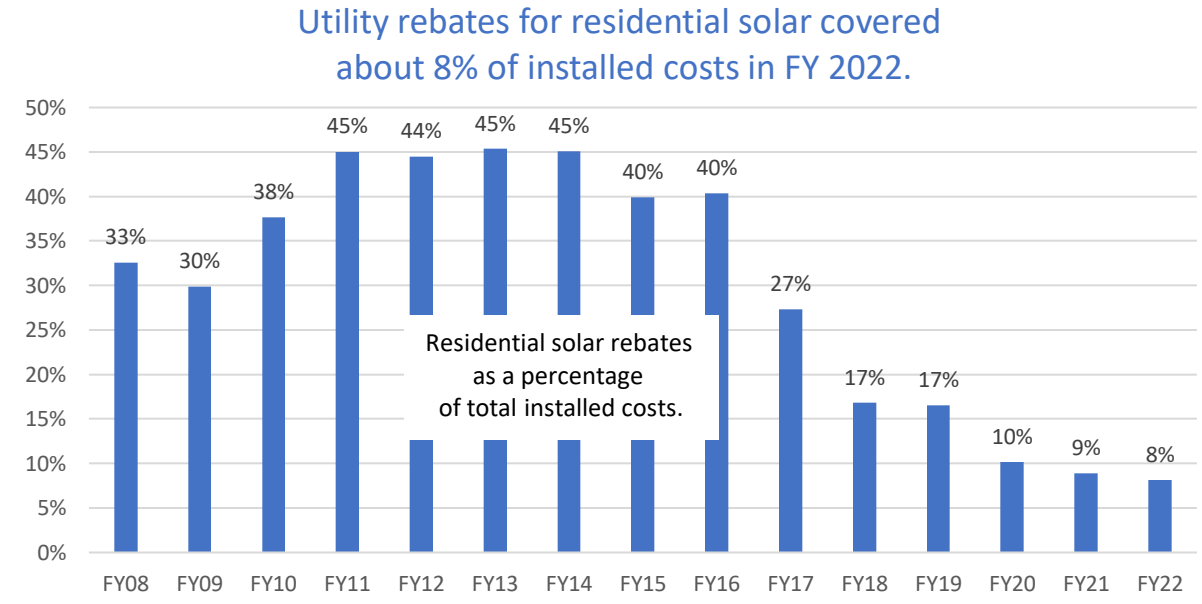

Figure 7-5: Residential Solar – Percentage of Installed System Costs Paid by Program Rebates

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. The method assumes an average production index of 1,324 kWh per kW_{DC} installed among a variety of residential PV systems at various tilts and orientations. This production factor was updated during FY 2022 based on Frontier Energy's review of metered solar energy production data. The new factor slightly reduces the estimated annual production relative to the older factor, which was based on modeling the annual energy production from a representative fleet of residential PV systems using NREL PVWatts Version 5.

7.2.2.2 Coincident Peak (CP) Demand Savings (kW)

Peak demand savings utilize a deemed savings factor of 0.433 kW of coincident peak savings per kW_{DC} installed, as described in the CPS Energy Guidebook. This factor was updated during FY 2022 based on Frontier Energy's review of metered solar energy production data. The factor slightly increases the estimated CP relative to the older factor, which was based on modeling the annual energy production from a representative fleet of residential PV systems using NREL PVWatts Version 5.

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 1.046 kW of NCP savings per kW_{DC} installed. This factor was updated during FY 2022 based on Frontier Energy's review of metered solar energy production data. The factor slightly increases the estimated NCP relative to the older factor, which was based on modeling the annual energy production from a representative fleet of residential PV systems using NREL PVWatts Version 5.

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 0.364 kW of ERCOT 4CP savings per kW_{DC} installed. This factor was updated during FY 2022 based on Frontier Energy's review of metered solar energy production data. The factor slightly increases the estimated ERCOT 4CP relative to the older factor, which was based on modeling the annual energy production from a representative fleet of residential PV systems using NREL PVWatts Version 5.

7.2.3 Results

The gross energy and demand savings for the Residential Solar Program are presented in Table 7-1.

Table 7-1: Residential Solar – Program 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)
Residential Solar PV	56,416,433	18,450	44,571	15,510

In every program year, Frontier reviews all solar data, identifies outliers and potential miscalculations and other errors in the data, and works with CPS Energy staff to jointly confirm and resolve issues identified.

Deemed savings values originally developed by Frontier in FY 2017 were validated via desk and field reviews during FY 2019. All savings calculations were updated during FY 2022 based on Frontier Energy's review of metered solar data.

Due to health concerns associated with the COVID-19 pandemic, on-site reviews were not conducted during FY 2022. Frontier plans to continue to monitor, validate, and adjust as necessary these deemed savings values at least every three years.

7.3 COMMERCIAL AND SCHOOLS SOLAR PROGRAM

7.3.1 Overview

CPS Energy has been providing rebates for solar PV systems installed on commercial and school buildings for more than 12 years. Under CPS Energy's tiered rebate structure, in FY 2022 new commercial projects paid out at a higher tier ($0.70/$W_{AC}$, subsequently reduced to $0.60/$W_{AC}$) for the first 25 kW installed, and at a lower tier for capacity greater than 25 kW ($0.50/$W_{AC}$, subsequently reduced to $0.40/$W_{AC}$, respectively). These amounts were reduced to 75 percent for non-local installers. Rebate levels offered were stepped down by $0.10/$W_{AC}$ between FY 2021 and FY 2022, so projects that completed during FY 2022 comprised a mix of rebates offered at both levels. All rebates were limited to $80,000 or 50% of total project costs. No school projects were completed during FY 2022.

Commercial solar systems varied in size from less than 2 kW_{DC} to greater than 300 kW_{DC}. While smaller systems were most common (systems less than 25 kW_{DC} accounted for more than half of all installs), the largest systems dominated the program in terms of new capacity added and rebates earned. The three largest installs accounted for more than half of all new capacity and nearly a quarter of rebates paid. Table 7-2 presents the number, capacity, and rebated amounts of commercial solar projects completed during FY 2022.

Table 7-2: Commercial & Schools Solar – Program Rebates

System Size (kWDC)	# of Projects	Total Capacity (kWDC)	Rebated Amount
<10	6	36.85	$23,974
10-24	8	119.33	$60,637
25<99	13	763.62	$366,409
100-<249	10	1,544.55	$644,502
250+	1	330.22	$80,000
Total	**38**	**2,794.97**	**$1,175,21**

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 2022, there were 38 commercial solar PV systems installed through the program, totaling 2,795 kWdc and $1.2 million in rebates distributed. The average commercial system size was 74 kW_{dc}.

The figure below summarizes the Commercial and Schools Solar Program history in terms of capacity installed, average system prices, and rebate levels annually.

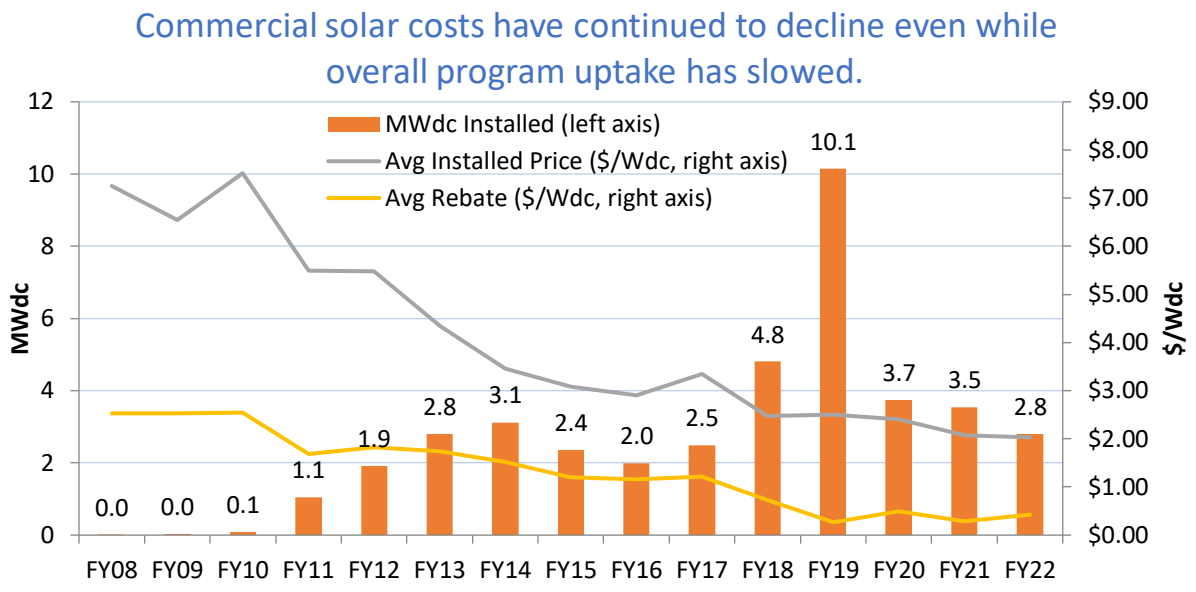

Figure 7-6: Commercial & Schools Solar – Program History: Annual Capacity Installed, Average System Price, and Average Rebate Levels

CPS Energy's contribution to the total installation costs of commercial solar has diminished over the program life. Utility rebates currently cover approximately 21% of installed costs.

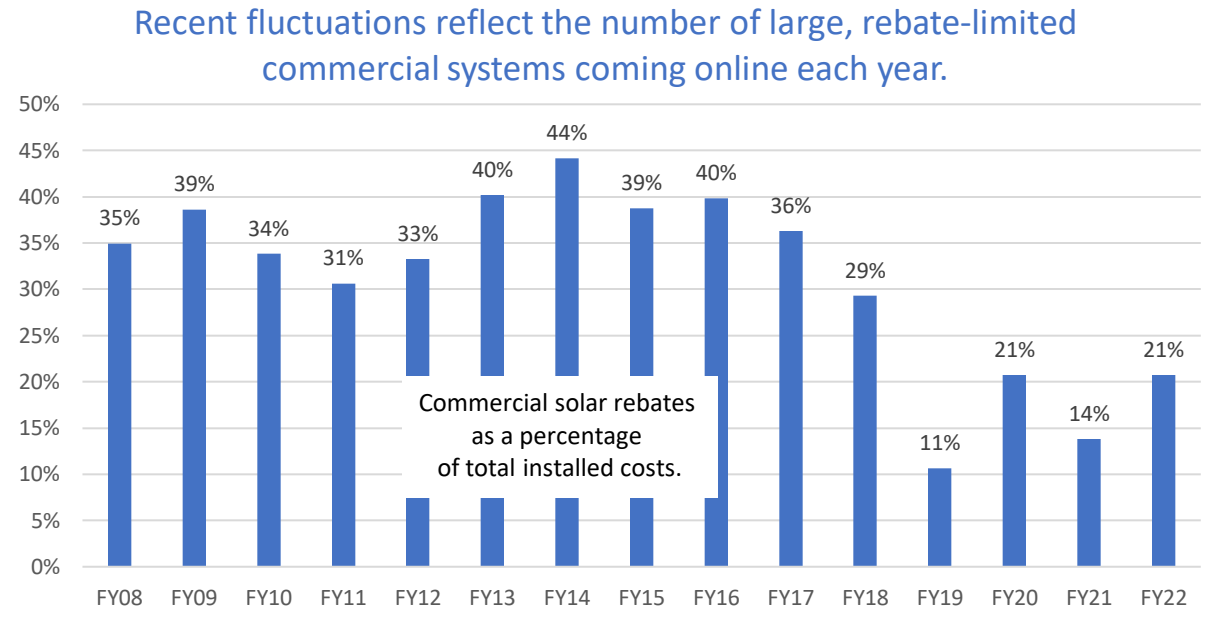

Figure 7-7: Commercial & Schools Solar – Percentage of Installed System Costs Paid by Program Rebates

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. The method assumes an average production index of 1,206 kWh per kW_{DC} installed among a variety of commercial and school PV systems at various tilts and orientations. This production factor was updated during FY 2022 based on Frontier Energy's review of metered solar energy production data. The new factor slightly reduces the estimated annual production relative to the older factor, which was based on modeling the annual energy production from a representative fleet of commercial PV systems using NREL PVWatts Version 5.

7.3.2.1 Coincident Peak (CP) Demand Savings (kW)

Peak demand savings utilize a deemed savings factor of 0.411 kW of coincident peak savings per kW_{DC} installed and is described in the CPS Energy Guidebook. This factor was updated during FY 2022 based on Frontier Energy's review of metered solar energy production data. The factor slightly increases the estimated CP relative to the older factor, which was based on modeling the annual energy production from a representative fleet of commercial PV systems using NREL PVWatts Version 5.

7.3.2.2 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. The CPS Energy Guidebook presents a deemed value of 0.915 kW of NCP savings per kW_{DC} installed. This factor was updated during FY 2022 based on Frontier Energy's review of metered solar energy production data. The factor slightly increases the estimated NCP relative to the older factor, which was based on modeling the annual energy production from a representative fleet of commercial PV systems using NREL PVWatts Version 5.

7.3.2.3 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 0.345 kW of ERCOT 4CP savings per kW_{DC} installed. This factor was updated during FY 2022 based on Frontier Energy's review of metered solar energy production data. The factor slightly decreases the estimated NCP relative to the older factor, which was based on modeling the annual energy production from a representative fleet of commercial PV systems using NREL PVWatts Version 5.

7.3.3 Results

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

Table 7-3: Commercial & Schools Solar – Program 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 & Schools Solar PV	3,370,245	1,149	2,557	964

In every program year, Frontier reviews all solar data, identifies outliers and potential miscalculations and other errors in the data, and works with CPS Energy staff to jointly confirm and resolve issues identified.

Deemed savings values originally developed by Frontier in FY 2017 were validated via desk and field reviews during FY 2019. All savings calculations were updated during FY 2022 based on Frontier Energy's review of metered solar data.

Due to health concerns associated with the COVID-19 pandemic, on-site reviews were not conducted during FY 2022. Frontier plans to continue to monitor, validate, and adjust as necessary these deemed savings values at least every three years.

7.4 ROOFLESS SOLAR PROGRAM

7.4.1 Overview

CPS Energy offers its customers community solar opportunities, referred to broadly as the "Roofless Solar" program in this report, and marketed to customers under the "Big Sun" program name. Under the Big Sun program, CPS Energy customers may opt to purchase panels in carport solar installations located around San Antonio and receive a credit on their electric bill for the energy produced. Advantages of the program design include:

- The program enables residential customers to buy into a "virtual" residential solar energy system at a significantly reduced cost compared to having one installed on their roof, while still enjoying the benefits of the federal residential renewable energy tax credit.
- All customers may participate, whether they own their own roof, or rent a home.
- Maintenance costs and production guarantees are included in the contract.

Three new commercial systems totaling 1,476 kW_{DC} were constructed during FY 2022 by a third-party developer. These new systems join others that were constructed in prior years to bring the program total to 6,216 kW_{DC}. Shares of these systems were sold by the developer to CPS Energy customers at \$2.40/W_{DC}, a price significantly less than the average \$3.78/W_{DC} seen in the Residential Solar Program this fiscal year. In return, customers began receiving bill credits worth \$0.09/kWh for the energy generated from their purchased share. Separately, CPS Energy pays the developer a small amount to cover maintenance and administrative fees over the contract term.

All FY 2022 Roofless Solar impacts are from the newest three solar installations.

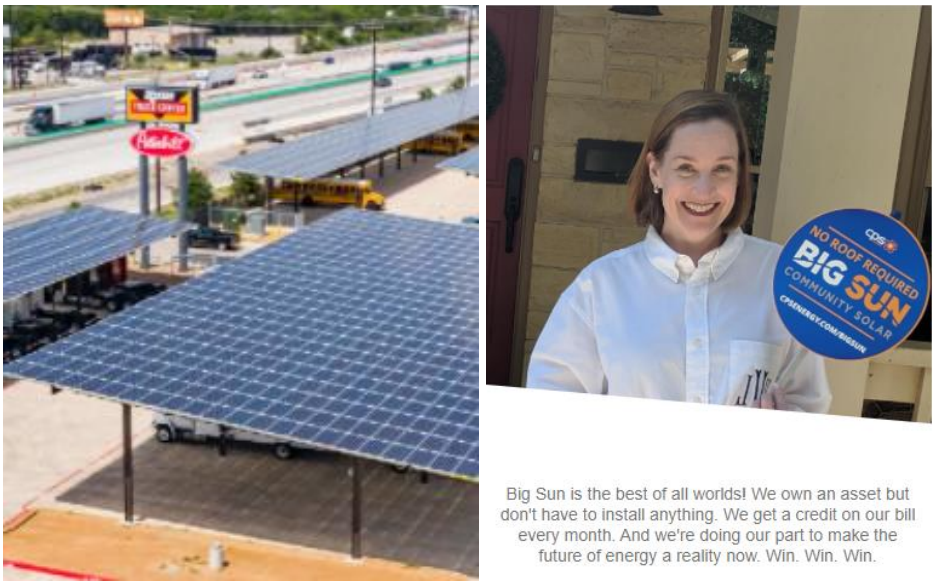

Figure 7-8: Roofless Solar – One of the Big Sun Commercial Carport Systems; a Big Sun Customer

7.4.2 Savings Calculation Method

Frontier obtained detailed specifications of each of the new Big Sun systems installed, enabling precise system modeling and estimation of energy and demand savings in a manner consistent with CPS Energy Guidebook principles. Frontier did not utilize the commercial solar deemed savings methodology presented in the CPS Energy Guidebook for these Big Sun systems, as those methods are designed for and more suited to a large and varied fleet of commercial solar energy systems.

7.4.2.1 Energy Savings (kWh)

Using detailed system specification data provided by CPS Energy, Frontier Energy modeled estimated annual and hourly output from each system using PVWatts and related Typical Meteorological Year (TMY) weather data. Energy savings estimates represent the sum of estimated energy from all new Big Sun systems.

7.4.2.2 Coincident Peak (CP) Demand Savings (kW)

Coincident peak demand savings were derived from PVWatts hourly output data from all new Big Sun systems using a probability-weighted average of estimated output during the 20 hours deemed most likely to be coincident with ERCOT peak loads as described in the CPS Energy Guidebook. The estimated hourly impacts were modeled seven times, once with each day of the week as the starting day, and the average value was reported. This method was used to control for potential misalignment between weather data used in the solar modeling and ERCOT peak load data.

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

Non-coincident demand savings represent the maximum kW estimated to be produced by all new Big Sun systems simultaneously in any single hour, as modeled in PVWatts.

7.4.2.4 ERCOT 4CP Demand Savings (kW)

The ERCOT 4CP demand savings estimate represents the 90th percentile of combined estimated output from all new Big Sun systems from 4-5 p.m. in June through September, as modeled in PVWatts. The estimated hourly impacts were modeled seven times, once with each day of the week as the starting day, and the average value was reported. This method was used to control for potential misalignment between weather data used in the solar modeling and ERCOT peak load data.

7.4.3 Results

The gross energy and demand savings for the FY 2022 incremental additions to the Roofless Solar program are presented in the following table. These represent the estimated annual energy and demand savings that would have been produced had all systems installed during FY 2022 been operational throughout the fiscal year, which is consistent with how savings are estimated for all energy efficiency programs.

Table 7-4: Roofless Solar – 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)
Big Sun	2,066,176	620	1,178	525

7.5 OTHER SOLAR PROGRAMS

CPS Energy continues to support existing solar programs, including SolarHostSA. This program added no new capacity during FY 2022. Therefore, no impact assessment is included in this report.

7.6 SOLAR ENERGY PROGRAM RECOMMENDATIONS

Frontier provides the following recommendations for CPS Energy residential and commercial solar rebate programs:

- The market for residential and large commercial solar installations in CPS Energy's service area is strong and continues to grow despite incremental reductions in the incentive amounts offered. Consideration of continued incremental reductions or elimination of residential and large commercial solar rebates is warranted. Other segments of the local solar market may benefit from continued attention.

8. EMERGING PROGRAMS

8.1 SUMMARY OF EMERGING PROGRAMS

CPS Energy launched two pilot electric vehicle (EV) charging programs starting in June 2021: (1) *Flex*EV Smart Rewards program and (2) *Flex*EV Off-Peak Rewards program. Due to the nascency of EV programs, Frontier categorizes and presents these first-year findings as Emerging Programs, rather than combining them with the mature, well-established energy efficiency, demand response, and weatherization program results. For the purpose of calculating a portfolio-wide cost-effectiveness ratio, the two emerging programs were included within the Demand Response section.

Frontier and CPS Energy worked together to establish an evaluation methodology ensuring accurate savings estimates despite low participation rates. As additional participants are added to the programs and lessons are learned through the evaluation process, methodology changes related to baseline estimates and other factors may be warranted for future evaluations.

These two pilot programs will last two years. Customers with an eligible level 2 EV charger can choose to participate in either program. Pilot program findings are presented in the following sections.

8.2 *FLEX*EV SMART REWARDS

8.2.1 Overview

Within the *Flex*EV Smart Rewards program, CPS Energy can make remote adjustments to participating EV chargers during event periods. EV chargers can be turned off or reduced to level 1 charging (charging rate no higher than 1.8 kW). Unlike other demand response programs, which usually have DR events during summer afternoons, events can be called from 2pm to 9pm during weekdays throughout the year. In return, customers receive a $250 credit on their utility bill, and a $5 credit toward the customer's bill each month if they remain enrolled in the program.[50]

*Flex*EV Smart Rewards program events can help alleviate "snap-back effect" (i.e., overconsumption) immediately after thermostat events (usually around 3-6 pm), as EV charging tends to begin coincidentally with the end of thermostat DR events (usually around 6-7 pm). By the end of FY 2022, there were 75 participants[51] and 25 events in the *Flex*EV Smart Rewards program.

[50] https://www.cpsenergy.com/en/about-us/programs-services/electric-vehicles/ev-charging-solutions.html.
[51] In FY 2022, 81 participants have joined *Flex*EV Smart Rewards program while 6 have dropped before the end of FY 2022. Net participation by the end of FY 2022 is 81 – 6 = 75.

The following table shows the number of events by month.

Table 8-1 *Flex*EV Smart Rewards – Program Events by Month

Month/Year	# Events
June 2021	5
July 2021	6
Aug 2021	7
Sept 2021	5
Oct 2021	2
Total	**25**

8.2.2 Program Participation

The following figure shows the participation trend by date throughout FY 2022.

Beginning on 4/16/2021, total participation reached 75 for *Flex*EV Smart Rewards program by the end of FY 2022.

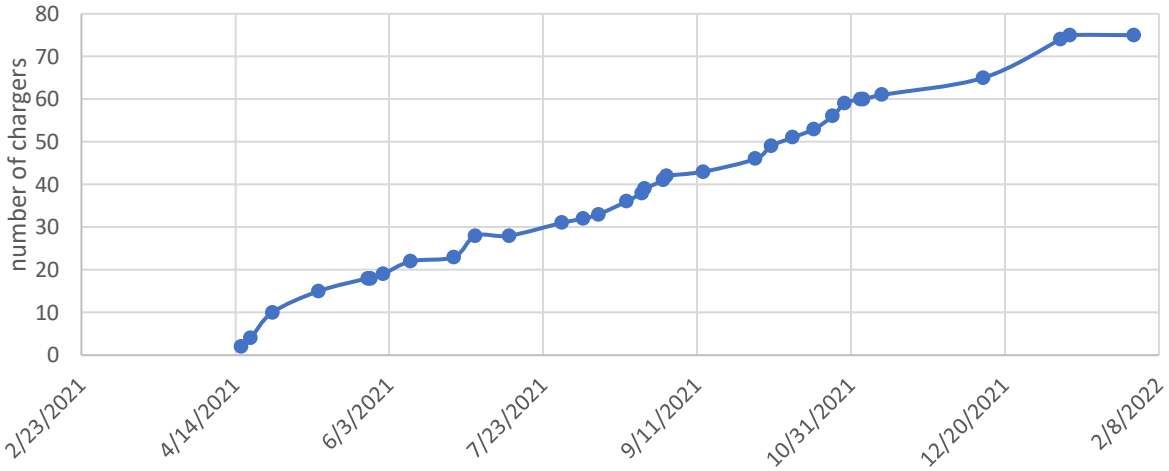

Figure 8-1: *Flex*EV Smart Rewards – FY 2022 Participation

By the end of FY 2022, providers of all participating chargers are either ChargePoint (32 chargers) or Enel X (43 chargers). Among these 75 participants, 33 have taken part in other residential DR programs, such as Smart Thermostat and BYOT.

8.2.3 Savings Calculation Methods

8.2.3.1 Per Device kW and kWh Savings

The following challenges were considered when estimating savings of pilot *Flex*EV Smart Rewards program:

(1) The limited number of participants, especially in the first several months after launch, made it very difficult to generalize a statistically valid EV charging load pattern. For example, there were only 18 participating chargers by May 2021.
(2) Even with a statistically significant number of participating chargers, the EV charging load profile is different from load profiles in residential thermostat DR programs, which are much more weather sensitive. Factors that affect EV charging profile may include but are not limited to: size, fullness, age, and maximum charging rate of EV battery, along with the customer's personal schedule. None of the above information was available in FY 2022.
(3) Charger level 15-minute interval data is only available after a customer joins *Flex*EV Smart Rewards Program. Interval charging data is automatically set to 0 before joining the program. As a result, there is no a priori information on EV charging load profiles for any customers prior to their participation.

April 2021 – January 2022 device-level EV charging interval data has been adopted[52] for quantifying per device/charger kW savings. This device-level data includes 15-minute interval energy consumption (kWh), average power, and peak power (captured and stored on the EnergyHub platform). Customer enrollment data including enrollment/unenrollment date and device type are also available.

Savings analyses are conducted in the following steps:

Step 1: Plot aggregated average non-event day device-level load profile by month to have a brief visual inspection on whether there were any significant EV charging behavioral changes throughout the program from April 2021 to January 2022.

[52] Household level AMI 15-minute interval consumption data was also available for *Flex*EV Smart Rewards participants. However, this dataset was eventually not used due to challenges of isolating EV load shifting factor from the whole household level consumption.

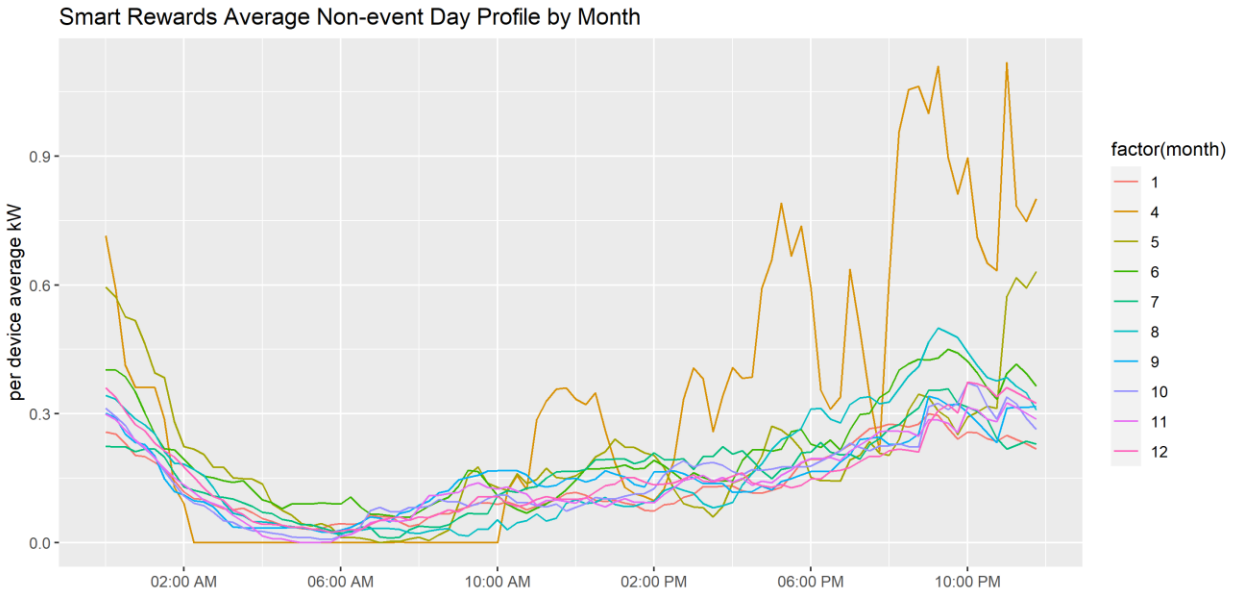

Figure 8-2: *Flex*EV Smart Rewards – Average Non-Event Day Profile by Month

As seen in the figure above, no significant EV charging behavioral changes have been detected from visual inspection. Therefore, we assume all non-event weekdays can serve as eligible days, and we adopt "10 previous + 10 post eligible days" analysis, which is illustrated in the following steps.

Step 2: Using device-level interval data, calculate baseline device-level load profile by aggregating load for 20 days – 10 eligible days prior to event day and 10 eligible days after event day. The baseline load profile is the average load profile for these 20 days.

Step 3: kW savings is the average kW difference during event-day load profile vs baseline-day load profile. Take August 11, 2021, event day as an example. The figure below shows the EV event-day vs baseline load profile:

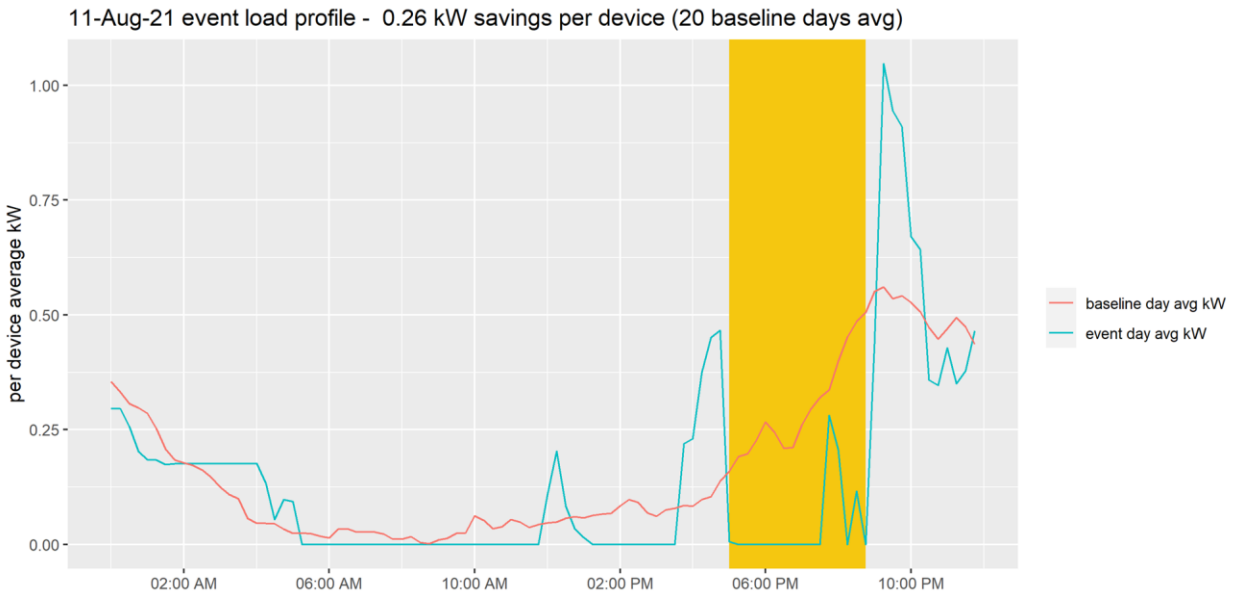

Figure 8-3: *Flex*EV Smart Rewards – Example Event Day vs. Baseline Load Profile – August 11, 2021

As shown in figure above, demand savings for the August 11, 2021, event was calculated as 0.26 kW per device. Multiplying this value by the total number of participating devices (33 devices) on that day yields achieved kW savings for that day: 0.26 kW x 33 = 8.58 kW.

8.2.3.2 Energy Savings (kWh)

Total energy savings (kWh) are zero by default because the program assumes only load shifting rather than energy savings.

8.2.3.3 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 participated devices by each event. The claimed achieved CP kW savings are the average kW savings during June – September events. Therefore, the two October events in FY 2022 were eliminated. Scaling the average kW savings by the end-of-year (EOY) customer count yields EOY CP kW savings. Incremental CP kW savings are the same as EOY CP demand savings because *Flex*EV Smart Rewards is a pilot program in FY 2022, and all participants are considered newly joined.

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

Delivered non-coincident peak savings for *Flex*EV Smart Rewards program is the maximum kW savings throughout all events in FY 2022. In summer 2021, this program reached maximum program level demand reduction during the 10/21/2021 event, so the kW savings on this day are used as the NCP kW savings for BYOT program. EOY NCP kW savings in FY 2022 were calculated as multiplying maximum per

device savings in summer 2021 events by EOY number of participants. Incremental NCP kW savings are the same as EOY NCP kW savings because FY 2022 is the first year of this pilot program.

8.2.3.5 ERCOT 4CP Demand Savings (kW)

During the summer of 2021, three *Flex*EV Smart Rewards DR events coincided with ERCOT 4CP events, yielding a 75% success rate in 4CP alignment. 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 EOY capability calculations, we scaled the per device kW savings during 4CP intervals to the number of devices at the end of FY 2022. Similarly to NCP kW, incremental 4CP kW savings are the same as EOY 4CP kW savings because FY 2022 is the first year of this pilot program.

8.2.4 Results

For the *Flex*EV Smart Rewards DR program, we present impacts in four sections:

1) Estimated per device kW savings during FY 2022.
2) Estimated program impacts during summer 2021 DR events.
3) EOY program capability based on program enrollment at the end of FY 2022.
4) EOY program capability based on incremental enrollment during FY 2022. This information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

8.2.4.1 Estimated Impacts During 2021 DR Events

As shown in the figure below, kW savings per device varied greatly by each DR event for *Flex*EV Smart Rewards program in FY 2022.

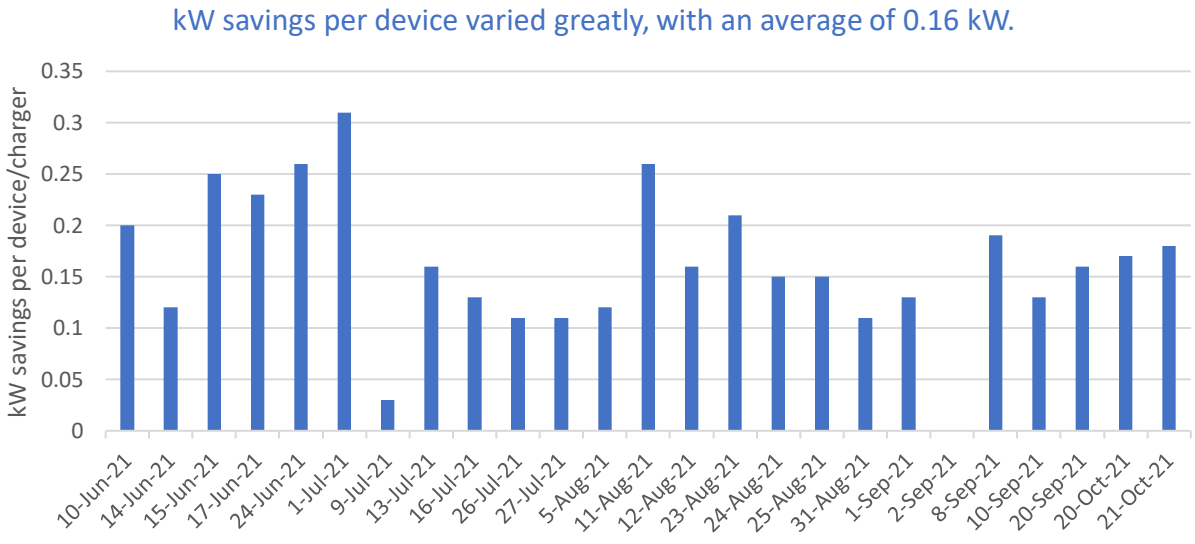

Figure 8-4: *Flex*EV Smart Rewards – Per Device/Charger kW Savings by Event

The figure above shows total kW savings by event throughout all FY 2022. Average savings across all 25 events were estimated at 5.2 kW.

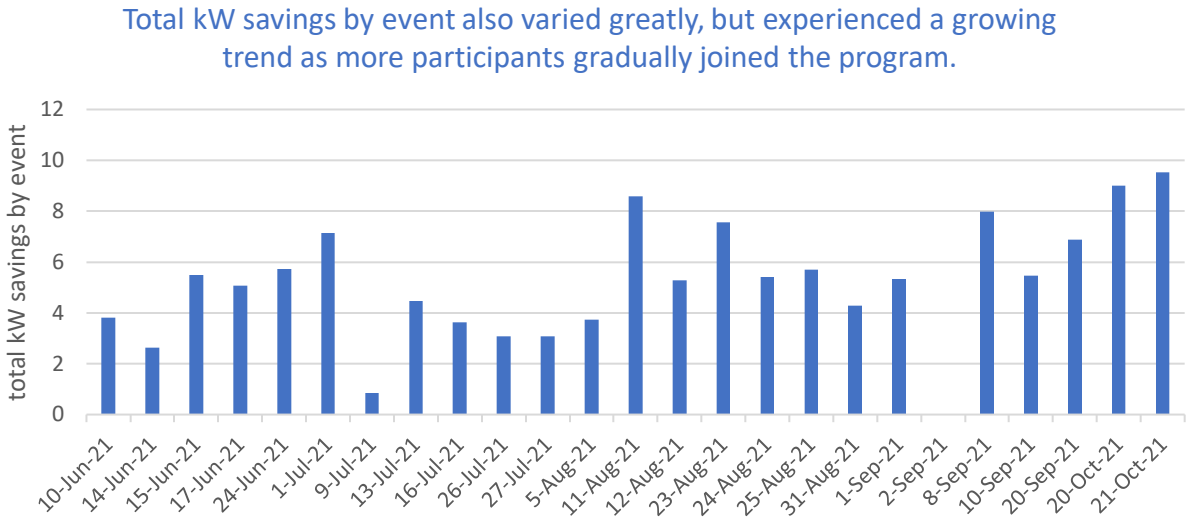

Figure 8-5: *Flex*EV Smart Rewards – Total kW Savings by Event

The table below shows estimated energy, peak demand, non-coincident peak demand, and ERCOT 4CP demand savings delivered by the *Flex*EV Smart Rewards program in FY 2022.

Table 8-2: *Flex*EV Smart Rewards – Delivered Energy and Demand Savings

Measure	Energy Savings (kWh)	CP Demand Savings (kW)	NCP Demand Savings (kW)	ERCOT 4CP Demand Reduction (kW)
*Flex*EV Smart Rewards	--	4.83	9.54	3.45

8.2.4.2 End-of-Year Program Capability

End-of-year program capability is based on end-of-year enrollment and is shown in Table 8-3.

Table 8-3: *Flex*EV Smart Rewards – EOY Program Energy and Demand Savings

Measure	EOY Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
*Flex*EV Smart Rewards	75	--	12.00	23.25	7.31

8.2.4.3 Incremental Impacts

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

Table 8-4: *Flex*EV Smart Rewards – Incremental Program Energy and Demand Savings

Measure	Gross Incremental Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
*Flex*EV Smart Rewards	75	--	12.00	23.25	7.31

8.3 *FLEX*EV OFF-PEAK REWARDS

8.3.1 Overview

The *Flex*EV Off-Peak Rewards program incentivizes customers to voluntarily charge during off-peak hours (before 4pm and after 9pm), without any direct intervention from CPS Energy. In return, customers receive a $125 credit on their utility bill and can earn a $10 monthly credit if charging is limited to no more than twice monthly during peak hours. At the end of FY 2022, there were 29 participants in the *Flex*EV Off-Peak Rewards program.[53]

8.3.2 Program Participation

The figure below shows the participation trend by date throughout FY 2022.

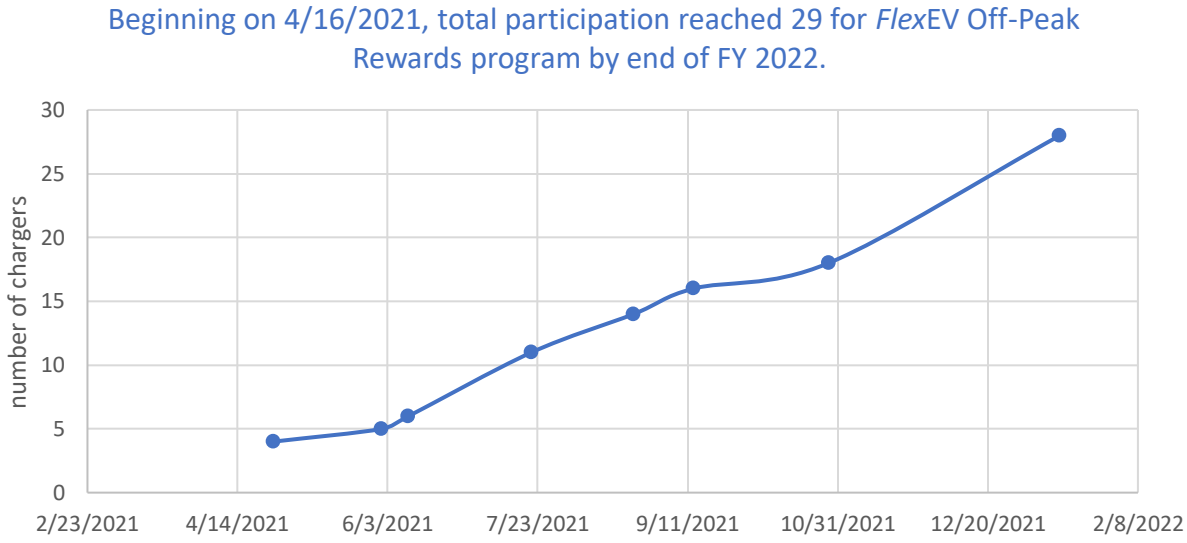

Figure 8-6: *Flex*EV Off-Peak Rewards – FY 2022 Participation

Participating charger providers were limited to ChargePoint (12 chargers) or Enel X (17 chargers) by the end of FY 2022. Among all 29 participants, 14 have taken part in other residential DR programs, such as Smart Thermostat and BYOT.

8.3.3 Savings Calculation Methods

Similar to estimating *Flex*EV Smart Rewards program savings, challenges such as limited participant size, no a priori device level load profile information, and lack of load pattern[54] also existed when estimating

[53] In FY 2022, 31 participants joined *Flex*EV Smart Rewards program while 2 dropped out before the end of FY 2022. Net participation by the end of FY 2022 is 31 – 2 = 29.

[54] Detailed explanation of such challenges posed in *Flex*EV Smart Rewards program can be found in section 8.2.3.1 Per Device kW and kWh Savings.

*Flex*EV Off-Peak Rewards program savings. In addition, the "10 previous + 10 post eligible days" methodology that was adopted in *Flex*EV Smart Rewards program does not apply to *Flex*EV Off-Peak Rewards program because *Flex*EV Off-Peak Rewards is not an event-based program, and participant charging behaviors may have changed immediately after joining the program.

With device-level 15-minute interval charging data from April 2021 to January 2022 alone, it is difficult to develop a valid baseline because there was neither a valid control group nor load profile before joining the program.

Using household-level 15-minute interval AMI data to quantify *Flex*EV Off-Peak Rewards program savings was also challenging due to difficulty with isolating program-only effects from the whole house load profile with limited number of participants.

With all the challenges considered above, we let eligible non-event days in *Flex*EV Smart Rewards program serve as the "control group" to generate baselines for estimation. As illustrated in section 8.2.3.1, non-event days in the *Flex*EV Smart Rewards program were the best option for a "control group" because we have not detected significant charging behavior change for these days. Savings analysis is described in detail by the following steps:

Step 1: For both *Flex*EV Smart Rewards and *Flex*EV Off-Peak Rewards datasets, aggregate non-event, non-holiday weekdays starting on July 22, 2021,[55] to generate two separate average load profiles. The average daily *Flex*EV Smart Rewards charging amount was then calculated at 3.77 kW while average daily *Flex*EV Off-Peak Rewards was calculated at 7.04 kW.

Step 2: Calculate the adjusting ratio between *Flex*EV Off-Peak Rewards and *Flex*EV Smart Rewards: 7.04 kW ÷ 3.77 kW = 1.87 kW.

Step 3: Apply adjusting ratio 1.87 to *Flex*EV Smart Rewards interval EV load to force the average load profile to be the same with that of *Flex*EV Off-Peak Rewards and therefore create a comparable "baseline." The figure below shows the average daily load profile of *Flex*EV Off-Peak Rewards and adjusted *Flex*EV Smart Rewards (baseline), with expected load shifting period (4pm to 9pm) highlighted in yellow.

[55] Days prior to July 22, 2021 were neglected in this analysis since there were less than 10 *Flex*EV Off-Peak Rewards participants during this period.

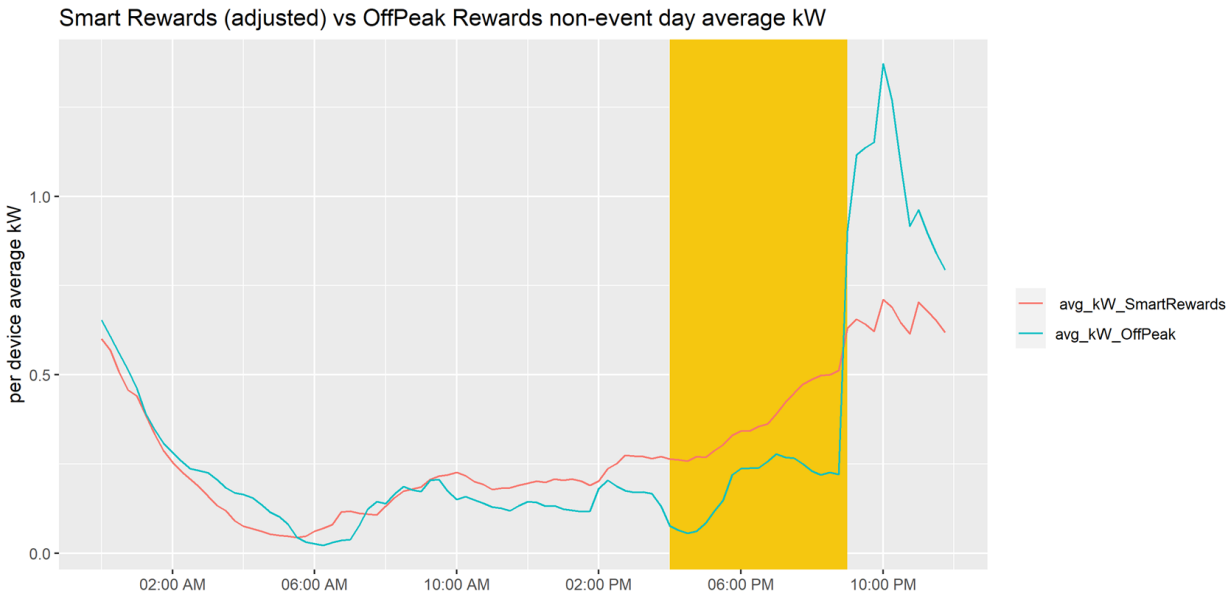

Figure 8-7: *Flex*EV Off-Peak Rewards – Comparison to Adjusted *Flex*EV Smart Rewards Non-event Non-Holiday Weekday Average Load Profile

Step 4: For both adjusted *Flex*EV Smart Rewards and *Flex*EV Off-Peak Rewards datasets, calculate daily average kW level during 4-9pm for every non-event, non-holiday weekday. The differences between 4-9pm kW level for these two datasets are the estimated kW savings for each non-event, non-holiday weekday.

Step 5: For the days which fall on event days of the *Flex*EV Smart Rewards program, kW savings per device were assumed as the average kW savings level throughout 7/22/2021 to 01/31/2022 – 0.21 kW.

Take 7/23/2021 as an example. Average 4pm – 9pm kW level for *Flex*EV Off-Peak Rewards is 0.175 kW and average 4pm – 9pm kW level for *Flex*EV Smart Rewards is 0.187 kW. Adjusted 4pm – 9pm kW level for *Flex*EV Smart Rewards is calculated as 0.187 kW * 1.87 = 0.349 kW. Estimated *Flex*EV Off-Peak Rewards savings for 7/23/2021 is estimated as 0.349 – 0.175 = 0.17 kW. Multiplying 0.17 kW by the total number of participating devices (11 devices) on that day yields achieved kW savings on that day: 0.17 kW * 11 = 1.9 kW.

8.3.3.1 Energy Savings (kWh)

Total energy savings (kWh) are zero by default because the program assumes only load shifting rather than energy savings.

8.3.3.2 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 participated devices by each event. The claimed achieved CP kW savings is the average

kW savings during 7/22/2021 – 9/30/2021 from non-holiday weekdays.[56] Scaling the per-device average kW savings by the end-of-year (EOY) customer count yields EOY CP kW savings. Incremental CP kW savings are the same as EOY CP kW savings because *Flex*EV Off-Peak Rewards is a pilot program in FY 2022, and all participants are considered newly joined.

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

Delivered non-coincident peak savings for *Flex*EV Off-Peak Rewards program is the maximum kW savings throughout all events in FY 2022, which occurred during 10/7/2021 4pm – 9pm. Therefore, the kW savings on this day are used as the NCP kW savings for BYOT program. EOY NCP kW in FY 2022 were calculated as multiplying maximum per-device savings throughout FY 2022 non-holiday weekdays by EOY number of participants. Incremental NCP kW savings are the same as EOY NCP kW savings because FY 2022 is the first year of this pilot program.

8.3.3.4 ERCOT 4CP Demand Savings (kW)

All summer 2021 4CP intervals occurred after 4pm, coinciding with the *Flex*EV Off-Peak Rewards load shifting period (4pm – 9pm). To estimate ERCOT 4CP demand savings in FY 2022, we average kW savings for these 4 days[57]. For the EOY capability calculations, we scaled the per-device kW savings during 4CP intervals to the number of devices at the end of FY 2022. Similarly to NCP kW, incremental 4CP kW savings are the same as EOY 4CP kW savings because FY 2022 is the first year of this pilot program.

8.3.4 Results

For the *Flex*EV Off-Peak Rewards DR program, we present impacts in four sections:

1) Estimated per device kW savings during FY 2022.
2) Estimated program impacts throughout FY 2022.
3) EOY program capability based on program enrollment at the end of FY 2022.
4) EOY program capability based on incremental enrollment during FY 2022. This information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

8.3.4.1 Estimated Impacts During FY 2022

As shown in the figure below, kW savings per device varied greatly every day for *Flex*EV Off-Peak Rewards program in FY 2022.

[56] Days prior to July 22, 2021 were neglected in this analysis since there were less than ten *Flex*EV Off-Peak Rewards participants during this period.
[57] We assume June 4CP day yields zero kW savings since only six *Flex*EV Off-Peak Rewards participants during this day.

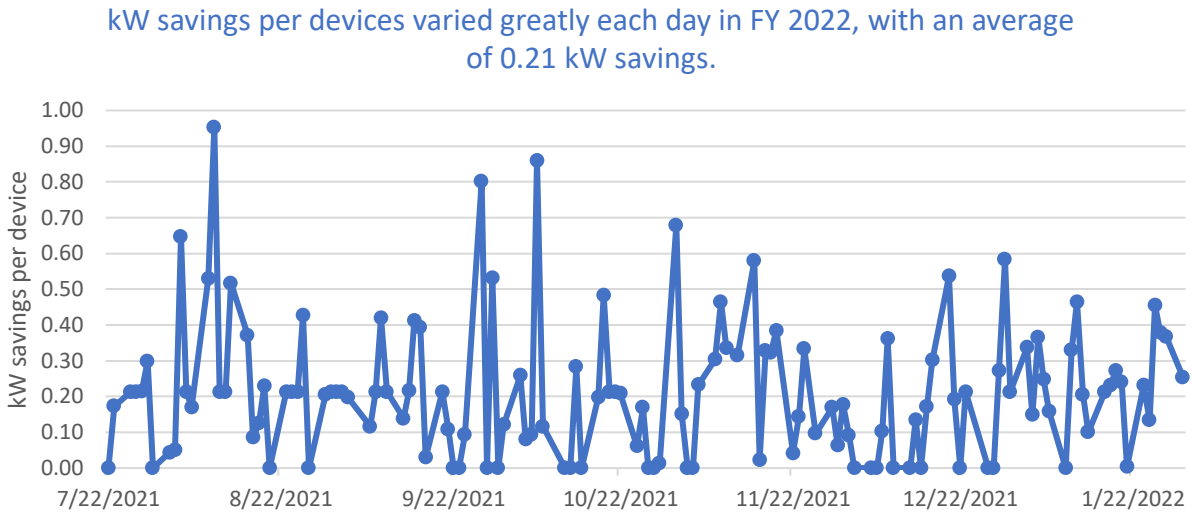

Figure 8-8: *Flex*EV Off-Peak Rewards kW Saving per Device in FY 2022[58]

The figure below shows total kW savings from non-holiday weekdays throughout all FY 2022. Average savings across all these days (after 7/21/2021) was estimated at 4 kW.

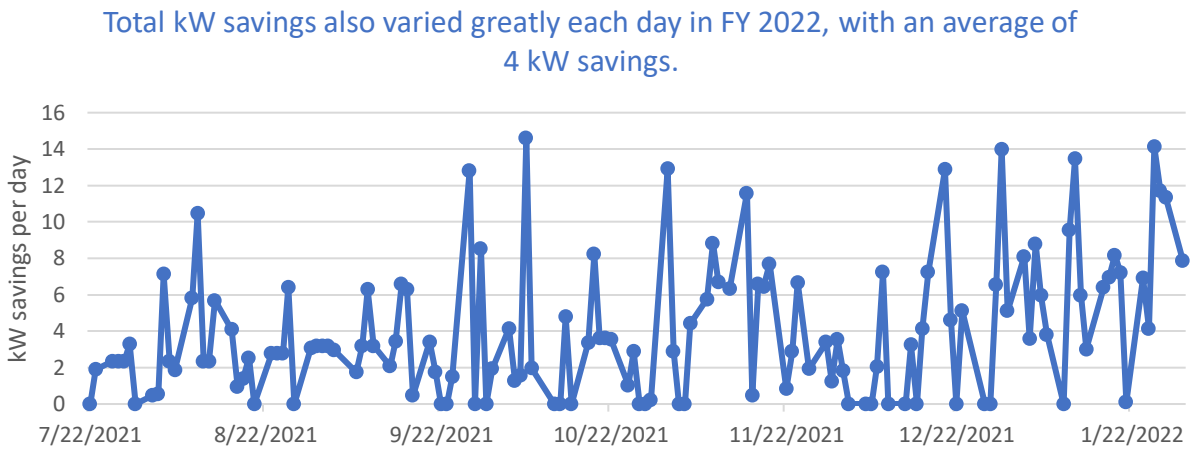

Figure 8-9: *Flex*EV Off-Peak Rewards total kW Savings by Day in FY 2022

The table below shows estimated energy, peak demand, non-coincident peak demand, and ERCOT 4CP demand savings delivered by the *Flex*EV Off-Peak Rewards program in FY 2022.

[58] Negative per-device savings were automatically set as 0.

Table 8-5: *Flex*EV Off-Peak Rewards – Delivered 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)
*Flex*EV Off-Peak Rewards	--	3.04	14.62	2.08

8.3.4.2 End-of-year Program Capability

End-of-year program capability is based on end-of-year enrollment and is shown in the below table.

Table 8-6: *Flex*EV Off-Peak Rewards – EOY Program Energy and Demand Savings

Measure	EOY Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
*Flex*EV Off-Peak Rewards	29	--	6.66	27.65	6.19

8.3.4.3 Incremental Impacts

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

Table 8-7: *Flex*EV Off-Peak Rewards – Incremental Program Energy and Demand Savings

Measure	Gross Incremental Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
*Flex*EV Off-Peak Rewards	29	--	6.66	27.65	6.19

8.4 EMERGING PROGRAMS RECOMMENDATIONS

Frontier provides the following recommendations for CPS Energy's *Flex*EV Programs:

- The unique flexibility of both programs can essentially extend the DR period and even shift load into late night periods when clean wind energy prevails in Texas. We recommend developing customized cost-effectiveness to incorporate all the environmental and societal benefits of these two programs.
- Savings estimates for these two programs can be significantly improved if either or both of the following pieces of information are available in the future: (1) EV charger-level interval data for participants prior to joining the EV programs and (2) a true control group is developed for the savings analysis.

9. TOTAL IMPACTS AND COST-EFFECTIVENESS

9.1 NET PROGRAM IMPACTS & COST-EFFECTIVENESS

Program impacts presented in the Weatherization, 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.

Adjustments to gross impacts include accounting for energy losses in the transmission and distribution system at the time of peak demand.

- 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 an energy loss factor provided by CPS Energy 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 table below. 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 following three economic metrics, in line with previous evaluations:

1. Cost of Saved Energy (includes DR) ($/kWh) = $0.029/kWh
2. Reduction in Revenue Requirements (includes DR) = $114,379,183
3. Benefit-Cost Ratio = 3.11

The net program impacts and results of the benefit-cost tests are provided in Table 9-1.

Table 9-1: FY 2022 Net Portfolio Impacts and Cost-Effectiveness

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net Coincident Demand Savings (kW)	Net Non-Coincident Peak Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Weatherization Program									
Weatherization	100%	7,412,745	3,297	8,771	3,123	$9,200,243	$1,142,050	$10,342,293	0.81
Energy Efficiency Programs									
Residential HVAC	95%	9,952,208	4,461	4,461	3,820	$3,525,472	$166,832	$3,692,304	2.85
Home Efficiency	93%	2,526,532	835	1,766	736	$824,936	$38,929	$863,865	2.61
New Home Construction	100%	1,923,236	1,118	1,656	1,342	$1,873,850	$88,445	$1,962,295	1.74
Residential Retail Partners	77%	-	-	-	-	$0	$0	$0	NA
Energy Savings Through Schools	95%	833,031	61	313	80	$196,869	$9,604	$206,473	1.07
Home Energy Assessments	84%	-	-	-	-	$0	$0	$0	NA
Cool Roof	100%	18,714	15	30	21	$9,344	$446	$9,790	3.46
Residential Subtotal		15,253,722	6,489	8,226	6,000	$6,430,472	$304,256	$6,734,728	2.44
C&I Solutions	100%	34,689,172	6,071	8,222	6,019	$5,347,524	$248,626	$5,596,150	3.19
Schools & Institutions	96%	38,216,377	3,768	12,100	3,759	$3,796,054	$182,566	$3,978,620	3.10
Small Business Solutions	93%	24,040,850	5,157	6,081	5,143	$2,690,695	$125,540	$2,816,235	4.31
Commercial Subtotal		96,946,400	14,996	26,403	14,921	$11,834,273	$556,732	$12,391,005	3.41
Energy Efficiency Subtotal		112,200,121	21,486	34,628	20,921	$18,264,744	$860,988	$19,125,732	3.07

Table continues on next page.

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net Coincident Demand Savings (kW)	Net Non-Coincident Peak Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Demand Response Programs*									
Smart Thermostat	100%	1,058,429	30,435	45,608	30,745	$908,978	$40,855	$949,833	4.18
Power Players - Behavioral DR	100%	933,510	17,537	18,113	8,564	$779,894	$34,245	$814,139	3.32
Nest DI	100%	14,379,486	16,361	17,997	11,991	$376,343	$21,847	$398,189	0.00
BYOT	100%	34,537,105	47,167	53,792	39,553	$3,791,865	$173,850	$3,965,715	4.89
C&I DR	100%	4,609,381	91,708	107,069	66,255	$4,885,475	$334,762	$5,220,237	2.61
FlexEV Smart Rewards	100%	0	13	25	8	$132,784	$93,905	$226,690	0.11
FlexEV Off-Peak Rewards	100%	0	7	30	7	$51,343	$36,310	$87,653	0.19
Demand Response Subtotal		55,517,911	203,228	242,634	157,122	$10,926,682	$735,775	$11,662,456	2.98
Renewable Energy Programs**									
Residential Solar PV	100%	59,435,770	20,088	48,526	16,887	$12,674,285	$2,894,133	$15,568,418	4.74
Commercial Solar PV	100%	3,550,617	1,250	2,784	1,050	$1,271,648	$291,596	$1,563,244	2.89
Roofless Solar	100%	2,176,755	675	1,282	572	$0	$27,436	$27,436	4.44
Solar Energy Subtotal		65,163,142	22,013	52,592	18,508	$13,945,933	$3,213,165	$17,159,099	4.57
Grand Total		240,293,918	250,023	338,625	199,674	$52,337,602	$5,951,978	$58,289,580	3.11

*The Program Administrator Cost Test (PACT) output, the benefit-cost ratio, is the ratio of the net present value (NPV) of avoided energy and capacity benefits, divided by the program's incentives and administrative costs. A PACT ratio greater than 1 indicates that the program delivered more benefits than costs incurred from the utility's perspective.

**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.

***CPS Energy's solar rebate programs are evaluated independently from the utility's net metering rate policy. If the estimated costs of net metering credits are factored in, the Residential and Commercial Solar program PACTs would be adjusted to 2.62 and 1.16, respectively. The Roofless Solar program is evaluated independently of customer bill credits that are paid out over time to subscribers. If the estimated costs of bill credits are factored in, the Roofless Solar PACT would be adjusted to 1.20.

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

9.2 EMISSIONS REDUCTION

Environmental emission reductions are based on annual energy savings and represent the emissions avoided through the STEP portfolio. Emission factors were provided by CPS Energy and include avoided Carbon Dioxide (CO_2) emissions factors in tons per kWh with a 25-year forecast, and emission factors in pounds per kWh for Nitrous Oxide (NOx), Sulfur Dioxide (SO_2) and Total Suspended Particles (TSP).[59]

First year avoided emissions include avoided CO_2 emissions attributable to the gross number of participants in FY 2022. Lifetime avoided emissions include avoided CO_2 emissions attributable to program impacts across the estimated useful lifetime (EUL) of each measure within each program. Measure EULs are documented in the CPS Energy Guidebook; program-level weighted average EULs are listed below.

Table 9-2: FY 2022 CO_2 Emissions Reduction Impacts by Program (tons)

Program	1st Year Avoided CO_2 Emissions (ton)	Lifetime Avoided CO_2 Emissions (tons)	Program Weighted Average EUL
Weatherization	3,399	30,078	17.3
Residential HVAC	4,563	40,144	16.6
Home Efficiency	1,158	9,249	14.6
New Home Construction	882	9,309	23.0
Residential Retail Partners	-	-	9.6
Energy Savings Through Schools	382	2,386	9.3
Home Energy Assessments	-	-	10.9
Cool Roof	9	72	15.0
Residential Subtotal	6,994	61,160	
C&I Solutions	15,905	126,191	13.9
Schools & Institutions	17,522	103,691	10.1
Small Business Solutions	11,023	81,528	12.3
Commercial Subtotal	44,450	311,410	
Smart Thermostat	485	3,221	10.0
Power Players (Behavioral DR)	428	428	1.0
Nest DI	-	-	10.0
BYOT	15,835	105,114	10.0
C&I DR	2,113	2,113	1.0
EV Smart Rewards	-	-	10.0
EV Off-Peak Rewards	-	-	10.0
Demand Response Subtotal	18,862	110,876	

Table continues on the next page.

[59] First year emissions factors provided by CPS Energy were: 917 lbs CO_2/MWh, 0.41 lbs NO_X/MWh, 0.12 SO_2 lbs/MWh, and 0.05 TSP lbs/MWh. Frontier converted these values to report imperial tons of each pollutant, consistent with past evaluations. Lifetime CO2 emissions were derived from a long-term forecast of emissions factors provided by CPS Energy. These emissions factors decrease over time, to approximately 80% of the FY 2022 value in year 5, 40% in year 10, and 26% in years 20-30.

Program	1st Year Avoided CO_2 Emissions (ton)	Lifetime Avoided CO_2 Emissions (tons)	Program Weighted Average EUL
Residential Solar PV	27,251	336,317	30.0
Commercial Solar PV	1,628	20,091	30.0
Roofless Solar	998	11,044	25.0
Solar Energy Subtotal	29,877	367,452	
Grand Total	103,582	880,977	

Commercial EE programs lead first-year avoided CO_2 emissions as they delivered the most energy impacts. Due to long EULs for solar, the solar programs lead the lifetime avoided CO2 emissions. Based on their implementation design, C&I DR and the Power Players behavioral DR programs have a one-year EUL. This short EUL is a primary reason why DR programs contribute a lower share of overall lifetime avoided CO_2 compared to first year avoided emissions.

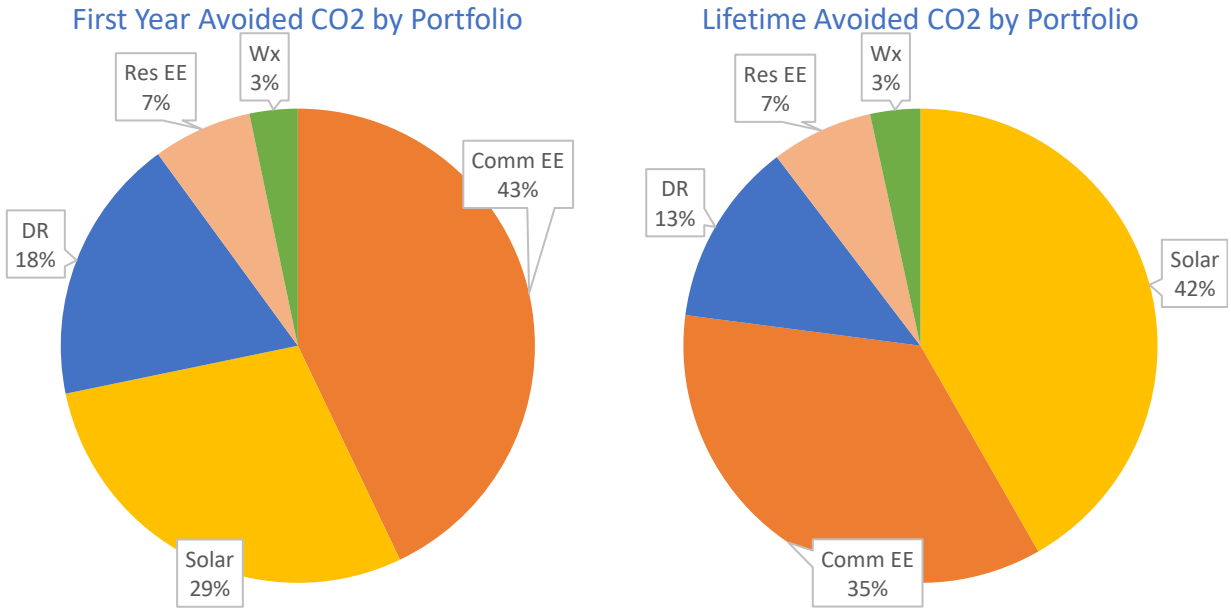

Figure 9-1: First Year and Lifetime Avoided CO_2 Emissions

Commercial EE programs provide the highest level of avoided emissions per customer due to the larger overall energy savings opportunity per site, followed by solar programs. Although Weatherization contributes only 3% of avoided emissions, it has a higher avoided emission value per participating home than residential EE or DR programs. Program participation counts are provided in section 1.3.

Table 9-3: FY 2022 Avoided CO_2 Emissions per Program Participant

Portfolio	1st Year Avoided CO2 Emissions (tons) per Participant	Lifetime Avoided CO2 Emissions (tons) per Participant
Solar	5.96	73.31
Commercial Energy Efficiency	36.05	252.56
Weatherization	2.06	18.24
Residential Energy Efficiency	0.49	4.25
Demand Response	0.04	0.24
Portfolio Average	0.22	0.77

First year avoided emissions for Nitrous Oxide (NOx), Sulfur Dioxide (SO_2) and Total Suspended Particles (TSP) are presented in Table 9-4.

Table 9-4: FY 2022 Avoided NOx, SO_2, and TSP Emissions

Program	NOx (lbs)	SO_2 (lbs)	TSP (lbs)
Weatherization	3,039	890	371
Cool Roof	4,080	1,194	498
Home Energy Assessments	1,036	303	126
Energy Savings Through Schools	789	231	96
Home Efficiency	-	-	-
New Home Construction	342	100	42
Residential HVAC	-	-	-
Retail Channel Partnerships	8	2	1
Residential Subtotal	6,254	1,830	763
C&I Solutions	14,223	4,163	1,734
Schools & Institutions	15,669	4,586	1,911
Small Business Solutions	9,857	2,885	1,202
Commercial Subtotal	39,748	11,634	4,847
Smart Thermostat	434	127	53
Power Players (Behavioral DR)	383	112	47
Nest DI	-	-	-
BYOT	14,160	4,144	1,727
C&I DR	1,890	553	230
EV Smart Rewards	-	-	-
EV Off-Peak Rewards	-	-	-
Demand Response Subtotal	16,867	4,937	2,057
Residential Solar PV	24,369	7,132	2,972
Commercial Solar PV	1,456	426	178
Roofless Solar	892	261	109
Solar Energy Subtotal	26,717	7,820	3,258
Grand Total	92,625	27,110	11,296

1515 S. Capital of Texas Hwy., Ste.110

Austin, TX 78746-6544

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