Evaluation, Measurement, and Verification of CPS Energy's FY 2021 DSM Portfolio

November 3, 2021

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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. In Fiscal Year (FY) 2020, CPS Energy 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 January 31, 2021. 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 2021. This report encompasses all STEP-funded DSM program activity accounted for by CPS Energy within FY 2021, which ran from February 1, 2020 through January 31, 2021.

This report describes the EM&V methodology and process and presents the findings of the evaluation. The evaluation focused primarily on verifying the energy and demand savings achieved by CPS Energy's FY 2021 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 2021

Fiscal Year 2021 built upon recent trends in program design and implementation, but coronavirus disease 2019 (COVID-19) restrictions did have an impact on CPS Energy's program performance. In March of 2020, following issuance of a public health disaster declaration by the Texas Governor, Bexar County issued a *Stay Home, Work Safe* order. The *Stay Home, Work Safe* order restricted people from leaving their residences except for exempted business activities. Some restrictions continued well into FY 2021 and continue to limit business-as-usual operations.

Overall, participation levels decreased as COVID-19 restrictions limited the ability of implementers to enter homes and facilities to identify savings opportunities and install efficiency measures. Despite the challenges, program administrators demonstrated agility in responding to innovative program ideas that enabled continued service to customers while minimizing direct contact. Weatherization and Residential energy efficiency programs increased kit distribution to accommodate a program year with limited access to perform in-home measures. Commercial energy efficiency programs shifted to virtual inspections and increased photo documentation.

Because of the generally long effective lifetime of measures in the Weatherization, Energy Efficiency, and Solar programs, we maintained the savings estimation approaches consistent with FY 2020 and no adjustments were made to account for changes in end-use load profiles. However, because Demand Response impacts are based on curtailments in a given year, evaluation approaches for some programs shifted from a time-temperature method to a meter-based evaluation approach for FY 2021. Incorporating meter data for savings analysis enabled evaluation methods that account for shifting consumption load profiles. Residential thermostat per device savings were generally higher than would have been returned using the time-temperature method due to increased residential consumption as

people responded to stay-at-home orders and worked remotely. More details on the evaluation approach for those programs are provided in section 6.

1.2 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 2021 extension, CPS Energy delivered 81 MW for STEP. Annual STEP contributions are counted as the net avoided non-coincident peak (NCP) MW delivered by incremental program participants.

81 MW	926 MW
Demand reduction, FY 2021	Demand reduction, cumulative FY 2009 – FY 2021

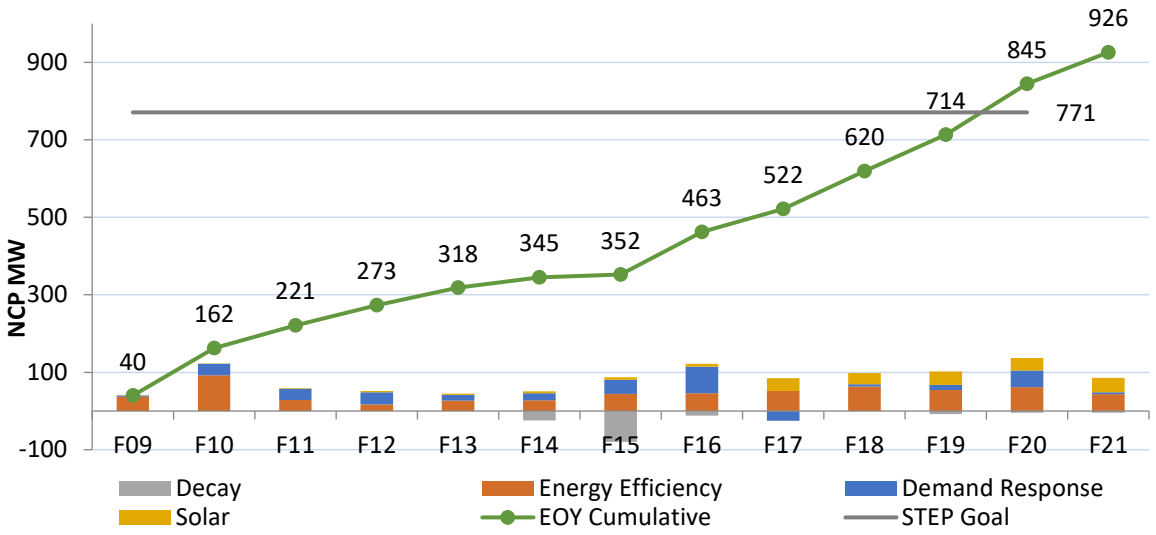

Figure 1-1: Cumulative Progress toward Meeting STEP Goal
In the figure: NCP = non-coincident peak, EOY = end of year.

Measures that were previously installed and have reached the end of their useful lives, or otherwise are rendered ineligible due to regulatory changes, are accounted for as decay. Measures reaching the end of their useful lives caused 4.8 MW of decay in FY 2021 and are detailed in Table 1-1.

Table 1-1: FY 2021 Measure Decay

Sector	Measure	FY2021 Decaying MW	Reason for Decay
Residential	Refrigerator Recycling	0.13	Expiring EUL
Residential	WashRight	0.53	Expiring EUL
Commercial	Large Lighting	3.69	Expiring EUL
Commercial	Window Film	0.05	Expiring EUL
Commercial	Whole Building Optimization	0.40	Expiring EUL
Total		4.80	

The STEP portfolio includes contributions from a diverse mix of programs reaching all customer sectors. Incremental impacts in FY 2021 were predominantly driven by Solar and EE programs, with residential solar delivering almost 40% of net incremental NCP impacts.

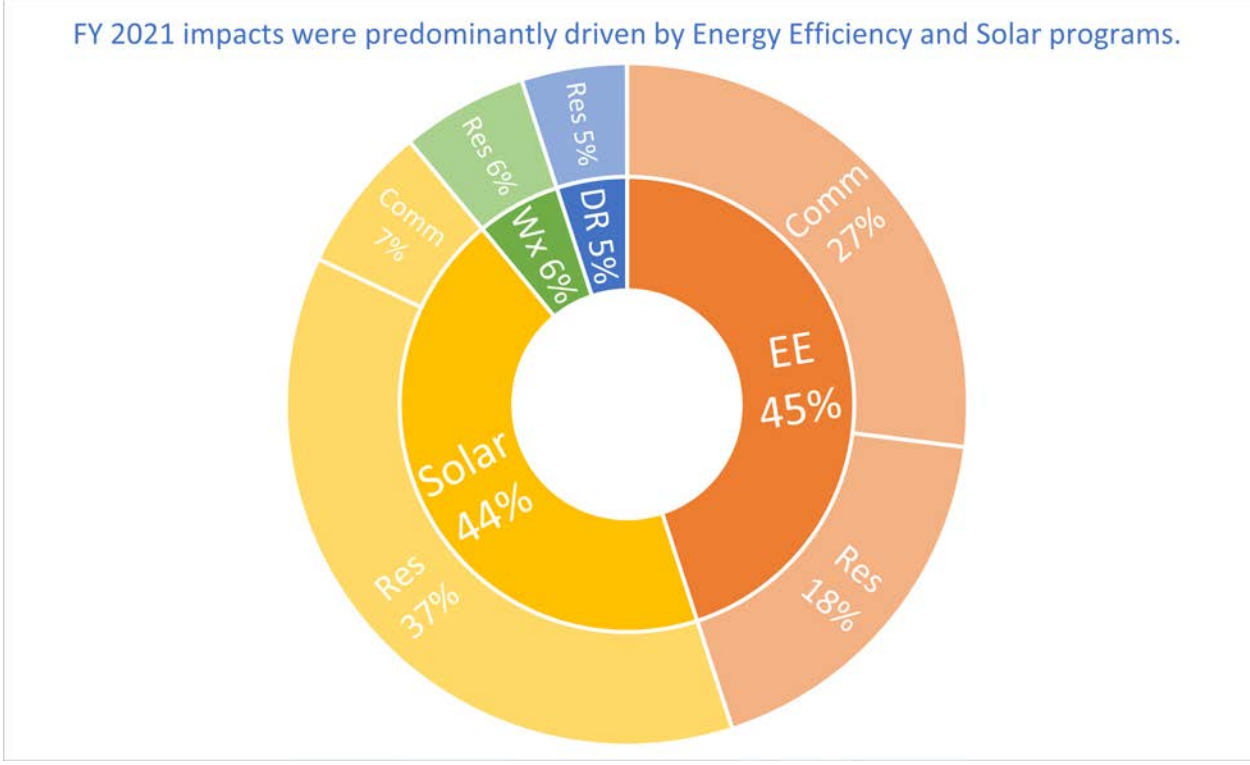

Figure 1-2: FY 2021 Net Incremental Contribution toward STEP by Portfolio and Sector
In the figure: Res = Residential, DR = Demand Response, Comm = Commercial, EE = Energy Efficiency, Wx = Weatherization.

The FY 2021 STEP portfolio reached more than 520,000 homes and 2,800 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 list in Table 1-2 represent enrolled/participating customers in FY2021.

Table 1-2: FY 2021 Count of Customers Served[1]

Portfolio	Residential	Commercial
Demand Response	459,233	1,950
Energy Efficiency	55,781	848
Solar	4,416	39
Weatherization	2,788	NA
Total	522,218	2,837

[1] Demand Response customer counts include a device per customer estimate that ranges from 1.19 to 1.33 depending on the program. Residential Energy Efficiency counts include an estimated 5 lamps per customer for the Retail lighting program.

1.3 PORTFOLIO ENERGY AND DEMAND IMPACTS AND COST-EFFECTIVENESS

The FY 2021 portfolio consists of Energy Efficiency programs contracted out to two implementers, with Solar Energy and Demand Response programs implemented internally by CPS Energy. This year's report includes Frontier's evaluation of 19 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 2021 Portfolio Impacts and Cost-Effectiveness

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Weatherization Program									
Weatherization	100%	4,968,904	2,380	5,028	2,276	$6,177,180	$1,083,502	$7,260,683	0.87**
Energy Efficiency Programs									
Residential HVAC	95%	18,214,192	7,658	7,658	6,486	$4,182,478	$194,952	$4,377,430	4.52
Home Efficiency	93%	2,789,309	1,221	2,397	1,002	$1,100,537	$51,298	$1,151,836	2.96
New Home Construction	100%	3,138,039	1,823	2,702	2,192	$3,233,368	$150,712	$3,384,080	1.71
Retail Channel Partnerships	77%	3,970,777	466	1,973	730	$914,437	$42,623	$957,060	1.62
Energy Savings Through Schools	95%	769,982	57	289	74	$160,666	$7,489	$168,154	1.33
Home Energy Assessments	84%	553,429	49	216	72	$142,335	$6,634	$148,970	1.44**
Cool Roof	100%	45,232	47	72	66	$20,852	$972	$21,824	4.84
Residential Subtotal		29,480,961	11,321	15,309	10,623	$9,754,673	$454,680	$10,209,354	3.05

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Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Energy Efficiency Programs (cont.)									
C&I Solutions	96%	47,226,815	8,121	11,269	8,040	$7,649,735	$356,566	$8,006,301	3.31
Schools & Institutions	96%	20,928,901	4,436	7,829	4,268	$4,190,218	$195,313	$4,385,531	2.21
Small Business Solutions	93%	18,691,258	3,425	4,295	3,438	$2,025,586	$94,416	$2,120,002	4.34
Commercial Subtotal		86,846,974	15,983	23,393	15,746	$13,865,538	$646,295	$14,511,833	3.13
Energy Efficiency Subtotal		116,327,935	27,303	38,703	26,369	$23,620,212	$1,100,975	$24,721,187	3.10
Demand Response Programs***									
Smart Thermostat	100%	1,082,426	40,441	46,010	33,144	$534,255	$24,892	$559,147	1.79
Power Players (Behavioral DR)	100%	1,254,458	21,542	24,494	11,139	$1,002,072	$46,688	$1,048,760	2.65
Google Nest Thermostats	100%	20,703,020	22,419	28,678	16,311	$380,479	$17,727	$398,206	2.19
Bring Your Own Thermostat	100%	32,945,071	45,278	54,042	29,998	$1,954,457	$91,061	$2,045,518	5.86
C&I DR	100%	3,796,702	101,274	119,440	73,457	$5,579,094	$452,614	$6,031,708	2.37
Demand Response Subtotal		59,781,678	230,954	272,664	172,908	$9,450,357	$632,982	$10,083,339	2.96

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Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Solar Energy Programs*									
Residential Solar	100%	53,068,088	15,255	31,450	13,730	$11,621,941	$2,634,837	$14,256,778	4.59
Commercial Solar	100%	5,156,316	1,551	3,066	1,350	$769,128	$178,076	$947,204	6.84
Roofless Solar	100%	5,501,886	1,743	3,115	1,478	$0	$57,734	$57,734	4.79
Solar Energy Subtotal		63,726,290	18,549	37,631	16,559	$12,391,069	$2,870,647	$15,261,717	4.74
Grand Total		244,804,807	279,187	354,027	218,112	$51,638,818	$5,688,106	$57,326,924	3.27

*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 benefit, divided by the program's incentives and administrative costs, expressed as:

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

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

** Demand savings for Google Nest thermostats installed through the Weatherization and Home Energy Assessment residential energy efficiency programs are included in the impacts for the Demand Response programs. We have allocated material costs to the DR programs and labor costs to the EE programs in order to align costs to impacts for purposes of cost-effectiveness calculations. For this reason, the PACT ratio cannot be directly calculated from data presented in the table.

*** 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 1.44 and 1.72, respectively. In a parallel manner, 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 1.48.

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

1.4 SUMMARY OF SAVINGS EVALUATION APPROACH

Frontier applied evaluation standards as published in the *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 intended to be updated annually to provide a common reference to Frontier's evaluation methodology.

1.5 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 3.27.
- Cost of Saved Energy (CSE), which represents the levelized program cost per annual kWh saved, was $0.0287/kWh. The CSE continues to decrease, demonstrating improvements to managing cost-effectiveness of the STEP portfolio.

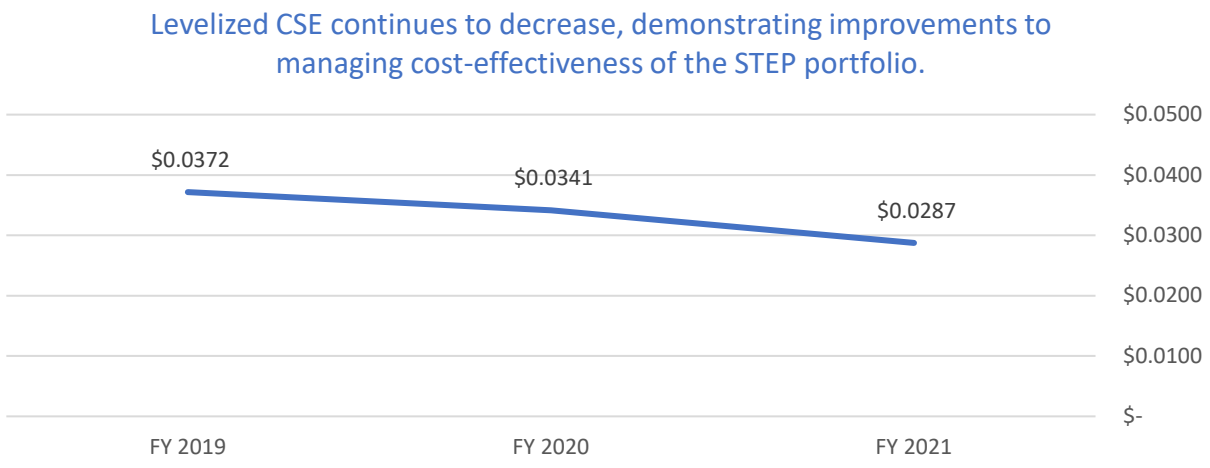


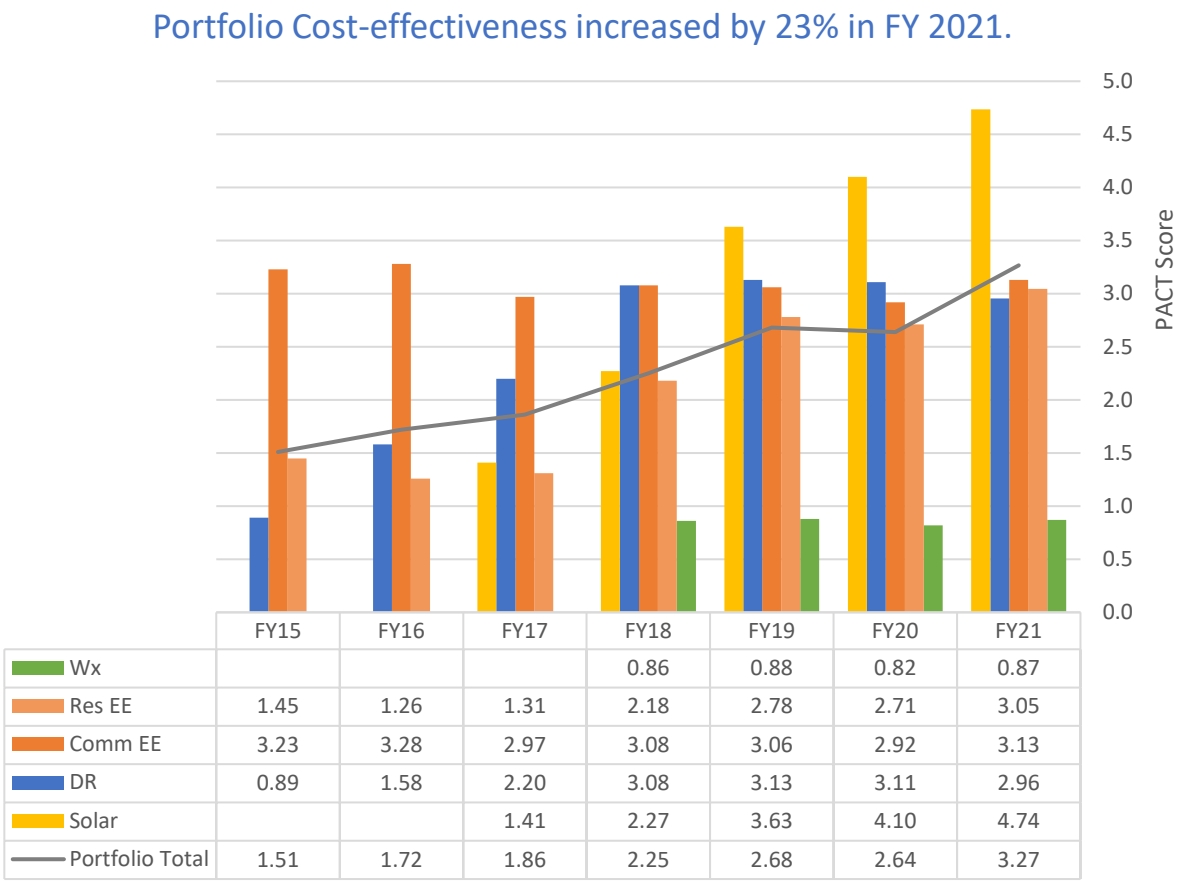
Figure 1-3: Levelized CSE Trend

- 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 $128,127,563.

1.6 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:

- In FY 2021, the portfolio UCT improved due to an increase in avoided energy costs and the decrease of solar program costs compared to FY 2020.
- In 2015 and 2016, Solar programs were included in Residential and Commercial Energy Efficiency.
- In 2015 through 2017, Weatherization was included in Residential Energy Efficiency.



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

Figure 1-4: STEP Cost-Effectiveness from FY 2015 through FY 2021.

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

2. EVALUATION METHODS

2.1 ENERGY IMPACTS

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

In 2016, Frontier adapted the Texas TRM to be applicable to CPS Energy's service territory. This provides CPS Energy with energy and demand impact estimates that have been vetted numerous times by independent third parties and are consistent with impact estimates being used by all of the investor-owned utilities in Texas. The adapted Texas TRM, along with other measures required for CPS Energy programs, can be found in the *CPS Energy Guidebook* and has been applied to the STEP evaluation since FY 2017. For this analysis, the 2020-2021 *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.[3] This approach relates actual historical weather data for San Antonio, day-of-week, and time-of-day variables to Electric Reliability Council of Texas (ERCOT) zonal peak conditions. Those historical relationships are then applied to TMY3 hourly weather data to estimate the hours in a TMY data file most likely to coincide with hours of high demand in ERCOT's CPS Energy-San Antonio zone. 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.

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

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

Based on Frontier's analysis, the hours presented in Table 2-1 have the highest probability of occurring during CPS Energy's peak (listed in order of probability, from highest to lowest). Additional hours are shown because some hours, such as those occurring on weekends or holidays, are eliminated for some measures. This analysis was completed in 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 FY 2021 4CP events within each demand response program/subprogram we multiplied the estimated load reduction per participant by the number of active participants and a "deployment success rate," the rate at which CPS Energy correctly anticipated and deployed each resource during FY 2021 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. In ERCOT energy prices may go up to $9,000/MWh ($9/kWh), which is over 407 times the average wholesale price of energy ($22.14/MWh in the CPS Energy zone) in 2020. 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 FY 2021 price spike events, we compiled energy savings from all DR programs for every deployment interval and multiplied the sum within each interval by the corresponding ERCOT load zone energy price less CPS Energy's avoided cost of energy during the summer peak period. This method estimates the value of energy savings achieved during DR events without double counting the value of avoided energy costs.

2.5 ECONOMIC ANALYSIS

The following cost-effectiveness metrics were calculated for CPS Energy's programs. For results, see section 1.5.

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 in FY 2021. 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 in FY 2021. This approach is consistent with other program benefit-cost calculations, but caution is advised when comparing DR results to benefit-cost calculations from prior years. This is especially the case where there are significant differences between cohorts from FY 2021 and other 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 to reduce their monthly utility bills. Eligible participants may receive free upgrades designed to increase the energy efficiency of their homes. In FY 2021, the program provided a range of services to 2,788 customers. Although COVID-19 restrictions limited access to customer homes to perform weatherization services, customers were offered kits containing LED light bulbs, faucet aerators, and pipe insulation.

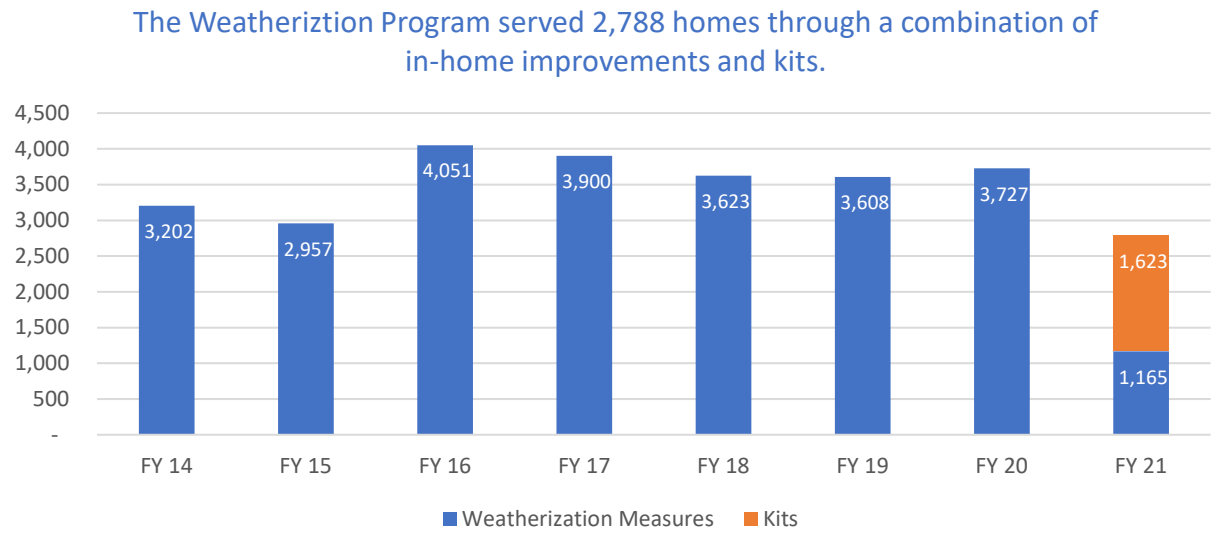


Figure 3-1: Weatherization – Participation Trends

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
- Water heater pipe insulation
- Water heater insulation
- Low-flow showerheads
- Air infiltration reduction
- Duct system improvement
- Faucet aerators
- DR-enabled Smart Thermostats

The measure mix was diverse, but envelope measures (including wall insulation, attic 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 2021.

- Attic insulation was the largest single measure and contributed more than 30% of energy savings and NCP kW impacts and more than 50% of CP kW impacts.
- Lighting contributed roughly 20% of energy impacts but represented a smaller share of peak impacts.

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

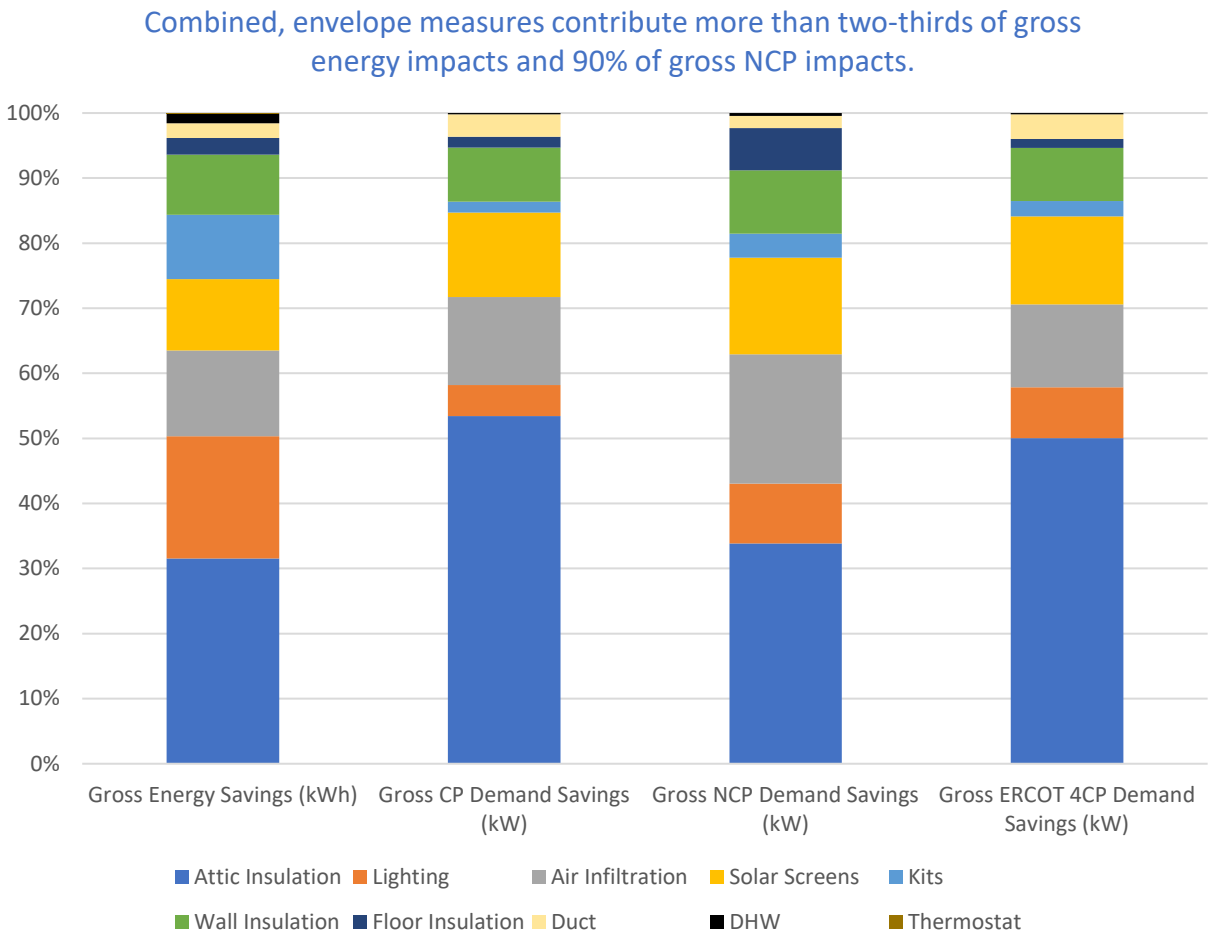


Figure 3-2: Weatherization – FY 2021 Gross Energy and Demand Impact Percentages by Measure

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. Frontier's desk review of sampled projects indicated that project documentation was difficult to locate

for projects reported from the new tracking system. Adjustments were made to project-level input assumptions where the reported measure inputs did not match the post-inspection documentation.

For each of the measures, Frontier determined energy savings using methodology from the 2020-2021 *CPS Energy Guidebook*. For programs or measures where other methods were used, those are referenced in each section.

3.1.2.1 Envelope Measures

Energy savings for this measure 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 detail on savings determination is 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 detail on those adjustment factors.

The following figures show frequency of installation and relative energy and demand impacts by envelope measure. The percentage of homes receiving envelope measures decreased from FY 2020 to FY 2021 due to COVID-19 restrictions that limited access for in-home measures.

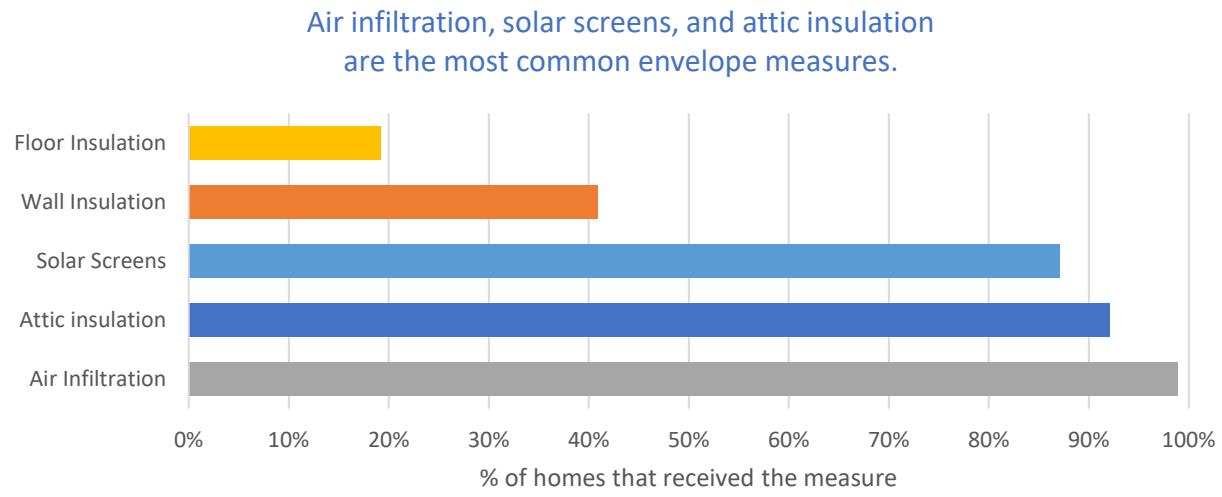


Figure 3-3: Weatherization – Frequency of Installation by Envelope Measure

[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.

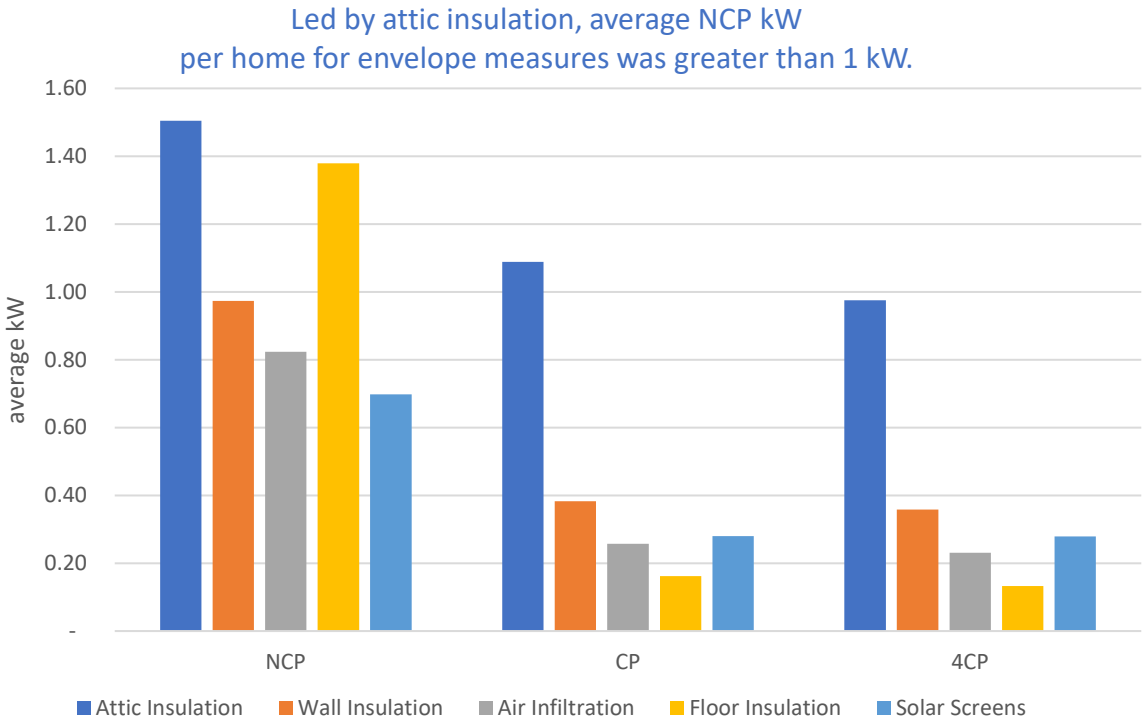


Figure 3-4: Weatherization – Average per Home NCP kW by Envelope Measure

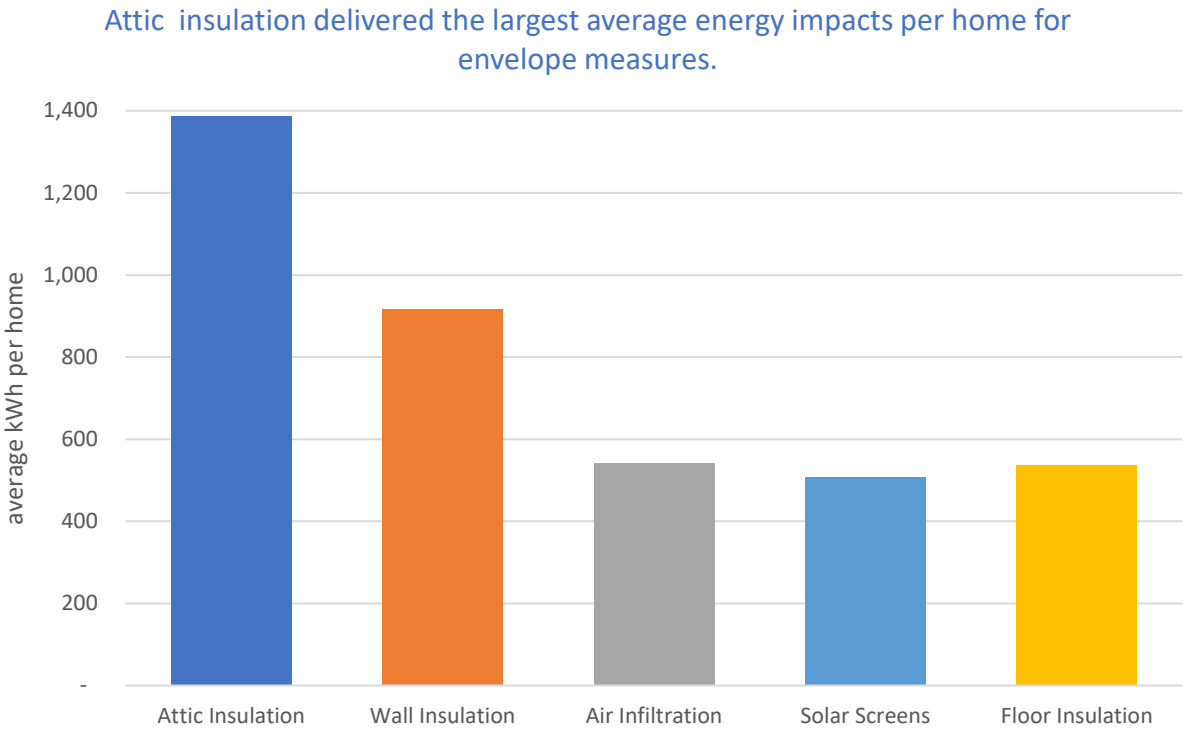


Figure 3-5: Weatherization – Average per Home kWh by Envelope Measure

Attic Insulation

As part of the Weatherization program, Franklin Energy installed attic insulation in 1,073 homes during FY 2021. Average gross impacts per home for attic insulation were 1,387 kWh, 1.09 CP kW, 1.50 NCP kW, and 0.97 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.

Wall Insulation

Franklin Energy installed wall insulation in 476 homes during FY 2021. 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. Average gross impacts per home for wall insulation were 916 kWh, 0.38 CP kW, 0.97 NCP kW, and 0.36 4CP kW.

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.

Air Infiltration Reduction

As part of the Weatherization program, Franklin Energy installed air infiltration control measures in 1,152 homes during FY 2021. Average gross impacts per home for air infiltration reduction are 541 kWh, 0.26 CP kW, 0.82 NCP kW, and 0.23 4CP kW.

Deemed savings are presented as a function of the CFM_{50} reduction achieved, as demonstrated by blower door testing. The *CPS Energy Guidebook* restricts base and post CFM_{50} readings to reasonable values that do not exceed building tightness limits. Where necessary to meet those requirements, pre- and post-CFM_{50} limits were applied to the documented CFM_{50} at each project site.

Floor Insulation

As part of the Weatherization program, Franklin Energy installed floor insulation in 224 homes during FY 2021. Average gross impacts per home for floor insulation are 538 kWh, 0.16 CP kW, 1.38 NCP kW, and 0.13 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.

Solar Screens

As part of the Weatherization program, Franklin Energy installed solar screens on 1,015 homes during FY 2021. Average gross impacts per home for solar screens are 508 kWh, 0.28 CP kW, 0.70 NCP kW, and 0.28 4CP kW.

The baseline was a single pane, clear glass, unshaded, 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 LED Lamps

As part of the Weatherization program, Franklin Energy installed LED lighting in 1,054 homes during FY 2021 compared to 3,558 homes in FY 2020. The decrease in participation is largely explained by COVID-19 restrictions preventing access to customer homes. Average gross impacts per home for LED lighting are 840 kWh, 0.10 CP kW, 0.42 NCP kW, and 0.15 4CP kW. Average savings increased due to the removal of the second-tier baseline previously prescribed by the Energy Independence and Security Act (EISA) 2020 backstop.

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.

Savings for general service lamps are applied over a reduced measure life meant to approximate the market adoption of omni-directional LEDs. The Weatherization program will be 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. 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.

3.1.2.1 Google Nest Thermostats

Google Nest thermostat installations were impacted by COVID-19 restrictions and two DR-enabled Google Nest thermostats were installed during FY 2021. Weatherization site visits and annual energy efficiency savings are attributed to the Weatherization program. Demand savings are attributed to the DR program and are not reflected here. Energy savings were estimated according to the program requirements established by the ENERGY STAR program as described in the *CPS Energy Guidebook*.

3.1.2.1 Duct System Improvement

As part of the Weatherization program, Franklin Energy performed duct sealing on 164 homes during FY 2021 compared to 532 homes in FY 2020. Projects were tracked in two separate tracking systems, the second of which contained 50 total reported Duct Sealing projects that were missing vital pieces of information required by the Program Tracking Data & Evaluation Requirements listed in the *CPS Energy Guidebook* Duct Sealing measure. Given these omissions, per-home impacts below are described separately to avoid conflating the two tracking systems' significantly different verified savings totals/averages (namely, those resulting from an alternative work-around methodology applied to the second tracking system's Duct Sealing population of 50, which will also be discussed subsequently, and those from the 113 projects of the first tracking system, which were reported and claimed correctly according to the Duct Sealing approach absent leakage testing).

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 (also known as "Major," "Medium," and "Minor" reduction levels, respectively). These ranges are determined by the contractor based on several factors, including a visual inspection, the amount of treated duct, and the severity of repaired leaks.

Average gross impacts per home for duct sealing improvements tracked by the first tracking system, which contained the entirety of variables necessary to conduct an empirically sound evaluation, are 650 kWh, 0.46 CP kW, 0.55 NCP kW, and 0.48 4CP kW. Approximately 63% of duct systems were reported as high leakage, compared to 34% average and 4% low leakage. This distribution (i.e., highly weighted in the "Major" reduction level category) is not uncommon for a program structure targeting low-income customers. The program incentive structure is also configured to provide no additional incentive for reporting a higher leakage category. Nonetheless, the evaluation team will monitor trends in reported leakage category in future evaluations to ensure that the current deemed savings are still appropriate for use in lieu of site-specific leakage testing.

Average gross impacts per home for duct sealing improvements tracked by the second tracking system are equivalent to the "Minor" reduction level category per reported heating type from the *CPS Energy Guidebook*. Per home, this equates to 331 kWh, 0.22 CP kW, 0.30 NCP kW, and 0.24 4CP kW for homes with gas-powered water heaters, and 507 kWh, 0.22 CP kW, 0.40 NCP kW, and 0.24 4CP kW for homes with electric water heaters. This determination was made after much discussion with Franklin Energy following attempted augmentation of the original data delivery with the criteria needed for verification. When the expansion of the original data with the necessary additional variables failed, Frontier and Franklin Energy opted to award "Minor" reduction level deemed savings to homes depending on their heating type. This approach accomplishes multiple objectives: it emphasizes the necessity of reporting requirements and incentivizes proper data collection through the lower verified savings that resulted from data omission, while still recognizing that these Duct Sealing projects did in fact occur and produced savings.

3.1.2.2 Domestic Hot Water

As part of the Weatherization program, Franklin Energy installed domestic hot water (DHW) measures in 269 homes during FY 2021. Average gross impacts per home for DHW measures are 269 kWh, 0.01 CP kW, 0.08 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.

FY 2021 saw an overall decrease in total and average DHW savings compared to FY 2020, likely due to a combination of the exogenous effects from the COVID-19 pandemic and an inordinate number of homes confirmed to have gas water heaters decreasing overall savings. Additionally, the number of homes serviced with DHW measures decreased from 586 to 254.

Methodologies utilized in FY 2020 remained the same for FY 2021. FY 2021 per-unit DHW savings algorithms are therefore calculated identically to FY 2020 per-unit DHW savings algorithms, though the average verified per-unit FY 2021 totals are slightly lower due to the existence of five gas-powered water heaters in sampled homes, four of which exist in the portion of projects logged by Franklin Energy's new tracking system introduced mid-way through the fiscal year. It is expected that sampled projects represent the tendencies of the larger population of projects, and thus the effect of these occurrences' verified savings of zero was extrapolated to the entire population by way of the sample's overall realization rate, which of course factors in these projects having zero savings in its calculation.

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. The R-value of the installed insulation was reported by Franklin Energy at R-3. Savings varied based on the location of the water heater, in conditioned or unconditioned space. Savings inputs based on the location of the water heater were applied based on project-specific documentation (in the event that this was not provided, the more conservative inputs assumptions would have been used to estimate impacts). FY 2021 realization rates are approximately 95% and 61% for conditioned and unconditioned pipe insulation, respectively, due to the fact that of the 12 total Pipe Insulation measures sampled, six installations, or 50%, were in excess of six feet and therefore capped, reducing total FY 2021 savings for this measure.

Water Heater Tank Insulation

Savings for this measure are determined using an assumption of a 30-gallon water heater of standard height and diameter, providing a tank surface area of 17.45 square feet. The R-value of the installed

insulation was reported by Franklin Energy at R-5. Savings varied based on the location of the water heater, in conditioned or unconditioned space. Savings inputs based on the location of the water heater were applied based on project-specific documentation. If not provided, the more conservative inputs assumptions were used to estimate impacts.

The *CPS Energy Guidebook* requires water heaters to be manufactured after 1991 to be eligible for this measure. Claimed savings were adjusted accordingly based on project documentation. This requirement was not enforced by Franklin Energy and all water heaters that were insulated were manufactured after 1991, resulting in reported (and verified) savings of zero for this measure.

Low-Flow Showerheads

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

Faucet Aerators

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

3.1.2.1 Weatherization Kits

As part of the Weatherization program, Franklin Energy distributed kits to 1,623 homes during FY 2021. This is a new development in the Weatherization program. Because of the COVID-19 pandemic, direct installs of various measures were at times impossible; the distribution of kits presented a safe alternative to servicing residential sites in person. Average gross impacts per home for kit measures are 287 kWh, 0.022 CP kW, 0.109 NCP kW, and 0.022 4CP kW.

Measures contained in the Weatherization kit are identical to those traditionally used in the Home Energy Assessment (HEA) kits. Kits are distributed exclusively to homes with electric water heaters, and consist of five 9-Watt LED lamps, one 1.5 GPM low-flow showerhead, one 1.5 GPM kitchen faucet aerator, one 1.0 GPM bathroom faucet aerator, and six feet of pipe insulation.

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

Pipe insulation savings are greater for conditioned spaces. Since this measure is contained in the Weatherization kits, but the distinction between conditioned and unconditioned is not made in an

upstream program, a weighted average of conditioned and unconditioned pipe insulation savings is taken to determine per-kit pipe insulation savings. Weights used in this averaging are conditioned and unconditioned pipe insulation counts from the direct-install portion of the Weatherization program. Pipe insulation furthermore utilizes a 50% installation rate overall for a kit program.

Additionally, the ratio of electric-to-gas water heaters (approximately 92%) from the direct-install portion of the Weatherization program was utilized here as well to discount the DHW measure-level savings, an adjustment made to reflect the population of homes that were initially identified as containing electric water heaters but were in fact confirmed to actually contain gas powered water heaters. Application of this discount to the measure-level algorithms does not, of course, affect gas water heater kits.

3.1.3 Results

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

Table 3-1: Weatherization Gross Energy and Demand Savings

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Attic Insulation	1,487,750	1,168	1,615	1,046
Lighting	884,978	104	440	163
Air Infiltration	623,784	296	949	266
Solar Screens	515,504	284	709	283
Kits	466,485	36	177	49
Wall Insulation	436,007	182	463	170
Floor Insulation	120,430	36	309	30
Duct	106,547	76	90	79
DHW	72,235	4	21	4
Thermostat	2,764	-	-	-
Total[6]	4,716,484	2,186	4,773	2,090

Rows may not sum to total due to rounding.

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

3.2 WEATHERIZATION PROGRAM RECOMMENDATIONS

The 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 include the following general items:

- For all measure types, identify primary and secondary (if applicable) cooling and heating types, and incorporate the new space heating adjustment factor defined in the guidebook. The *CPS Energy Guidebook* that will apply in FY 2022 contains an update that distinguishes between central and space resistance heating. There are no savings specified for projects reporting "mix" cooling or heating.

- For all lighting measures, including lamps contained in kits, ensure that project tracking systems reference the latest baselines, and identify key program tracking data and evaluation requirements as outlined in the *CPS Energy Guidebook*.

- For duct sealing measures, ensure that program tracking records the variables enumerated in the *CPS Energy Guidebook*'s Program Tracking Data and Evaluation Requirements section.

- The population receiving Weatherization kits is expected to exhibit the traits of the Weatherization direct-install program's population. Variables utilized in the kit program that make assumptions about the kit population should therefore be generated from the direct-install population.

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 2021.

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

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

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

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

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

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

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

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

Projects were evaluated against the 2020-2021 *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 2021 program participants as measured at the participant or end-user level and adjusted to account for net-to-gross ratios and line losses.

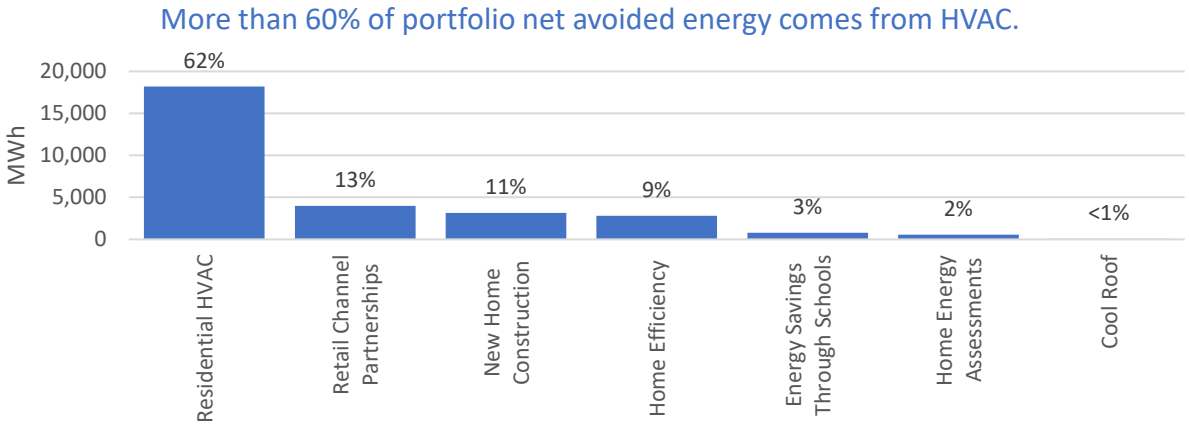


Figure 4-1: Summary of Residential Impacts – Net Avoided Energy by Program

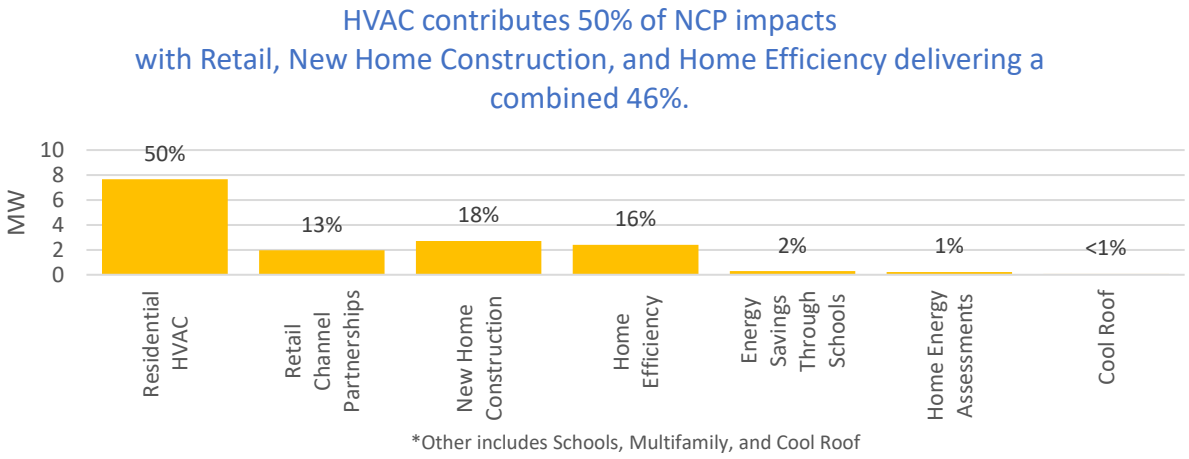


Figure 4-2: Summary of Residential Impacts – Net Avoided Non-Coincident Peak by Program

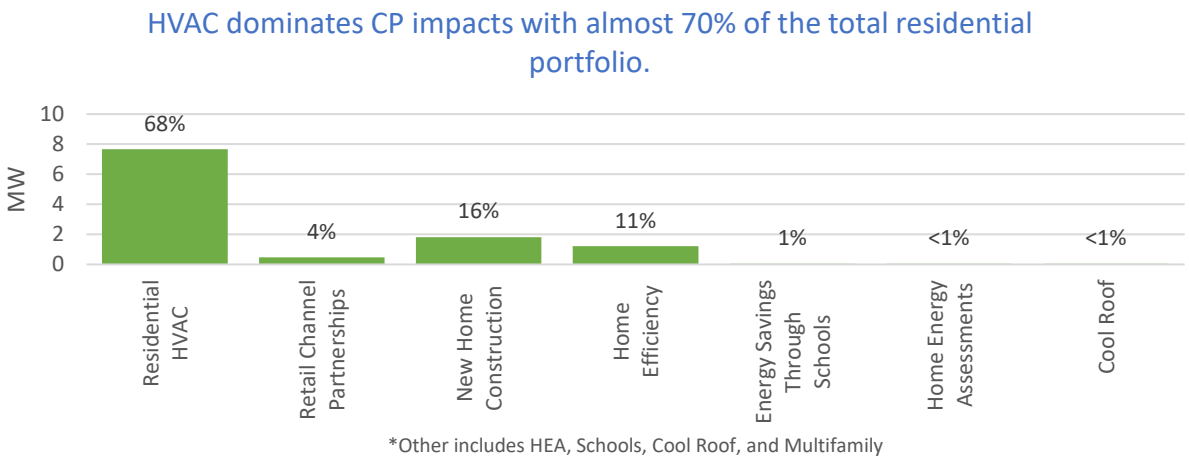


Figure 4-3: Summary of Residential Impacts – Net Avoided Coincident Peak by Program

4.2 HOME EFFICIENCY PROGRAM

4.2.1 Overview

CPS Energy's Home Efficiency program offers incentives for attic insulation and variable-speed pool pumps. Through the home efficiency program, Franklin Energy served 1,632 homes in FY 2021, down from 1,890 in FY 2020. Pool pump participation share is increased in FY 2021 to 30% after remaining relatively stable near 25% in recent years. This is possibly due to easier access for installation of exterior home measures than for insulation which requires entry to customer homes.

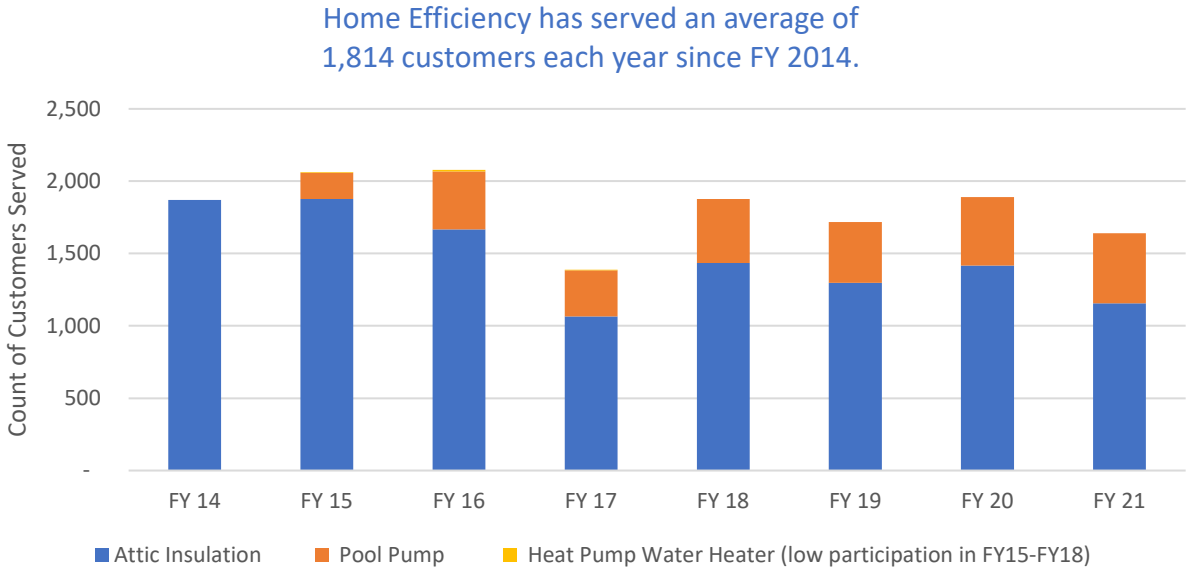


Figure 4-4: Home Efficiency – Participation Trends

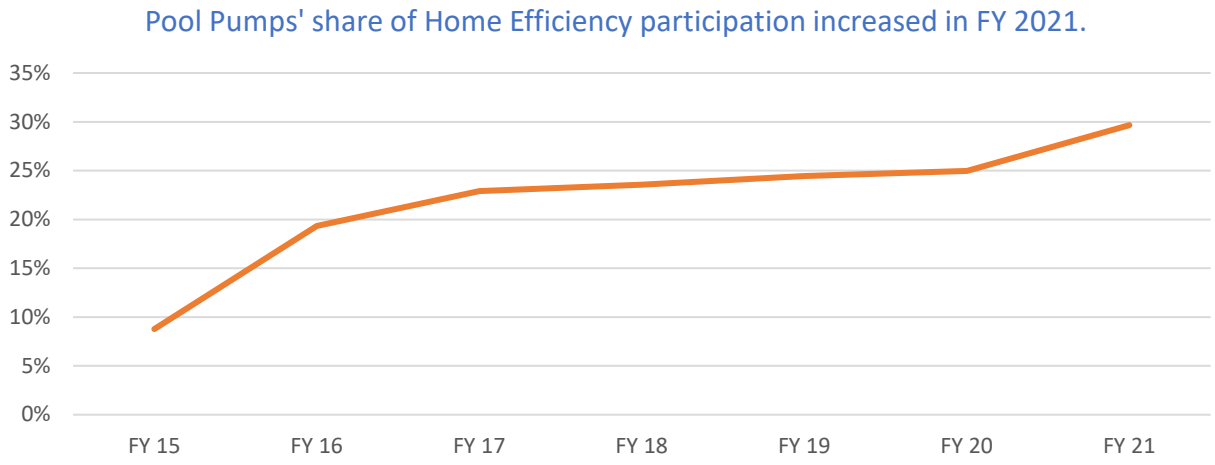


Figure 4-5: Home Efficiency – Pool Pump Participation Share

The proportion of total program energy and peak impacts derived from each measure type is presented in Figure 4-6.

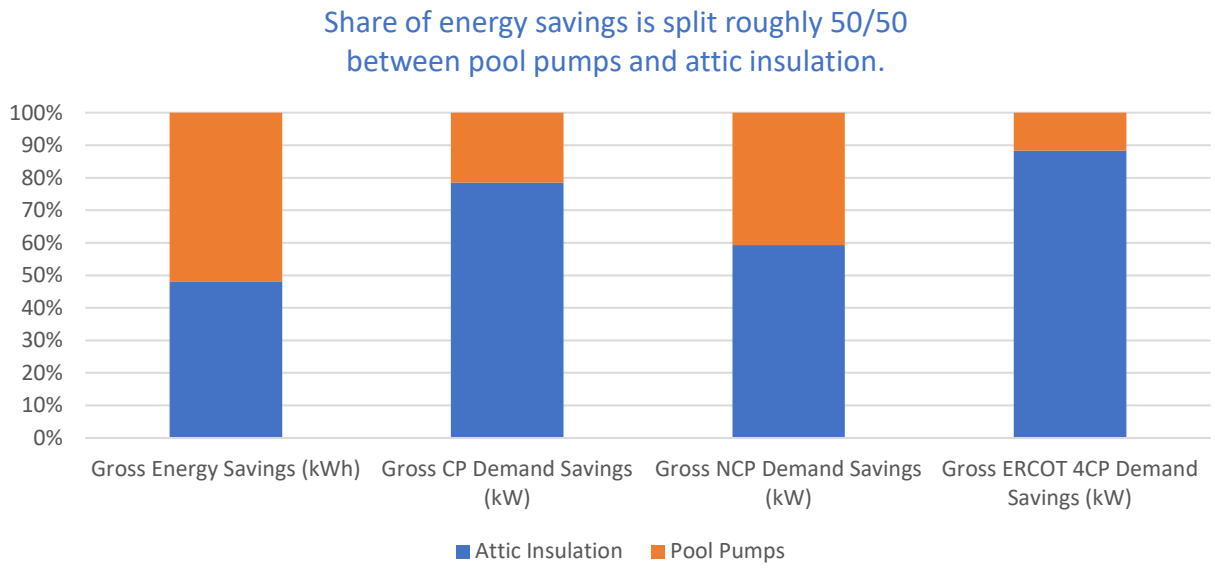


Figure 4-6: Home Efficiency – FY 2021 Gross Energy and Demand Impact Percentages by Measure

4.2.2 Savings Calculation Method

Frontier conducted a desk review of sampled projects and found that project documentation supported the reported project data and no adjustments were made to project-level input assumptions. Projects were evaluated against the 2020-2021 *CPS Energy Guidebook*.

4.2.2.1 Attic Insulation

CPS Energy incentivized 1,156 attic insulation installations in FY 2021, compared with 1,418 attic insulation installations in FY 2020. Average gross impacts per home for attic insulation are 1,181 kWh, 0.82 CP kW, 1.25 NCP kW, and 0.76 4CP kW.

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

4.2.2.2 Variable-Speed Pool Pumps

Through the Home Efficiency program, CPS Energy provided incentives for the installation of 484 variable-speed pool pumps in FY 2021 compared to the 472 pool pumps installed in FY 2020. Average gross impacts per home for pool pumps are 3,061 kWh, 0.54 CP kW, 2.06 NCP kW, and 0.24 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.

4.2.3 Results

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

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

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Attic Insulation	1,365,530	946	1,451	874
Pool Pumps	1,481,365	259	996	116
Total[7]	2,846,895	1,206	2,447	990

Rows may not sum to total due to rounding.

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

4.3 RESIDENTIAL HVAC PROGRAM

4.3.1 Overview

This program promotes the installation of energy efficient Heating, Ventilation, and Air Conditioning (HVAC) equipment. The program covers the installation of central air conditioners (ACs), central heat pumps (HPs), window air conditioners (WACs), and ground source heat pumps (GSHPs). During FY 2021, a total of 6,601 HVAC systems were incentivized through CPS Energy's Residential HVAC program for HVAC equipment installed in 6,021 homes.

The following figures illustrate residential HVAC participation trends from FY 2014 to FY 2021. 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 Franklin Energy.

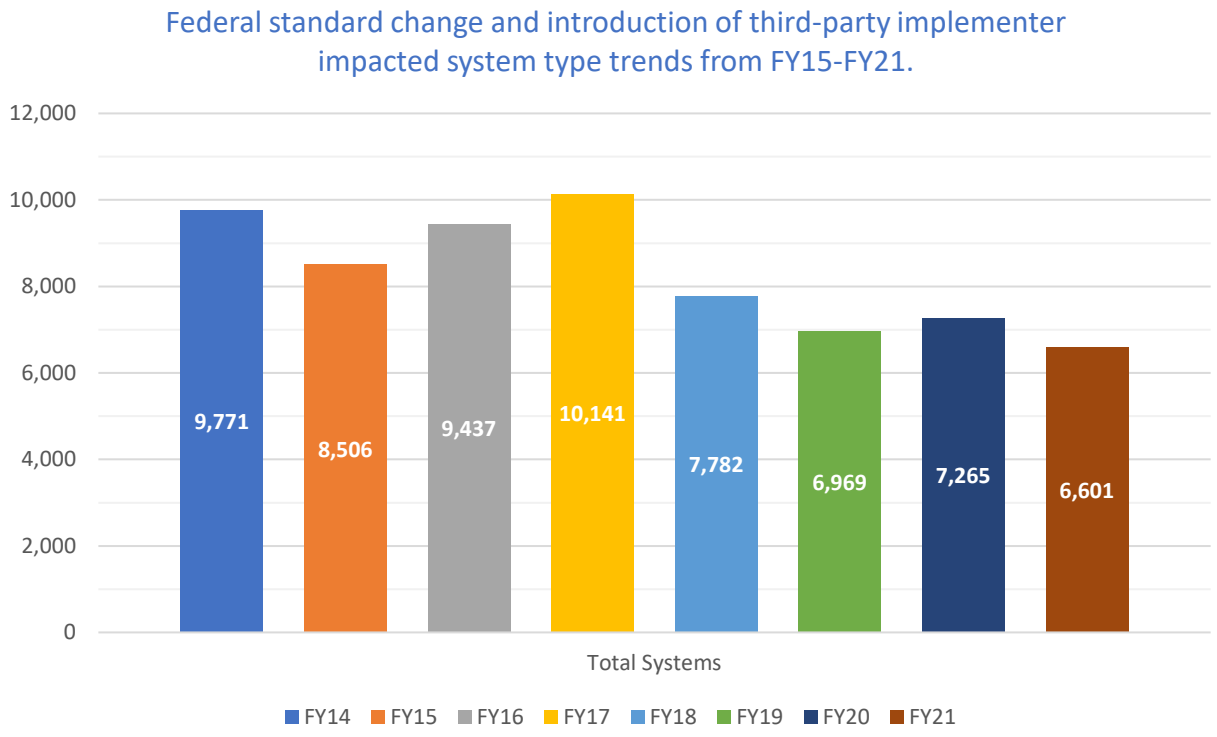


Figure 4-7: Residential HVAC – Participation Trends

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 decrease in participation in FY 2021 compared to FY 2020 is largely explained by COVID-19 restrictions preventing access to customer homes. The HVAC program may have been less impacted compared to other measures due to measure priority to meet high cooling loads and because equipment is isolated to outdoor and attic locations.

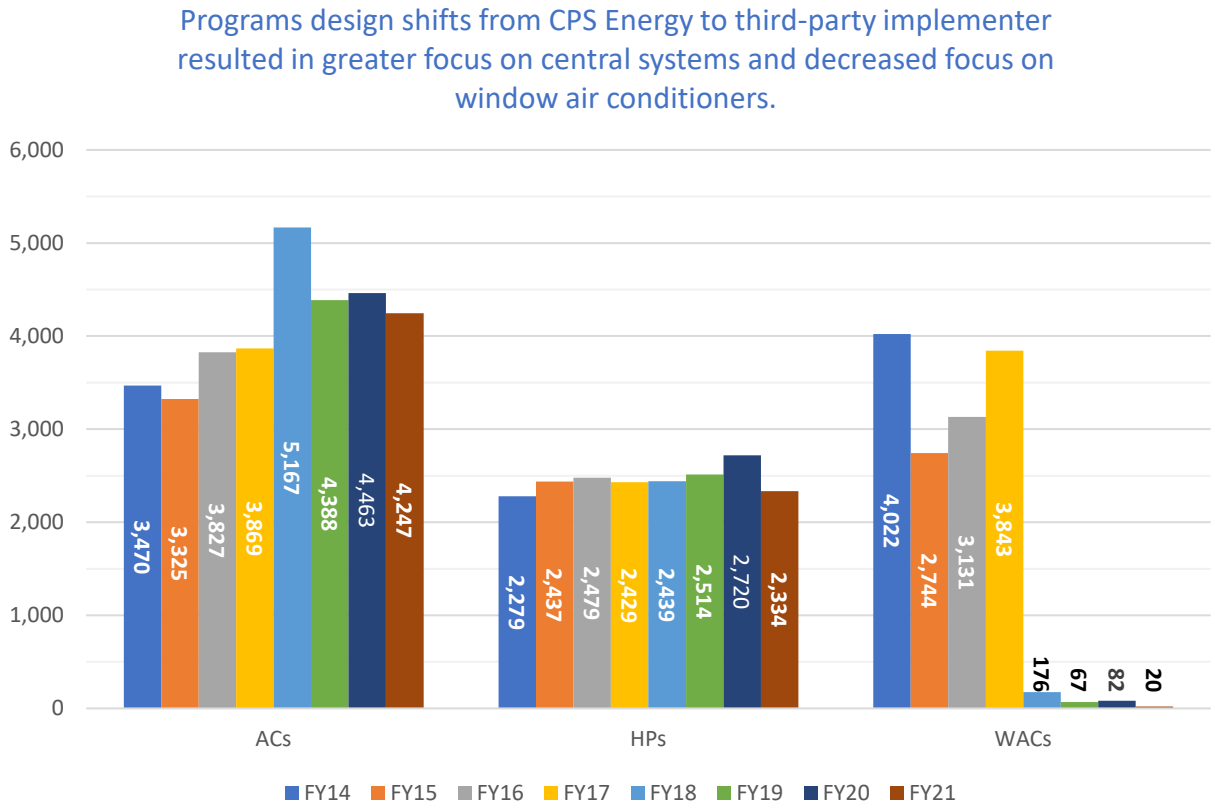


Figure 4-8: Residential HVAC – Participation Trends by System Type

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

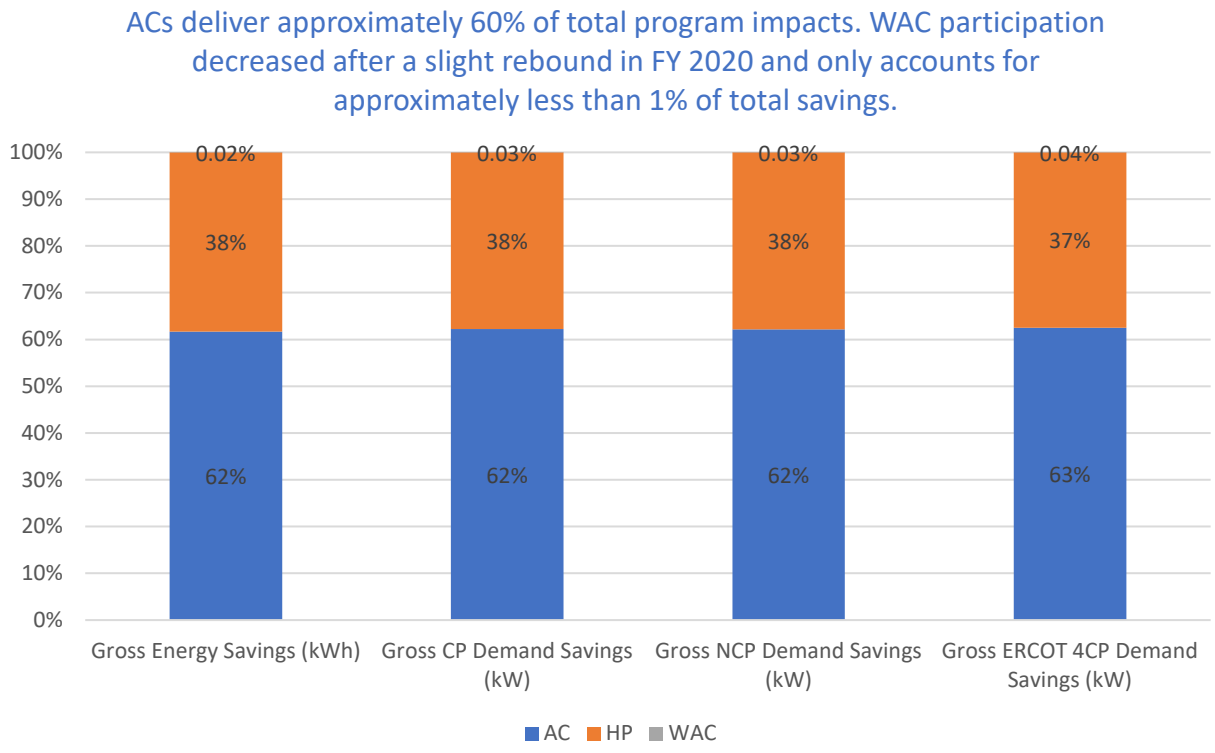


Figure 4-9: Residential HVAC – Gross Energy and Demand Impact Percentages by Measure

4.3.2 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, 2020 and January 31, 2021 were evaluated against the 2020-2021 *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).[8] These performance curves provide the capacity and efficiency of the heat pump operating in cooling mode across a wide range of outside air temperatures. Unit loading was estimated as a function of outside air temperature, and hours of cooling mode operation under different loadings

[8] 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.

were estimated using bin weather data for each weather zone. The model uses a set of normalized performance curves to scale the rated performance values as a function of outdoor dry-bulb temperature ranging from 65 to 115 degrees Fahrenheit. The total capacity and Energy Input Ratio (EIR = 1/COP) curves are a function of entering wet-bulb temperature (EWB) and outdoor dry-bulb temperature (ODB) with quadratic curve fittings.

In heating mode, predicted HVAC operation was limited to meeting 77% of load, using a factor applied in Manual J to correlate design load hours to equivalent full load hours under actual operating conditions, taking into account that heating systems are not always operated even when outdoor conditions indicate they should be in operation. It was assumed that typical HVAC systems are sized to 115% of their design cooling load (oversized by 15%). Heating mode capacity was related to rated cooling capacity using rated capacity in cooling and heating mode according to data exported from the AHRI Directory.[9]

For early retirement projects, remaining useful life (RUL) assumptions were incremented by a year to account for bulk installation during the 2020 calendar year. Frontier also applied CPS Energy's updated discount rate, avoided capacity cost, and avoided energy cost factors specific to FY 2021. These factors are used to weight savings over the dual baselines used for early retirement projects. These factors are also not known to the implementation vendor at the beginning of the fiscal year, which means that final measure realization rates are marginally impacted by factors outside of implementer control.

WAC savings were calculated using a replace-on-burnout baseline by multiplying the installed capacity by the change in system efficiency using the engineering algorithms described in the *CPS Energy Guidebook*. No GSHP projects were installed in FY 2021.

4.3.3 Equipment Verification

To verify the accuracy of the reported equipment specifications, reported system capacities and efficiencies were validated against the AHRI Directory for the single AC project and against the ENERGY STAR® certified product listing[10] 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

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

available project documentation. Savings were calculated against an adjusted heat pump baseline for projects where this documentation was not available or inconsistent.

4.3.4 Results

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

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

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Central Air Conditioners	11,225,778	4,605	4,758	3,920
Central Heat Pumps	6,969,573	2,796	2,892	2,349
Window Air Conditioners	3,503	2.4	2.6	2.3
Total	18,198,854	7,403	7,653	6,271

Rows may not sum to total due to rounding.

4.4 NEW HOMES CONSTRUCTION PROGRAM

4.4.1 Overview

The New Homes 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 4-3: New Residential Construction – FY 2021 Incentive Levels

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

*Two 15%-better-than-IECC-2015 projects and one 30%-better-than-IECC-2015 project, all with *no* BSAG certification, were paid incentives of $1,100; these projects correspond to projects submitted in previous years under previous incentive levels but were processed following changes to the incentive rate structure.

**Two 15%-better-than-IECC-2015 with BSAG certification were paid incentives of $1,300; these projects correspond to projects submitted in previous years under previous incentive levels but were processed following changes to the incentive rate structure.

4.4.1 Participation Trends

CPS Energy's FY 2021 new residential construction program provided incentives for 2,752 new homes.

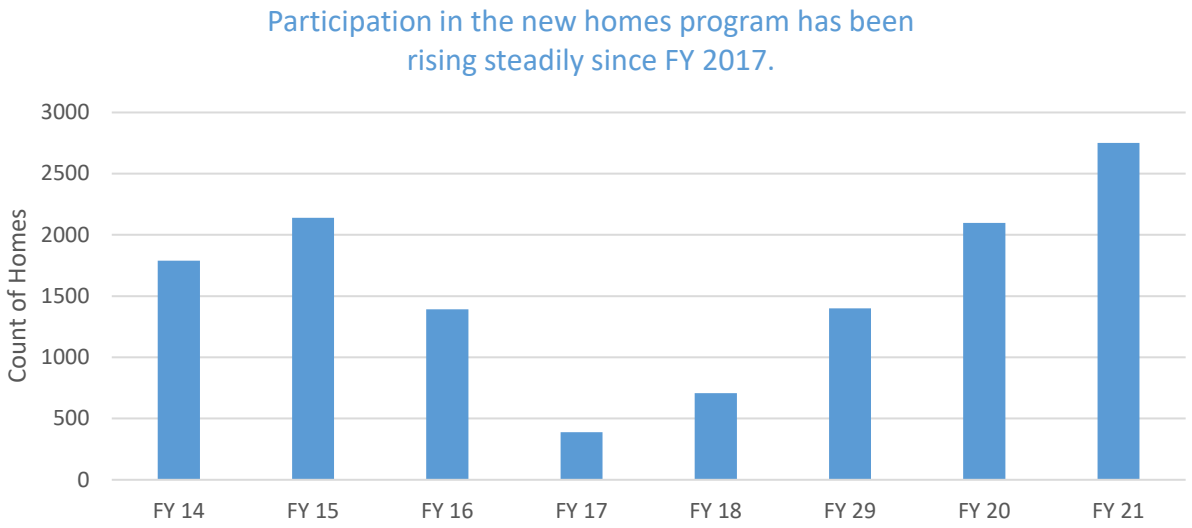


Figure 4-10: New Home Construction Program – Participation Trends

In the FY 2021 program, there were 2,468 homes *certified by BSAG*, or approximately 90% of the total 2,752 homes (this is furthermore roughly equivalent to FY 2020's BSAG percentage). Two main builders, Lennar and KB Homes, built approximately 75% of all the certified homes in the program.

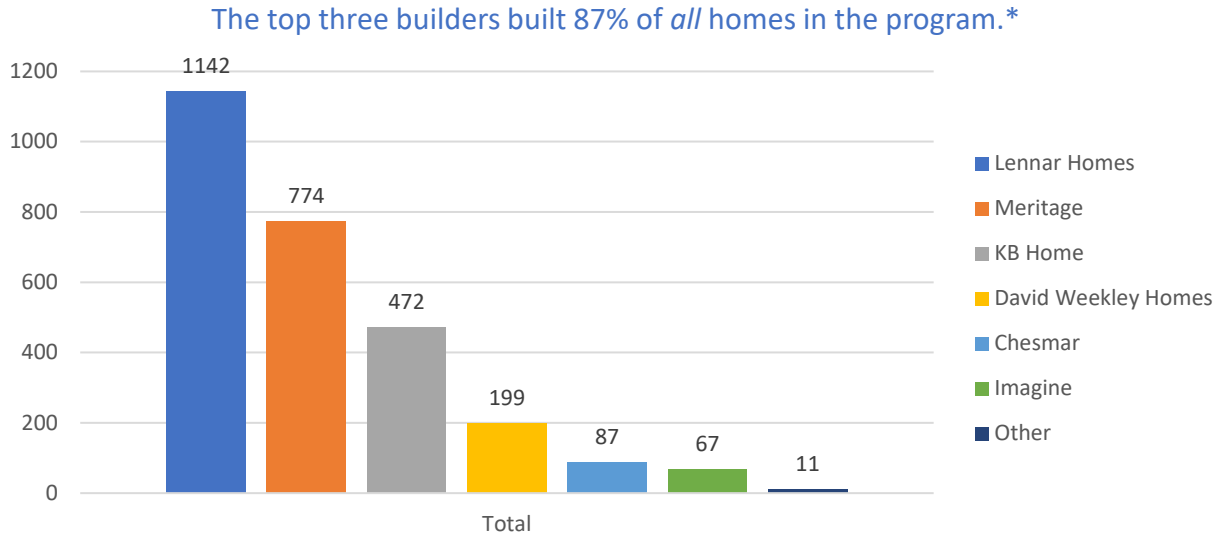


Figure 4-11: New Home Construction Program – Participation by Builder

*Builders in the "Other" category include CVF Homes, Serene Homes, Sitterle Homes, and Sustainable Homes

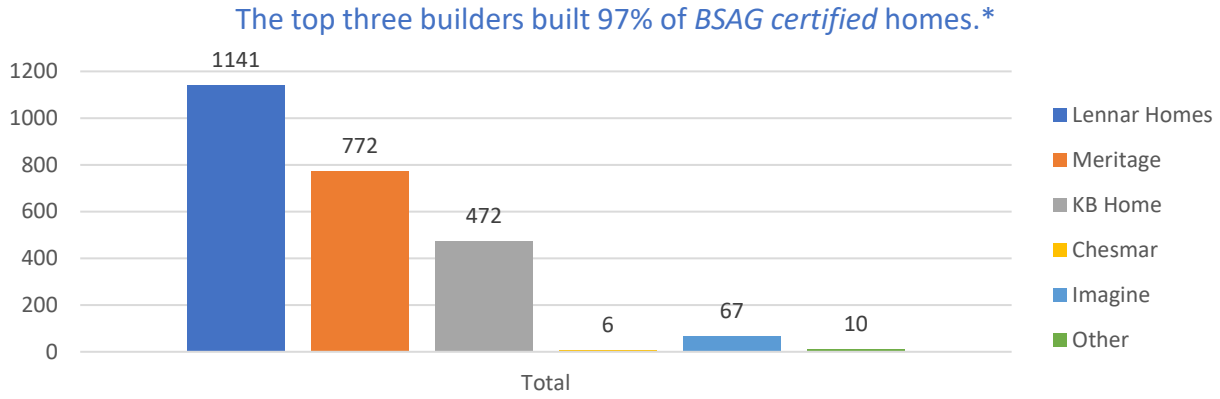


Figure 4-12: New Home Construction Program – BSAG Certified Participation by Builder

*Builders in the "Other" category include CVF Homes, Sitterle Homes, and Sustainable Homes

Ten 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 70% of the FY 2021 total).

4.4.2 Savings Calculation Methods

Homes are accepted to the program based on ratings developed using the Energy Systems Lab's (ESL) International Code Compliance Calculator (IC3) and Architectural Energy Corporation's REM/Rate—the software used to establish ENERGY STAR® program compliance. Both tools provide site and source energy savings estimates based on a comparison of the predicted energy use in the as-built home to the energy use the models predict for a reference model, which incorporates the features of a home built to the reference code (IECC 2015) and equipped to relevant standards (e.g., federal equipment efficiency standards for HVAC units, water heaters, etc.). Source energy savings estimates are the basic requirement for establishing whether program guidelines have been met and the incentive tier for a given project. However, neither tool provides the 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. A majority of homes have 16 SEER air conditioners (or 16 SEER/8.5 and higher HSPF heat pumps), and some have tankless water heaters. Many are bringing the attics inside the envelope, insulating at the roof deck and completely sealing the attic; almost all are installing radiant barriers.

Perhaps the most important feature in determining by how much participating homes 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 Table 4-4.[11]

Table 4-4: New Residential 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

4.4.3 Results

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.

The estimated energy savings and coincident peak, non-coincident peak, and ERCOT 4CP demand savings for the FY 2021 residential new construction program are presented in Table 4-5.

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

Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
2,978,627	1,674	2,565	2,013

[11] 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%-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). These per home (30% better than the IECC 2015 baseline) energy and demand savings are listed in Table 4-4.

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

4.5 HOME ENERGY ASSESSMENT

4.5.1 Overview

The Home Energy Assessment (HEA) Program provides energy-saving products to CPS Energy customers by means of an in-person home energy assessment or through home energy assessment direct installation kits. The HEA Program served 2,072 homes in FY 2021.

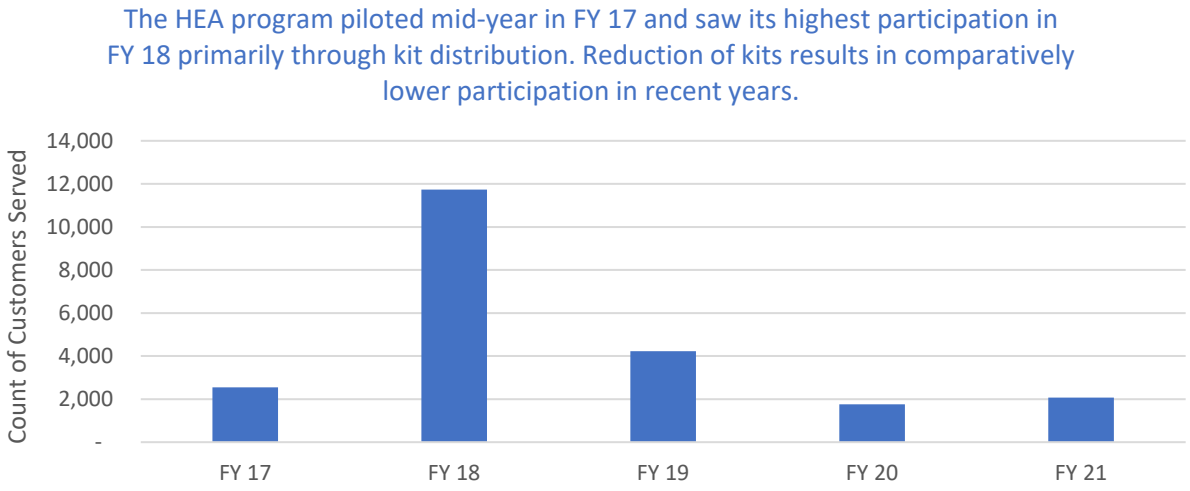


Figure 4-13: Home Energy Assessment Program – Participation Trends

The figure below presents a percentage breakdown of program savings by measure type. Kits represent the largest share of savings by measure type, caused by limited access to homes in FY 2021 for direct installation of lighting, domestic hot water, and thermostat measures.

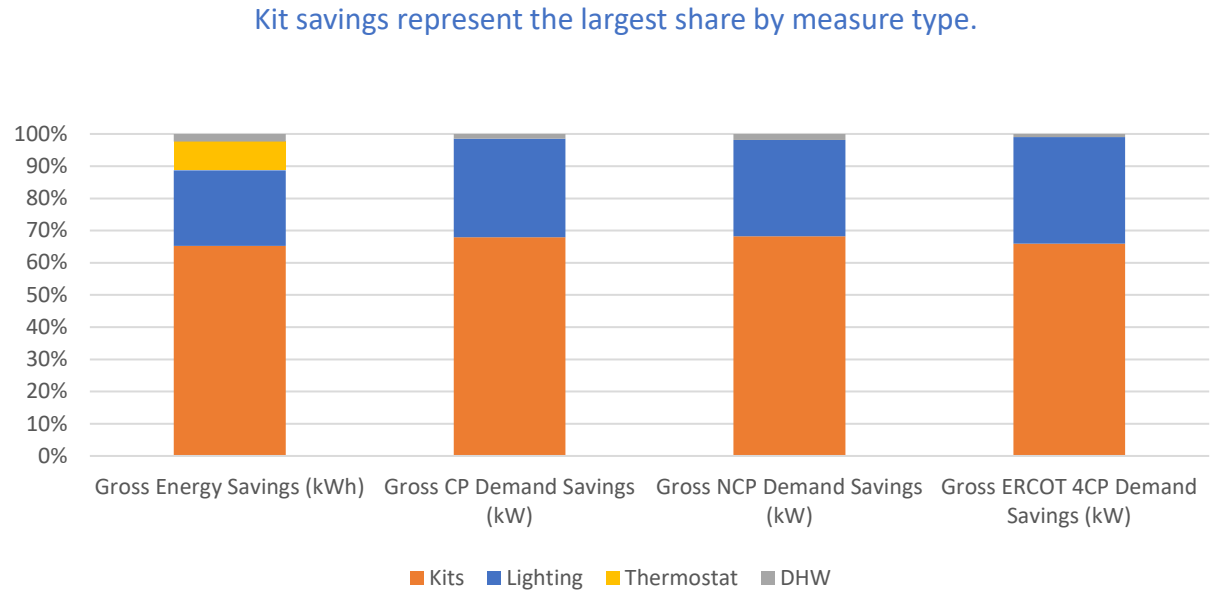


Figure 4-14: Home Energy Assessment Program – Gross Energy and Demand Impact Percentages by Measure

4.5.2 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, 2020 and January 31, 2021 were evaluated against the 2020-2021 *CPS Energy Guidebook*.

The sections below include the savings methodologies for direct installations of LED lamps, low-flow showerheads, faucet aerators, and water heater pipe insulation. The following sections also include the savings methodologies for two types of HEA kits, one for customers with electric water heaters and one for customers with gas water heaters.

4.5.2.1 LED Lamps

As part of the HEA program, Franklin Energy installed LED lighting in 152 homes during FY 2021 compared to 1,440 homes in FY 2020. The decrease in participation is largely explained by COVID-19 restrictions preventing access to customer homes. Average gross impacts per home for LED lighting are 972 kWh, 0.11 CP kW, 0.48 NCP kW, and 0.17 4CP kW. Average savings increased due to the removal of the second-tier baseline previously prescribed by the Energy Independence and Security Act (EISA) 2020 backstop.

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.

Savings for general service lamps are applied over a reduced 8-year measure life meant to approximate the market adoption of omni-directional LEDs. 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.

4.5.2.2 Domestic Hot Water

As part of the HEA program, Franklin Energy installed domestic hot water (DHW) measures in 32 homes during FY 2021. This represents a marked decrease in homes from FY 2020, primarily due to COVID-19 restrictions in direct-install programs. Much of this lost ground is regained through HEA kits. Average gross impacts per home for DHW measures are 470 kWh, 0.02 CP kW, 0.15 NCP kW, and 0.02 4CP kW.

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

Water heater heating types were not reported for this program. Thus, the Weatherization program's data was utilized as a proxy to compute an estimated electric-to-gas water heater heating type ratio for the HEA program. In the Weatherization program, there were multiple gas-powered water heaters in sampled homes. It is expected that sampled projects represent the tendencies of the larger population of projects, and, given that the HEA program is similarly a direct install program, these gas water heater occurrences were extrapolated to the entire HEA DHW population by applying the Weatherization program's ratio of electric-water-heater-homes-to-total-sampled-homes, approximately equaling 92%, to the DHW savings algorithms for HEA to adjust the per-unit total measure savings.

Water Heater Pipe Insulation

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

Low-Flow Showerheads

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

Faucet Aerators

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

4.5.2.3 Google Nest-E Thermostats

Google Nest-E thermostat installations are coordinated with CPS Energy's residential demand response program. DR-enabled Google Nest-E thermostats are installed during HEA site visits and annual energy efficiency savings are attributed to the HEA program. Energy savings are estimated according to the

program requirements established by the ENERGY STAR® program as described in the *CPS Energy Guidebook*. Demand savings are attributed to the DR program and are not reflected here.

As part of the HEA program, Franklin Energy installed 54 Google Nest-E thermostats in 46 homes during FY 2021. Almost 75% of installations occurred in gas-heated homes. The main benefits of this measure occur during summer demand response. Please see section 6.5 for details on summer impacts.

Three-quarters of thermostats were installed in gas-heated homes.

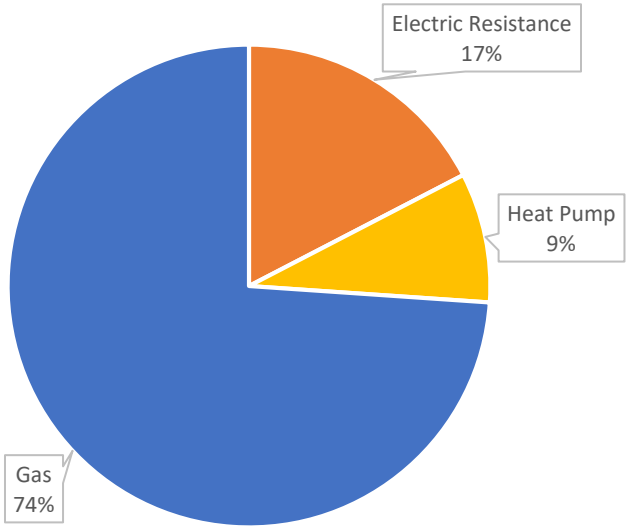


Figure 4-15: Home Energy Assessment Program – Thermostats by Heating Type

4.5.2.4 HEA Kits

As part of the HEA program, Franklin Energy distributed kits to 1,918 homes during FY 2021. This represents a significant increase from FY 2020 counts (because of the COVID-19 pandemic, direct installs of various measures were at times impossible; the distribution of kits served as a safe alternative to servicing residential sites in person). Average gross impacts per home for kit measures are 214 kWh, 0.019 CP kW, 0.087 NCP kW, and 0.027 4CP kW.

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

Pipe insulation savings are greater for conditioned spaces. Since this measure is contained in HEA kits, but the distinction between conditioned and unconditioned is not made in an upstream program, a weighted average of conditioned and unconditioned pipe insulation savings is taken to determine per-kit pipe insulation savings. Weights used in this averaging are conditioned and unconditioned pipe insulation counts from the Weatherization program. Pipe insulation furthermore utilizes a 50% installation rate overall for a kit program.

Additionally, the ratio of electric-to-gas water heaters (approximately 92%) from the Weatherization program was utilized here as well to adjust the DHW measure-level savings, an adjustment made to reflect the population of homes which were initially identified as containing electric water heaters but were confirmed to contain gas power water heaters. HEA kit savings have been discounted as such in the past using this ratio from the Weatherization program given how water heater fuel type is not reported in the HEA program. This discount's application to the measure-level algorithms does not, of course, affect gas water heater kits.

This measure received almost no participation in FY 2020, as Franklin Energy planned to phase out this measure due to diminishing lighting savings. However, participation increased significantly in FY 2021 based on a combination of increased lighting savings due to the elimination of the EISA second-tier baseline and impacts related to COVID-19. This measure proved effective at combating restrictions limiting access to customer homes. As site visit restrictions are lifted, this measure is likely to remain effective until the lighting market baseline changes to LED.

Kits for Customers with Electric Water Heaters

As part of the HEA program, Franklin Energy distributed kits to 1,071 homes with electric water heating during FY 2021. Average gross impacts per home for electric DHW kit measures are 287 kWh, 0.023 CP kW, 0.109 NCP kW, and 0.032 4CP kW.

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

Kits for Customers with Gas Water Heaters

As part of the HEA program, Franklin Energy distributed kits to 847 homes with gas water heating during FY 2021. Average gross impacts per home for gas DHW kit measures are 121 kWh, 0.014 CP kW, 0.060 NCP kW, and 0.022 4CP kW.

Gas water heater kits consist of five 9-Watt LED lamps. Kit components for the HEA program include measures targeting lighting and DHW savings. Because no electric savings can be claimed for DHW measures installed in homes with gas water heating, kits for these customers contain lightbulbs only.

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 Weatherization program, by measure.

Table 4-6: Home Energy Assessment 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	147,700	16.67	73.39	26.12
Thermostats	55,920	-	-	-
DHW	15,026	0.77	4.70	0.77
Kits	410,473	37.00	168.00	52.00
Total[12]	629,119	54.44	246.09	78.89

Rows may not sum to total due to rounding.

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

4.6 ENERGY SAVINGS THROUGH SCHOOLS

4.6.1 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 2021 the program distributed 5,434 kits, compared to 9,933 in FY 2020.

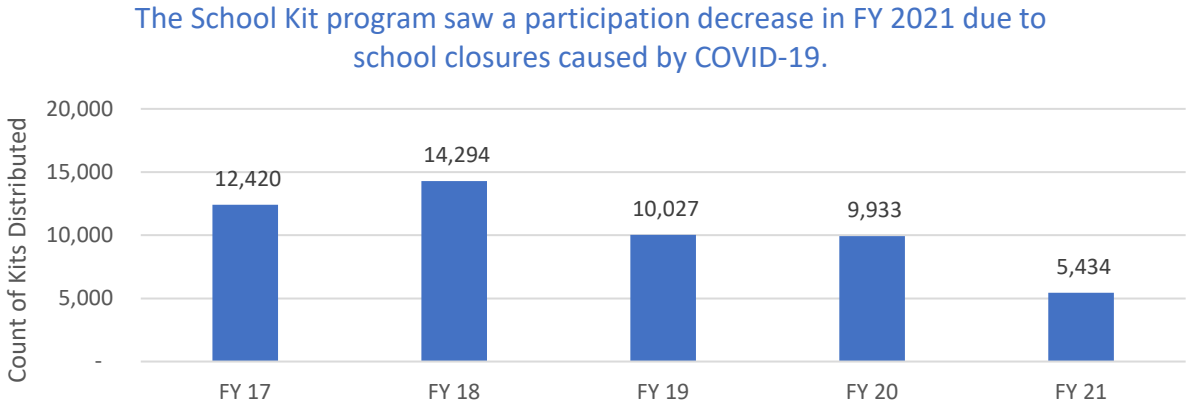


Figure 4-16: Energy Savings Through Schools – Participation Trends

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.

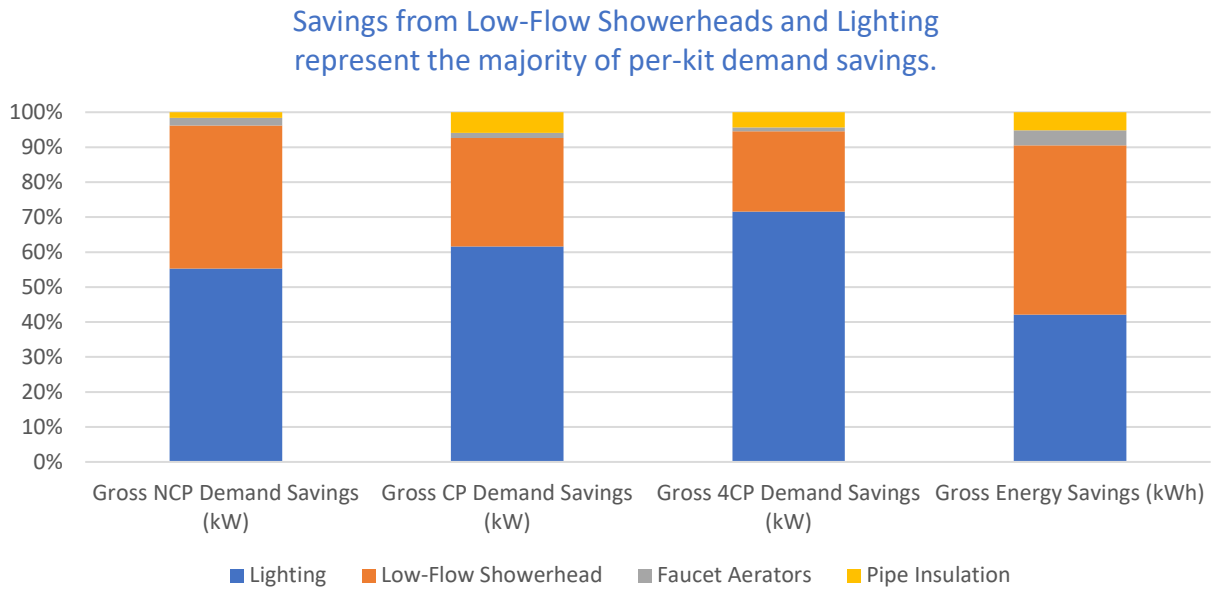


Figure 4-17: Energy Savings Through Schools – Gross Energy and Demand Impacts by Measure

4.6.2 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, 2020 and January 31, 2021 were evaluated against the 2020-2021 *CPS Energy Guidebook*.

As part of the Energy Savings Through Schools program, Franklin Energy distributed 5,434 kits to 44 schools during FY 2021. In comparison to FY 2020, this was a decrease 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, 0.012 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, this difference was approximately 0.01 kW. However, as a result of the EISA baseline changes described in the next section, this effect will be emphasized for future evaluations where the lighting savings are expected to increase.

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.

4.6.2.1 LED Lamps

The *CPS Energy Guidebook* includes separate calculation methodologies for omni-directional EISA-compliant and specialty EISA-exempt LED lighting. 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 is affected by several factors. Frontier applied updated CPS Energy discount rate, avoided capacity cost, and avoided energy cost inputs specific to FY 2020. These factors are used to weight savings for each baseline to provide a single annualized savings value. These inputs were not known to the implementation vendor at the beginning of the fiscal year, which means that final measure realization rates were marginally impacted by factors outside of implementer control.

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. The savings calculation also incorporates an interactive effects factor to account for the impacts on cooling and heating loads. Specialty lamp EULs will continue to be calculated based on rated product lifetimes.

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

4.6.2.2 Domestic Hot Water

Savings for all projects were validated using the savings methodologies outlined in the *CPS Energy Guidebook*. Showerhead and aerator coincident, non-coincident, and 4CP peak demand factors were calculated using a DHW load profile developed from the Building America Analysis spreadsheet for existing homes. Pipe and water heater insulation coincident, non-coincident, and 4CP peak demand factors were calculated using an assumption that the load shape for this measure 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 2021 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.

4.6.3 Results

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population. The following are the gross energy and demand savings for the 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	769,334	55	289	72

4.7 RESIDENTIAL RETAIL PARTNERS

4.7.1 Overview

The Residential Retail Partners program offers in-store rebates for ENERGY STAR® certified lighting. There were two participating retailers (30 total locations) in this program in FY 2021. Rebates were offered for 4 different lighting products, down from 76 products in FY 2020. The retail program targeted specific areas based on previous participation levels and focused on fewer products for more common residential applications. Average gross impacts per retail location are 163,588 kWh, 18.57 CP kW, 81.28 NCP kW, and 29.09 4CP kW. Savings vary significantly based on installed lamp type because of the various baselines in effect for this measure.

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 a review of hours most consistent with the CPS Energy 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.

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, 2020 and January 31, 2021 were evaluated against the 2020-2021 *CPS Energy Guidebook*. Product specific savings vary significantly based on installed lamp types and quantities due to the various baselines in effect for this measure. Annual savings increased due to the removal of the second-tier baseline previously prescribed by the Energy Independence and Security Act (EISA) 2020 backstop.

Savings for general service lamps are applied over a reduced 8-year measure life meant to approximate the market adoption of omni-directional LEDs. 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.

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.

Table 4-8: Residential Retail Partners Gross Energy and Demand Saving

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
LED	4,907,632	557.10	2,438.54	872.79

4.8 COOL ROOF

4.8.1 Overview

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

There were 50 projects rebated in FY 2021, with an average installed solar reflectance of 68% and average roof area of 2,232 square feet.

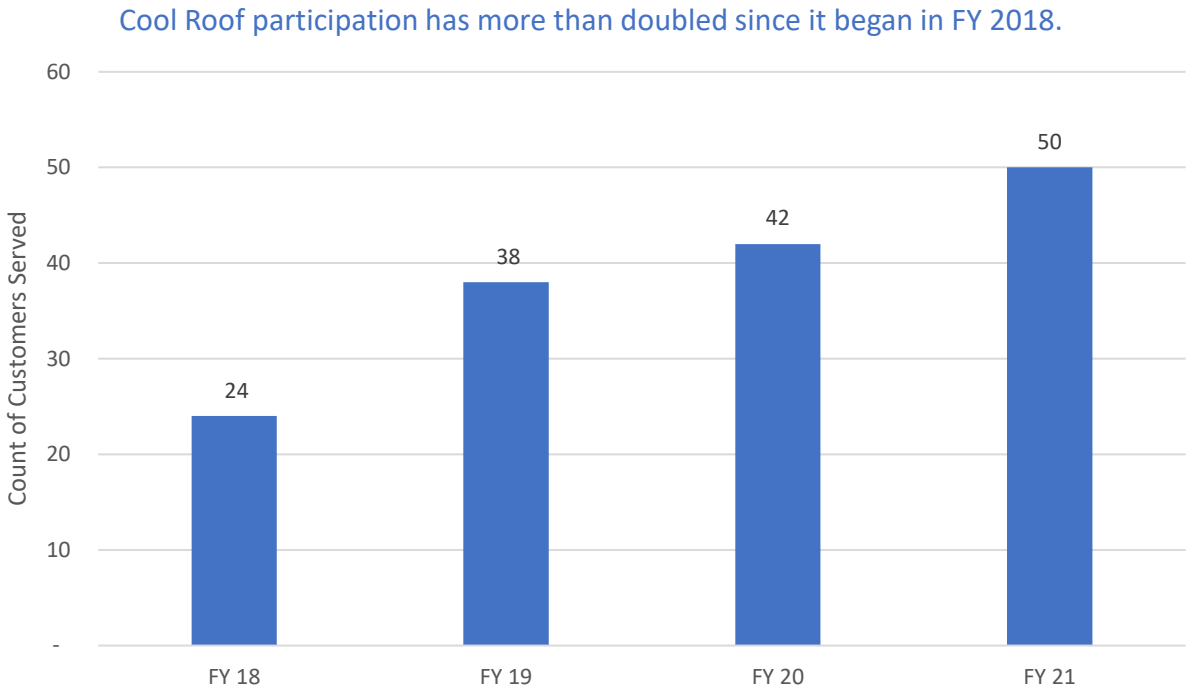


Figure 4-18: Cool Roof Program – Participation Trends

The Cool Roof program has seen great improvement in cost-effectiveness since it began in FY 2018, with UCT increasing from 0.41 in FY 2018 to 4.84 in FY 2021. The pilot year had significant administrative startup costs that contributed to the low UCT result. By FY 2021, the program implementation team has streamlined administration of the program leading to much lower administrative costs.

There were 29 installations at gas heated homes, 16 at homes heated with electric resistance, and five installations at homes with heat pump heating systems.

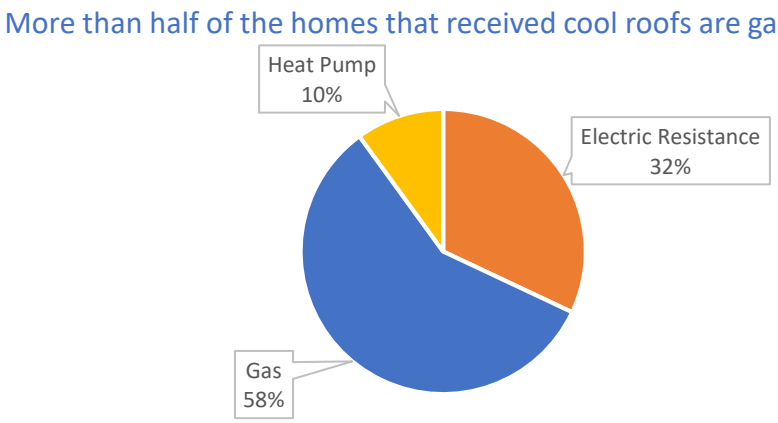


Figure 4-19: Cool Roof Program – Installations by Heating Type

4.8.2 Savings Calculation Method

Energy savings for this measure are determined using calibrated simulation models developed using NREL's BEopt 2.6 software running EnergyPlus 8.4 as the underlying simulation engine. The models were updated with the 2019-2020 *CPS Energy Guidebook* to incorporate updates adopted by the most recent Texas TRM. This resulted in higher deemed savings than were previously estimated in the pilot program in FY 2018. The simulation models used for other *CPS Energy Guidebook* envelope measures were adapted to estimate impacts for Cool Roof. Coincident, non-coincident,[13] and 4CP peak demand savings were determined using building energy simulation models developed by subtracting the whole house energy use in each hour of the post-retrofit models from the energy use in the pre-retrofit models.

Projects completed in FY 2021 were evaluated based on a desk review of project documentation including square footage, invoices, and confirmation of roofing system reflectivity. Minor adjustments were made to reported project inputs where documentation indicated a different heating type or square footage.

4.8.3 Results

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

Table 4-9: Residential Cool Roof Gross Energy and Demand Savings

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Cool Roof	42,935	43	69	61

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

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 include the following general items:

- For all lighting measures, including lamps contained in kits, ensure that project tracking systems reference the latest baselines, and identify key program tracking data and evaluation requirements as outlined in the *CPS Energy Guidebook*.
- We recommend reviewing and updating the HVAC savings calculations used for program tracking to ensure consistency with the *CPS Energy Guidebook*.
- ENERGY STAR® appears to have an issue in their qualified product listing that resulted in several window AC projects being reported with a matching ENERGY STAR® certificate, but the efficiency rating (CEER) did not comply with the current ENERGY STAR® minimum efficiency standard. To ensure that only eligible projects are rebated, implementers should confirm that the WAC savings calculation is enforcing the minimum efficiency requirement rather than only requiring ENERGY STAR® certification.
- Expanding the smart thermostat measure offering would help eliminate a significant lost opportunity cost. ENERGY STAR® qualifying smart thermostats are a well-suited match to the HVAC retrofit program. This measure could be offered at a low rebate level (approximately $50/unit) with little to no documentation burden beyond that which is required for the existing HVAC measures.
- Conducting primary research into the key input assumptions for school kits increases the accuracy of the evaluation and helps characterize the CPS Energy customer end-use fuel sources. Program administrators can conduct additional student surveys to gather data that supports the current percent-electric-water-heater variable and existing installation rate assumptions (e.g., in-service rates, percent of electric water heating assumption). The results of the surveys can be incorporated for future implementation of the Energy Savings Through Schools kit program.
- Looking forward in the event that new products are added to the Retail lighting program for the upcoming program year, document ENERGY STAR® qualification at the time product is added to program offerings to alleviate issues related to verifying ENERGY STAR® qualification as products are retired from the ENERGY STAR® qualified product list or replaced by a newer product.
- The *CPS Energy Guidebook* that will apply in FY 2022 dictates that 5% of claimed savings for general service lamps with an equivalent wattage less than or equal to 100 watts are

considered commercial. Residential programs can still claim these savings, but they should calculate savings estimates using commercial savings methodologies.

- Ensure that tracking systems incorporate the EISA first-tier baselines for B shape ("Bulged") lamps with an equivalent wattage greater than 40 watts and CA shape ("Candelabra") lamps with an equivalent wattage greater than 40 watts.

- Frontier anticipates revisions to the current New Homes Construction modeling scheme will be necessary upon the 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 an increasing participation trend in the program, the fact that IECC 2015 will be two iterations behind this next most current code base, and that a temporary workaround was introduced in last year's evaluation to accommodate homes that are 30% more efficient than the IECC 2015 baseline[14], Frontier recommends that CPS Energy consider allowing Frontier to dedicate resources toward updating the current NHC model.

[14]That is, rather than 15% more efficient than the IECC 2015 baseline: Frontier algebraically estimated the incremental savings that occurred from a15%-to-30%-more-efficient-than-IECC-2015 increase in FY 2021, with the procedure detailed in the New Homes Construction section of this report.

5. COMMERCIAL PROGRAMS

5.1 SUMMARY OF COMMERCIAL IMPACTS

CPS Energy's commercial programs portfolio addresses most markets and major commercial end uses. FY 2021 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 2021:

- C&I 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 2020-2021 *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 2021 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.[15]

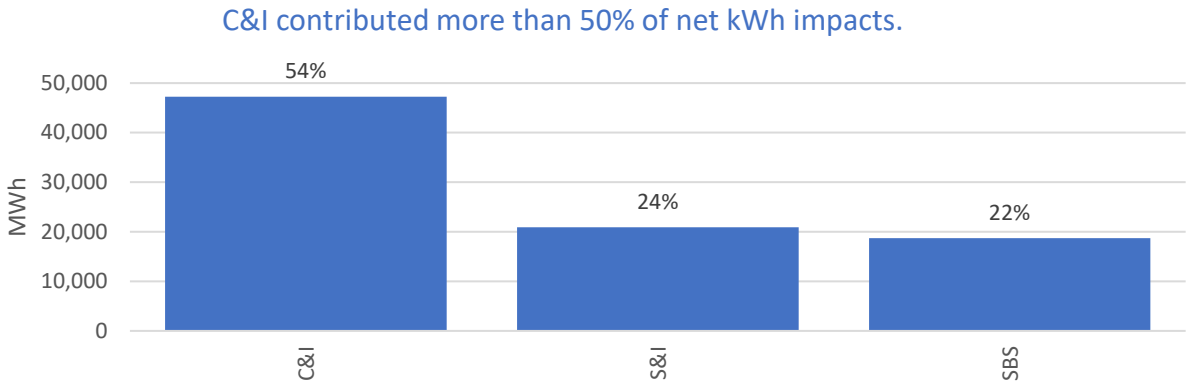


Figure 5-1: Summary of Commercial Impacts – Net Avoided Energy by Program

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

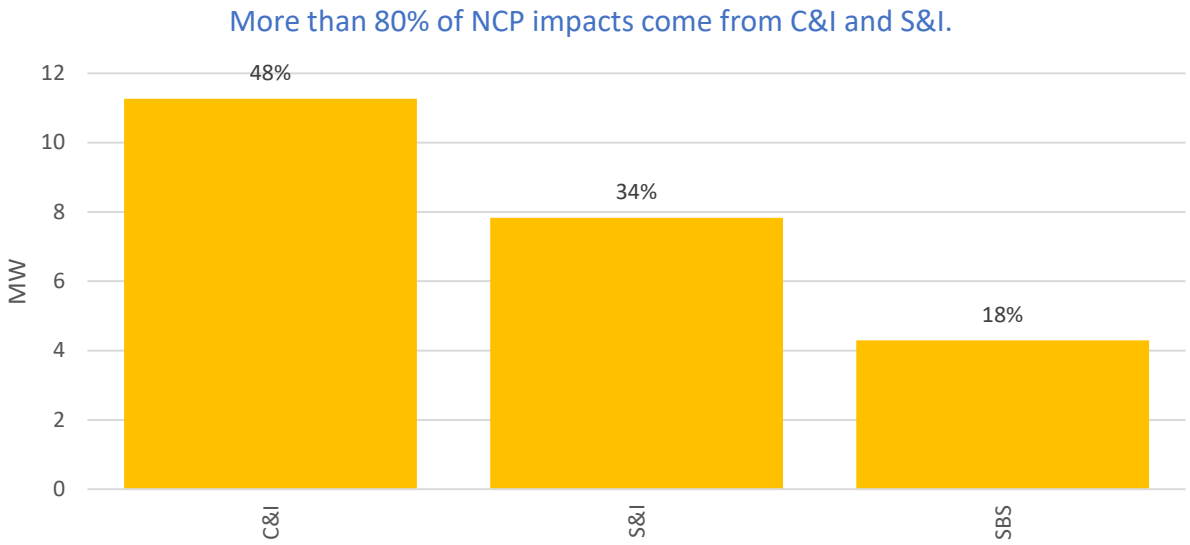


Figure 5-2: Summary of Commercial Impacts – Net Avoided NCP by Program

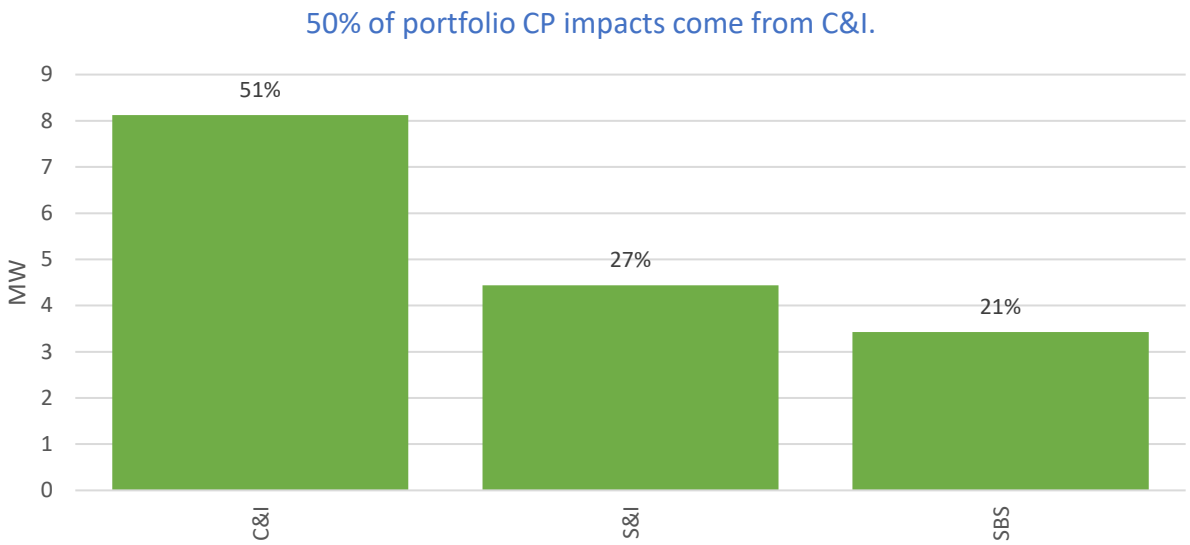


Figure 5-3: Summary of Commercial Impacts – Net Avoided CP by Program

5.2 C&I SOLUTIONS

5.2.1 Overview

The C&I Solutions (C&I) program includes the installation of the following commercial energy efficiency measures: lighting, lighting controls, HVAC, HVAC tune-up, HVAC occupancy controls, variable frequency drive (VFD), and custom. In FY 2021, a total of 486 projects were incentivized through the C&I program, compared to 632 in FY 2020.

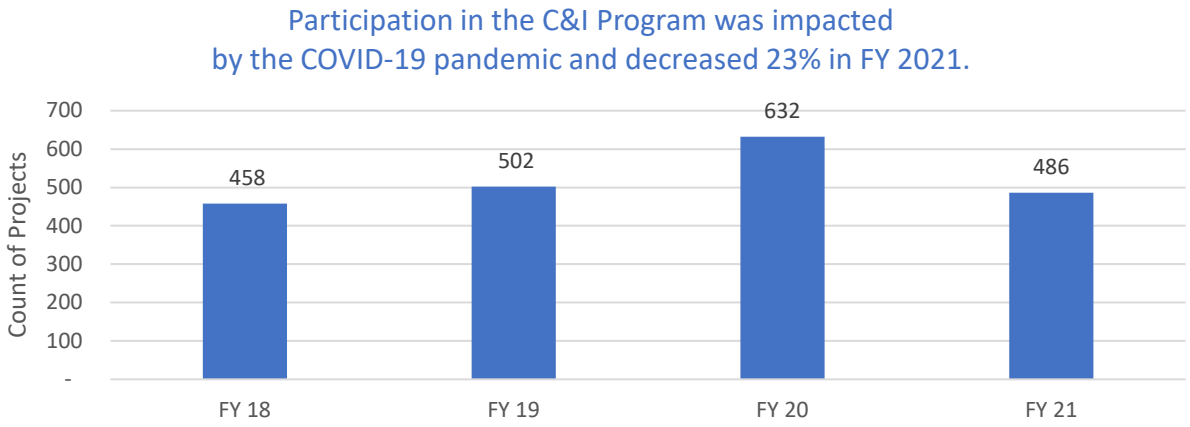


Figure 5-4: Commercial & Industrial – Participation Trends

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.

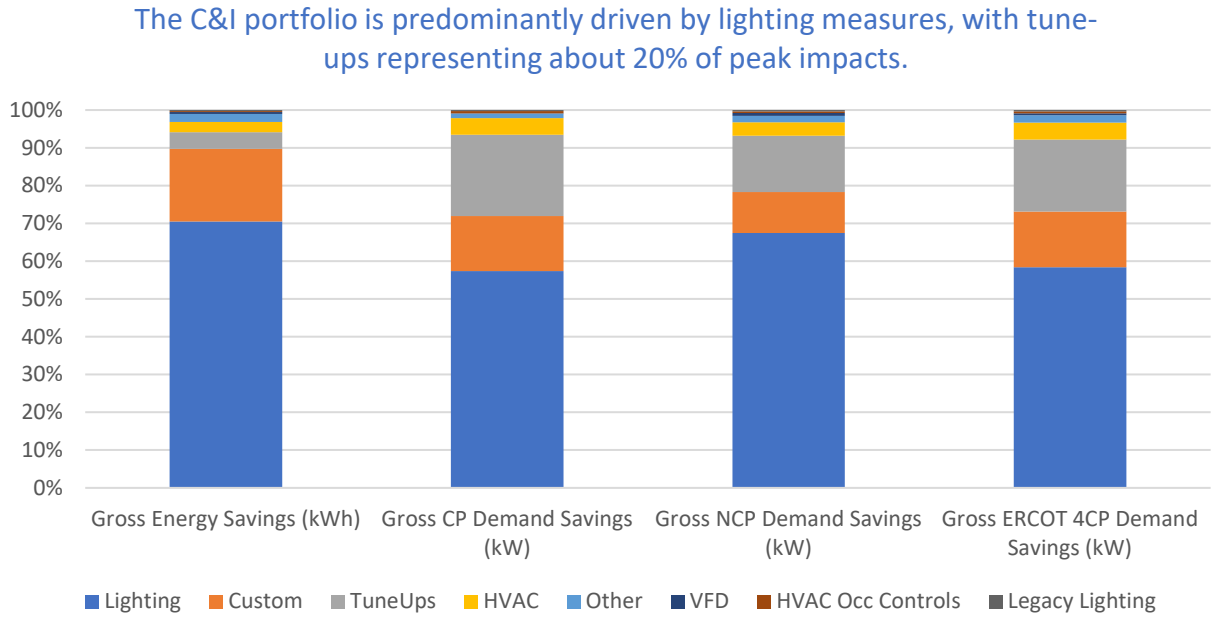


Figure 5-5: Commercial & Industrial – Gross Energy and Demand Impacts by Measure

5.2.2 Savings Calculation Method

A desk review was performed for a sample of projects incentivized in this program. Frontier selected a sample size to achieve a 90/10% confidence and precision interval. The results of the savings analysis for the sample were applied to the full program population. Projects were evaluated against the 2020-2021 *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 normally supplemented by evaluator site inspections. However, no site inspections were possible due to safety protocols related to COVID-19.

Outdoor and Mercantile each delivered roughly 30% of C&I Lighting impacts in FY21. Warehouse, Office, and Manufacturing are other primary drivers, with relatively even distribution for the remaining building types.

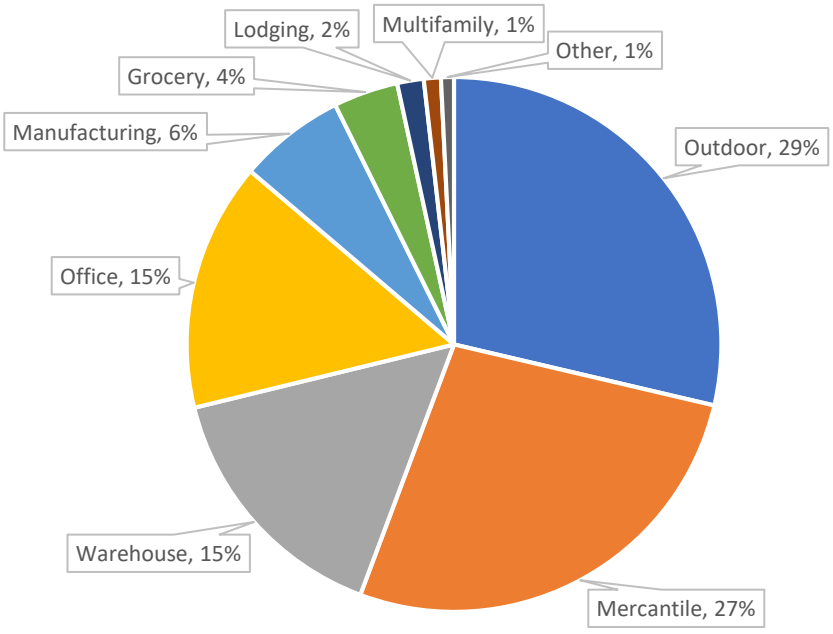


Figure 5-6: C&I Solutions – Percent of kWh Savings by Building Type for Sampled Lighting Projects

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. CLEAResult 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 CLEAResult.

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 2021 measure population. Because CLEAResult does not calculate 4CP kW savings, verified 4CP kW was compared to verified CP kW savings to create a CP to 4CP adjustment factor for each desk review project. A weighted average adjustment factor was then applied to the verified CP kW savings for the total measure population, yielding verified 4CP kW savings.

5.2.2.2 HVAC

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 normally supplemented by evaluator site inspections. However, no site inspections were possible due to safety protocols related to COVID-19.

C&I HVAC impacts were split almost evenly between DX AC/HPs, Water Cooled Chillers, and Air Cooled Chillers in FY21.

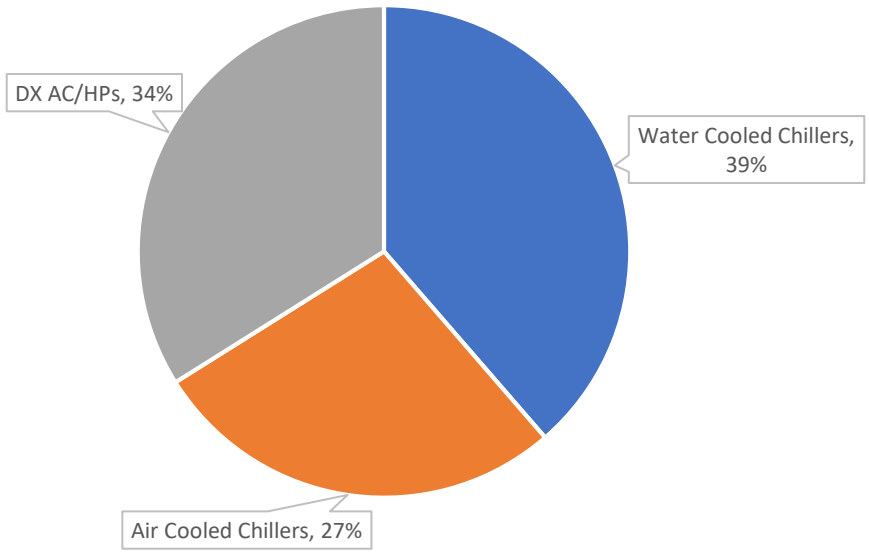


Figure 5-7: C&I Solutions – Percent of kWh Savings by System Type for HVAC Projects

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 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, RUL assumptions accounted for bulk installation during the 2020 calendar year. Frontier applied updated CPS Energy discount rate, avoided capacity cost, and avoided energy cost factors specific to FY 2021. These factors are used to weight savings over the dual baselines used for early retirement projects. These factors are not known to the implementation vendor at the beginning of the fiscal year, indicating that final measure realization rates could be marginally impacted by factors outside of implementer control. However, updated avoided cost assumptions did not affect the resulting realization rates for the FY 2021 evaluation period because escalation and discount rates remained the same as for the previous fiscal year.

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.

ER projects deliver 37% of C&I HVAC impacts in FY21, down from 50% in FY20. ROB impacts increased from 10% to 48%. This trend is likely due to the impact of COVID-19, with customers being less likely to risk exposure.

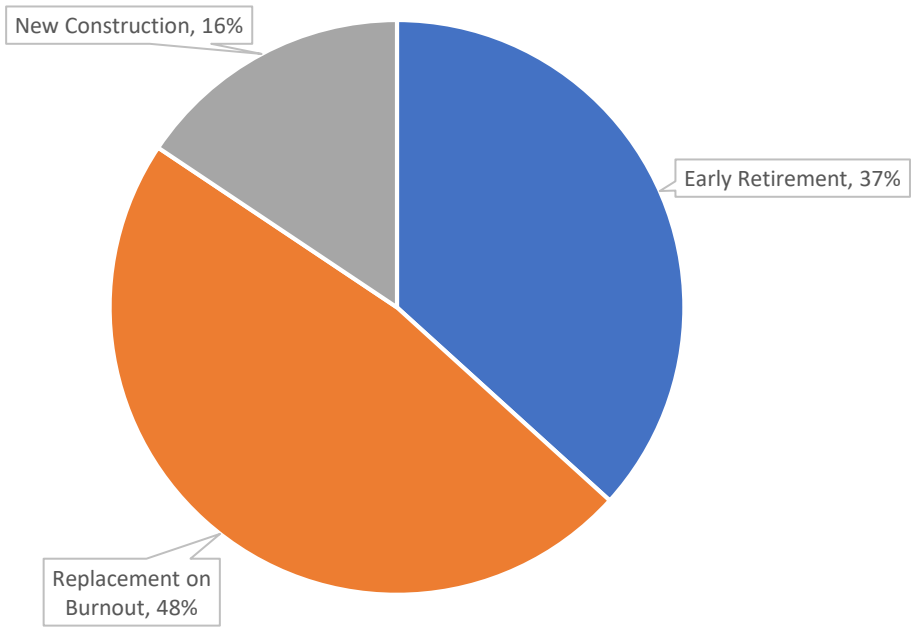


Figure 5-8: C&I Solutions – Percent of kWh Savings by Baseline Type for HVAC Projects

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 CLEAResult does not calculate 4CP kW savings, verified 4CP kW was compared to verified CP kW savings to create a CP to 4CP adjustment factor for each desk review project. A weighted average adjustment factor was then applied to the verified CP kW savings for the total measure population, yielding verified 4CP kW savings.

5.2.2.3 HVAC Tune-up

The 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 177 HVAC tune-up projects submitted in FY 2021. Frontier sampled 25 projects for desk review consisting of 674 individual HVAC system tune ups. More than 60% of sampled tune-ups were completed at retail strip mall locations.

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

Building Type	Number of Systems	Average Tonnage
Strip Mall	410	4.7
Nursing Home	93	2.4
Full-Service Restaurant	57	5.2
Primary School	56	13.6
Outpatient Healthcare	16	4.2
Religious Worship	14	5.4
Convenience	10	5.1
Quick-Service Restaurant	8	4.9
Public Assembly	5	8.0
Service	3	4.0
Small Office	2	6.3
Total	**674**	**5.2**

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, filter, improper airflow, and/or incorrect refrigerant charge. CLEAResult requested that the evaluation team apply an alternate efficiency loss factor obtained from field-measured performance data. However, the request was made at the end of the evaluation schedule, with insufficient time for the evaluation team to conduct a comprehensive review of the request. Based on limited review, the evaluation team decided that rather than applying either the default EL from the Guidebook or the alternate EL requested by CLEAResult, we applied the average realization rates from FY 2019 and FY 2020 to the total claimed impacts for the tune-up measure. Going forward, the default EL from the Guidebook will be utilized unless CLEAResult requests an alternate approach with sufficient time for review.

5.2.2.4 HVAC Occupancy Controls

Due to the small population of this measure type, Frontier selected all projects for desk review. Savings were validated using the savings methodologies outlined in the *CPS Energy Guidebook*.

Project documentation was reviewed to verify control type, controlled loads, degree setback, building type, and heating type. Project documentation is normally supplemented by evaluator site inspections. However, no site inspections were possible due to safety protocols related to COVID-19.

5.2.2.5 Custom/Other

There were 71 custom and other projects completed in FY 2021, targeting a variety of end uses that included HVAC, refrigeration, envelope, and process loads. While COVID-19 restrictions prevented site access to verify installations, Frontier conducted documentation review for a sample of 48 of those other projects.

Certain measures like variable frequency drives (VFD) and electronically commutated motor (ECM) evaporator fans follow savings methodologies as described in the *CPS Energy Guidebook*. Custom projects were validated individually during implementation by reviewing submitted M&V plans and confirming procedures aligned with claimed savings as described in the calculation methodology.

An efficient refrigeration design for a refrigerated warehouse project completed post-installation verification in FY 2021. The M&V plan for this project required post-construction calibration using meter data to verify model assumptions. Post-construction meter calibration was not completed, and an alternative verification method was implemented that reduced claimed savings by 13%. Despite this adjustment, the refrigeration project contributed more than 50% of the energy savings for other measures sampled for documentation review in the C&I program in FY 2021.

One custom refrigeration project received more than 50% of the energy savings for other measures sampled for documentation review.

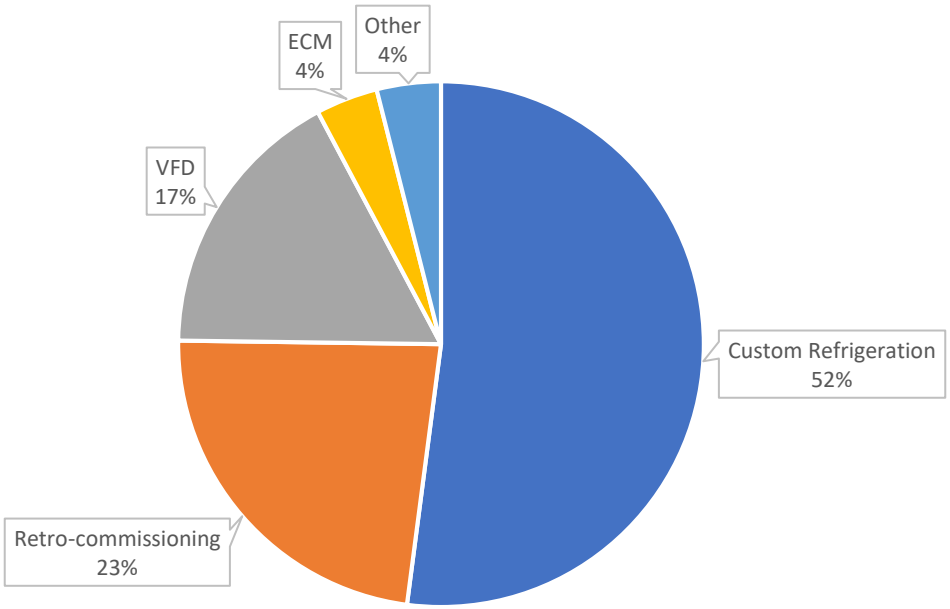


Figure 5-9: C&I Solutions – Energy Savings by Type of Other Project

C&I saw an increase in retro-commissioning (RCx) projects, which were formerly implemented in the now-retired Whole Building Optimization program. Retro-commissioning projects contributed almost one quarter of savings for other projects sampled for documentation review in FY 2021. 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 limited access to sites, no attempt was made to confirm that adjustments to building operation controls persisted. However, project documentation submitted for review included detailed screenshots of building control systems schedules and system setpoints to verify the implemented measures.

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	32,915,575	4,458	7,515	4,494
Custom	8,982,128	1,131	1,210	1,131
Tune-ups	2,067,848	1,663	1,471	1,471
HVAC	1,242,135	346	393	343
Other	1,023,383	94	193	150
VFD	205,619	5	84	40
HVAC Occ Controls	140,608	43	43	37
Legacy Lighting	118,217	24	42	28
Total[16]	46,695,513	7,771	11,144	7,693

Rows may not sum to total due to rounding.

[16] 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, and custom. In FY 2021, a total of 122 projects were incentivized through the Schools & Institutions program, compared with 99 in FY 2020.

Participation in the S&I program saw a slight increase in FY 2021.

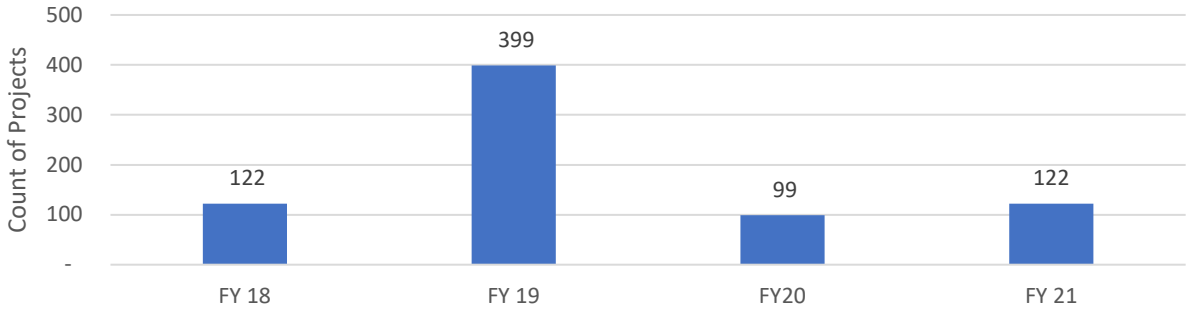


Figure 5-10: Schools & Institutions – Participation Trends

Figure 5-11 presents percentage breakdowns of gross energy, NCP, CP and 4CP demand impacts by measure. Commercial Behavior-Operational Projects (CBOP) and retro-commissioning projects (RCx) predominantly impact HVAC system operation, which has a low peak coincidence for schools and therefore those projects represent a lower share of CP and 4CP impacts.

The S&I portfolio exhibits a more diverse measure mix than C&I.

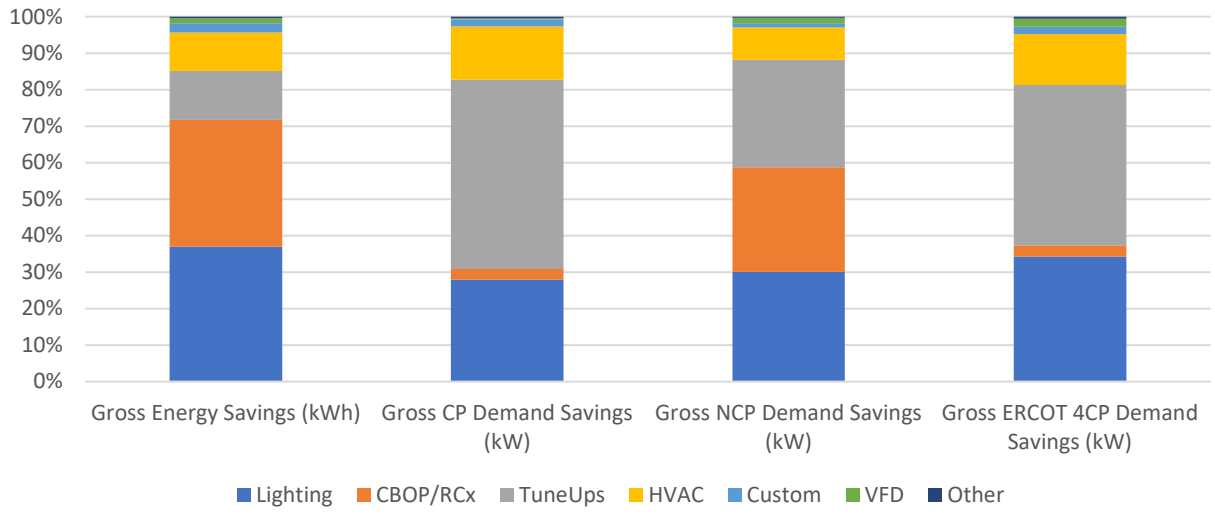


Figure 5-11: Schools & Institutions – Gross Energy and Demand Impacts by Measure

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, 2020 and January 31, 2021 were evaluated against the 2020-2021 *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 normally supplemented by evaluator site inspections. However, no site inspections were possible due to safety protocols related to COVID-19.

Education delivered roughly 40% of S&I Lighting impacts in FY21 compared to 16% in FY20. Outdoor dropped to roughly 20% in FY21 compared to 74% in FY20. Most outdoor lighting was located at Education sites.

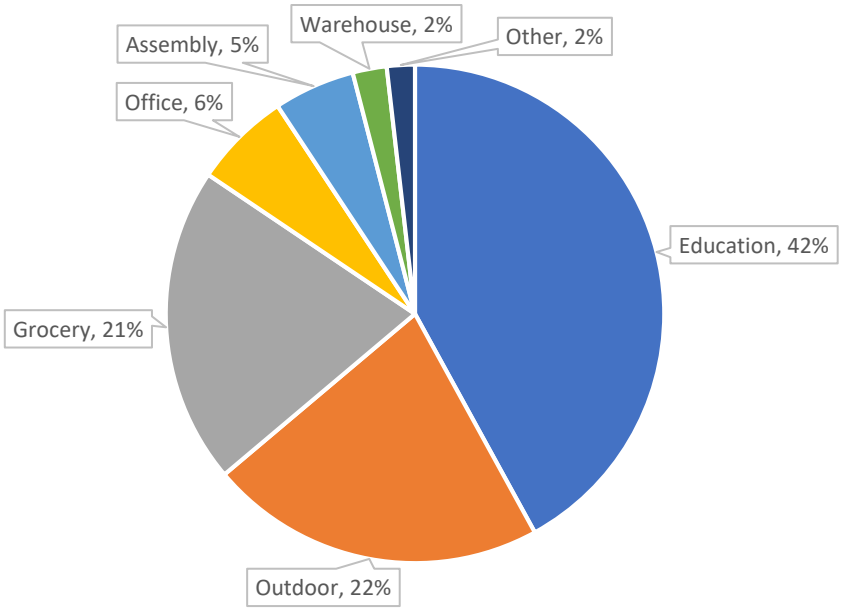


Figure 5-12: Schools & Institutions – Percent of kWh Savings by Building Type for Sampled Lighting Projects

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. CLEAResult 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 CLEAResult.

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

5.3.2.2 HVAC

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 normally supplemented by evaluator site inspections. However, no site inspections were possible due to safety protocols related to COVID-19.

Water Cooled Chillers are still the primary savings driver but decreased to 60% in FY21 compared to 76% in FY20. DX savings increased to 18% compared to 1% in FY20, likely due to increased new construction projects in the desk review sample.

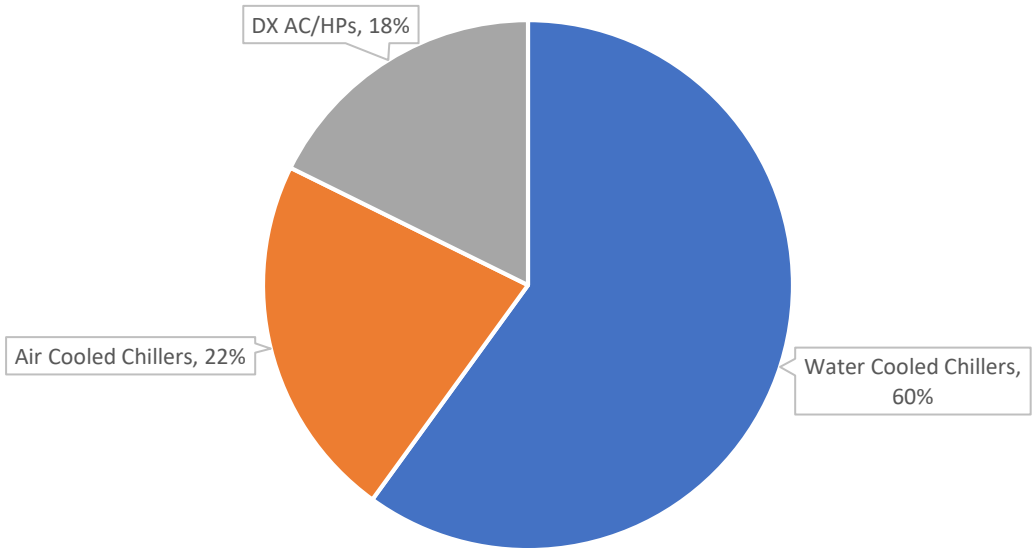


Figure 5-13: Schools & Institutions – Percent of kWh Savings by System Type for HVAC Projects

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, RUL assumptions accounted for bulk installation during the 2020 calendar year. Frontier applied updated CPS Energy discount rate, avoided capacity cost, and avoided energy cost factors specific to FY 2021. These factors are used to weight savings over the dual baselines used for early retirement projects. These factors are not known to the implementation vendor at the beginning of the fiscal year, indicating that final measure realization rates could be marginally impacted by factors outside of implementer control. However, updated avoided cost assumptions did not affect the resulting realization rates for the FY 2021 evaluation period because escalation and discount rates remained the same as for the previous fiscal year.

ER projects deliver 72% of S&I HVAC impacts, demonstrating that the program is effectively encouraging early adoption of efficient HVAC. Increase in ER/NC and decrease in ROB can be explained by focus on high savings projects for desk review sample.

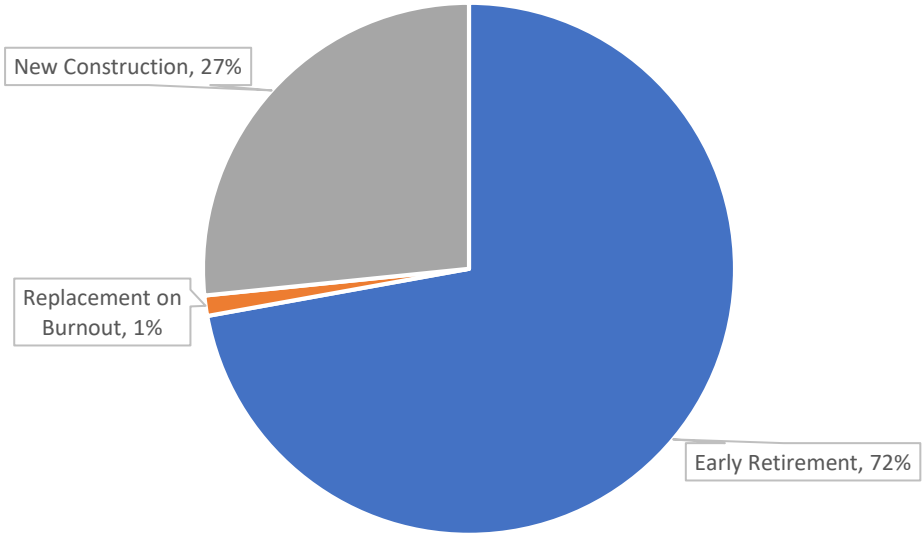


Figure 5-14: Schools & Institutions – Percent of kWh Savings by Baseline Type for HVAC Projects

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 CLEAResult does not calculate 4CP kW savings, verified 4CP kW was compared to verified CP kW savings to create a CP to 4CP adjustment factor for each desk review project. A weighted average adjustment factor was then applied to the verified CP kW savings for the total measure population, yielding verified 4CP kW savings.

5.3.2.3 HVAC Tune-up

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 77 HVAC tune-up projects submitted in FY 2021. Frontier sampled 17 projects for desk review consisting of 501 individual HVAC system tune ups. More than 90% 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	Number of Systems	Average Tonnage
Primary School	468	9.6
Secondary School	17	30.7
Public Assembly	12	11.5
Small Office	4	5.1
Total	501	10.3

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, filter, improper airflow, and/or incorrect refrigerant charge. CLEAResult requested that the evaluation team apply an alternate efficiency loss factor obtained from field-measured performance data. However, the request was made at the end of the evaluation schedule, with insufficient time for the evaluation team to conduct a comprehensive review of the request. Based on limited review, the evaluation team decided that rather than applying either the default EL from the Guidebook or the alternate EL requested by CLEAResult, we applied the average realization rates from FY 2019 and FY 2020 to the total claimed impacts for the tune-up measure. Going forward, the default EL from the Guidebook will be utilized unless CLEAResult requests an alternate approach with sufficient time for review.

5.3.2.4 Custom/Other

There were 18 custom and other projects completed in FY 2021, including included envelope, VFDs, retro-commissioning and school behavioral initiatives. While COVID-19 restrictions prevented site access to verify installations, Frontier conducted documentation review for a sample of 11 of those other projects. Additional documentation on six projects was requested but not received. However, those size projects were all retro-commissioning projects, and review of five other RCx projects in the S&I program included well-documented and detailed screenshots of building control systems schedules and system setpoints to verify the implemented measures.

Certain measures like variable frequency drives (VFD) follow savings methodologies as described in the *CPS Energy Guidebook*. Commercial Behavior-Operational Projects (CBOPs) undergo whole-building meter-based measurement and verification. School districts participating in FY 2021 include Judson Independent School District (ISD) and San Antonio ISD. Adjustments were made to account for changes to building operations including construction and COVID-19 impacts.

The behavioral schools projects dominated savings contributions for other projects selected for documentation review.

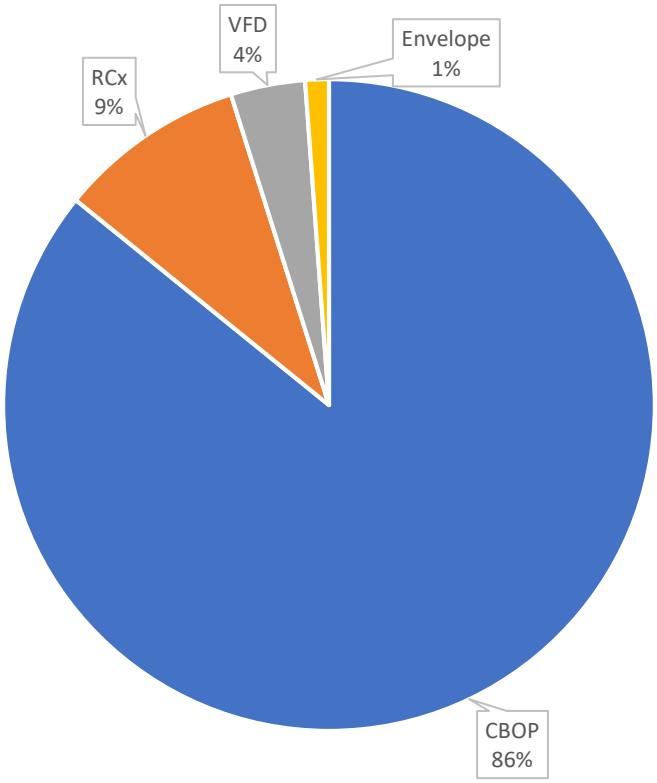


Figure 5-15: S&I – Energy Savings by Type of Other Project

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	7,650,440	1,186	2,329	1,399
CBOP/RCx	7,196,744	124	2,221	124
Tune-ups	2,764,966	2,202	2,277	1,795
HVAC	2,190,660	620	686	571
Custom	522,352	81	87	81
VFD	279,600	10	118	91
Other	88,689	22	24	23
Total[17]	20,693,451	4,245	7,742	4,084

Rows may not sum to total due to rounding.

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

5.4 SMALL BUSINESS SOLUTIONS

5.4.1 Overview

This program includes the installation of the following commercial energy efficiency measures: direct install lighting and lighting controls, direct install HVAC, HVAC tune-ups, and midstream lighting. In FY 2021, a total of 219 direct install projects and 21 midstream batches were incentivized through the Small Business Solutions (SBS) program.

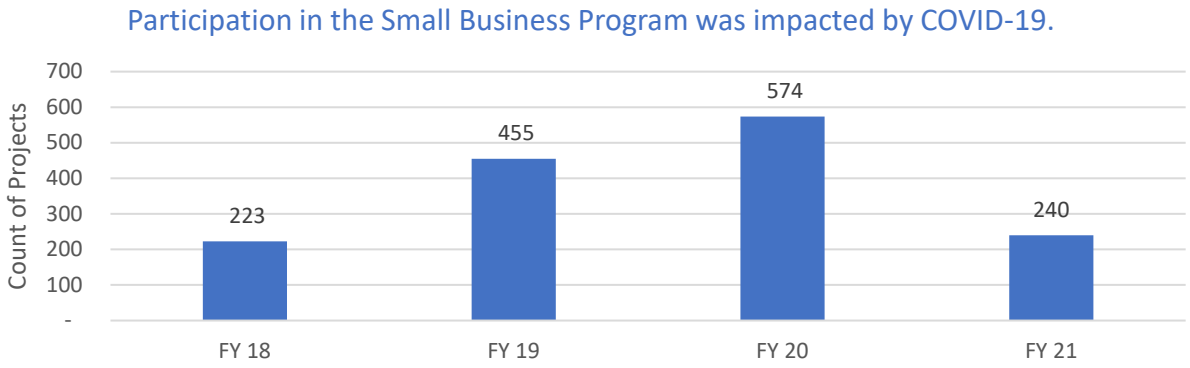


Figure 5-16: Small Business Solutions – Participation Trends

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

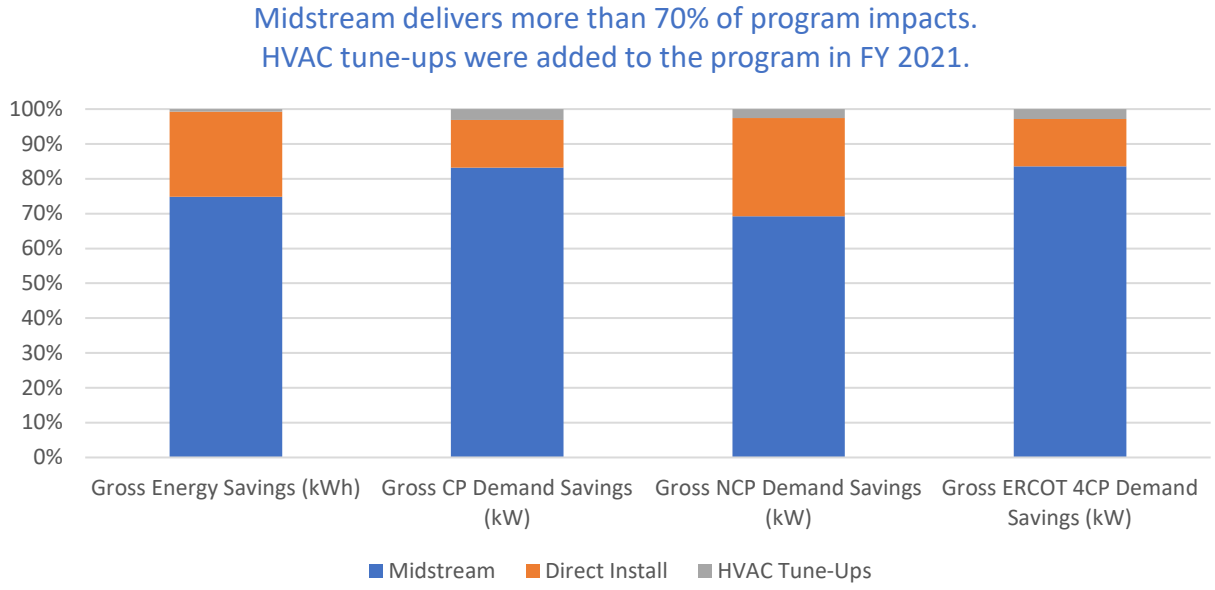


Figure 5-17: Small Business Solutions – Gross Energy and Demand Impacts by Measure

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, 2020 and January 31, 2021 were evaluated against the 2020-2021 *CPS Energy Guidebook*.

5.4.2.1 Direct Program – Lighting Measures

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 2021 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. Project documentation is normally supplemented by evaluator site inspections. However, no site inspections were possible due to safety protocols related to COVID-19.

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

5.4.2.2 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 in the SBS – Direct Program. The major difference with this program is that savings are awarded based on an assumed weighting of building types. These weightings vary based on the lamp or fixture type.

In addition to validating the savings calculation against the *CPS Energy Guidebook*, fixture counts, fixture types, baseline wattages, rated wattages, and lumen ratings were verified against reported model numbers. Assumptions for select model numbers were further verified against DesignLights Consortium (DLC) or ENERGY STAR® qualified product listings. 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, CLEAResult 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 CLEAResult does not calculate 4CP kW savings, verified 4CP kW was compared to verified CP kW savings to create a CP to 4CP adjustment factor for each desk review project. A weighted average adjustment factor was then applied to the verified CP kW savings for the total measure population, yielding verified 4CP kW savings.

5.4.2.3 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. There were three HVAC tune-up projects submitted in FY 2021. Frontier sampled all three projects for desk review consisting of 97 individual HVAC system tune ups. Almost 50% 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	Number of Systems	Average Tonnage
Strip Mall	48	4.8
Service	20	5.0
Full-Service Restaurant	17	5.5
Convenience	4	4.3
Outpatient Healthcare	3	6.0
Quick-Service Restaurant	3	5.3
Primary School	1	5.0
Small Office	1	3.0
Total	97	4.9

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, filter, improper airflow, and/or incorrect refrigerant charge. CLEAResult requested that the evaluation team apply an alternate efficiency loss factor obtained from field-measured performance data. However, the request was made at the end of the evaluation schedule, with insufficient time for the evaluation team to conduct a comprehensive review of the request. Based on limited review, the evaluation team decided that rather than applying either the default EL from the Guidebook or the alternate EL requested by CLEAResult, we applied the average realization rates from FY 2019 and FY 2020 to the total claimed impacts for the tune-up measure. Going forward, the default EL from the Guidebook will be utilized unless CLEAResult requests an alternate approach with sufficient time for review.

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)
Direct Lighting	4,639,458	453	1,239	456
Midstream Lighting	14,230,728	2,771	3,038	2,792
HVAC Tune-up	142,400	105	112	94
Total[18]	19,012,586	3,329	4,389	3,342

Rows may not sum to total due to rounding.

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

5.5 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 include the following general items:

- Lighting and Lighting Controls:
  - Review the requirements in the *CPS Energy Guidebook* and ensure the tracking systems incorporate the latest methodologies and input assumptions.
  - Implementers can add 4CP calculations to their tracking systems. Because lower interactive effects factors are applied to the deemed NCP kW calculation, evaluated CP or 4CP kW savings occasionally exceed the evaluated NCP kW savings, Frontier awards the max of NCP, CP, and 4CP as the evaluated NCP kW savings.
  - To increase realization rates, project scopes including both LED fixture and integral LED lamps should report savings separately. If savings are reported together, the evaluation team will only evaluate savings for the reported category, and the remaining claimed savings will be unrealized.
  - Update fixture codes and associated wattages to match the standard wattage table from the 2020 Lighting Survey Form (LSF).
  - Ensure that documentation enables confirmation of fixture counts, such as by clearly indicating specific areas/rooms that were sampled during the inspection and ensure that photos are in focus and do not crop out key fixture information.
  - To best align savings assumptions with site activities, savings for multifamily residence patios should be calculated using savings methodologies specified for residential outdoor lighting.
  - Update savings coefficients (annual operating hours and coincidence factors) for all affected building types. Most building types were updated in a previous guidebook release, and there is a new “Other” building type that is applicable to all projects that do not fit one of the deemed building types.
- HVAC:
  - To best align savings assumptions with site activities we recommend using 24-hour Quick-Service Restaurant for 24-hour convenience stores, rather than using 24-hour Stand-Alone Retail. This is based on building type descriptions and examples related to food/drink sales, as described in the CPS Energy Guidebook.
  - For high performance tune-up measures, we recommend ensuring that a minimum of 10% of systems receive pre-testing. Only 3.9% of systems in CPS Energy’s FY 2021 program received pre-testing.
  - For high performance tune-up measures, we recommend modifying invoice requirements so that there is one invoice per project. The invoice should document each system that received a tune-up during the project. In FY 2021, there was an

average of 50 tune-ups per project, which makes individual system signature requirements cumbersome and adds cost to verification of system information.

- For the Schools and Institutions Program, to ensure consistency of savings methodology between program tracking estimates and evaluation results, we recommend updating to the latest Guidebook savings coefficients. Certain building types were significantly impacted by coefficient changes and make up a significant portion of claimed savings.
- Small Business
    - 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 perform field inspections. Specifically, contractors should provide a project-specific invoice including installed fixture counts and model numbers. Contractors are not expected to provide photos of all fixtures if a project-specific invoice can be used to verify project counts. If no project-specific invoice is provided, the evaluation team will attempt to verify reported fixture quantities via inspection or using contractor site photos. If the counts cannot be verified, savings will only be awarded for the number of unique fixtures evident in the site photos. Additional recommendations are included in a separate memo to program administrators.
    - For the Small Business Midstream projects, it is important to note that the *CPS Energy Guidebook* that will apply in FY 2022 dictates that 95% of claimed savings for general service lamps with an equivalent wattage less than or equal to 100 watts should be calculated using residential savings methodologies.
    - To assist with reporting participation, the evaluation team requests that CLEAResult add fixture/lamp count to the standard reporting fields for all midstream projects. This information is easily extracted from batch documentation for the desk review sample, but it is requested for the entire midstream project population moving forward.

6. DEMAND RESPONSE PROGRAMS

6.1 SUMMARY OF DEMAND RESPONSE IMPACTS

CPS Energy offered the following demand response programs in FY 2021:

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.

For benefit-cost calculations, our approach focuses only on the incremental impacts of new participants added in FY 2021, 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 8-1, estimated savings are reported from all active participants to most accurately represent actual program capability at the end of FY 2021. These savings are adjusted to account for net-to-gross ratios and distribution line losses.

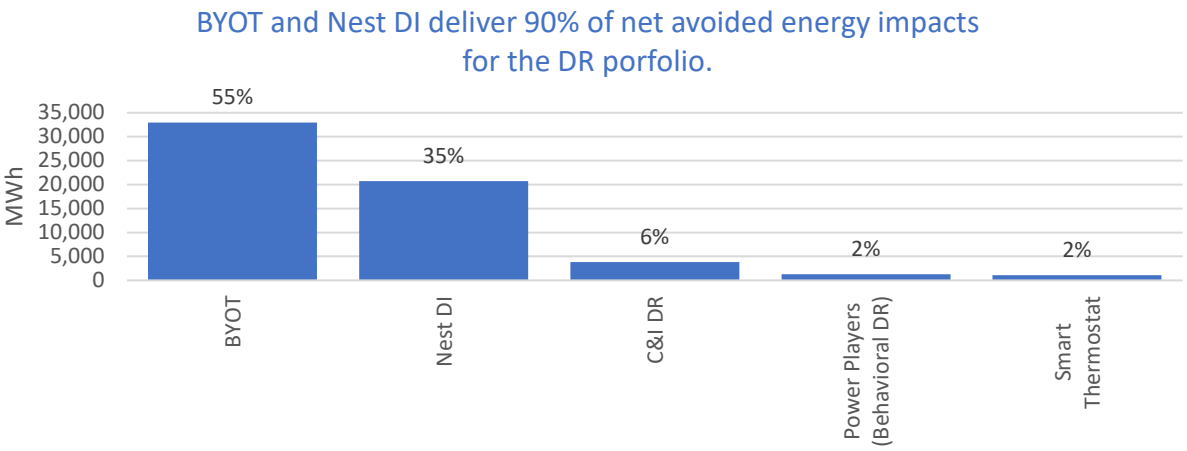


Figure 6-1: Summary of Demand Response Impacts – Energy (MWh) by Program

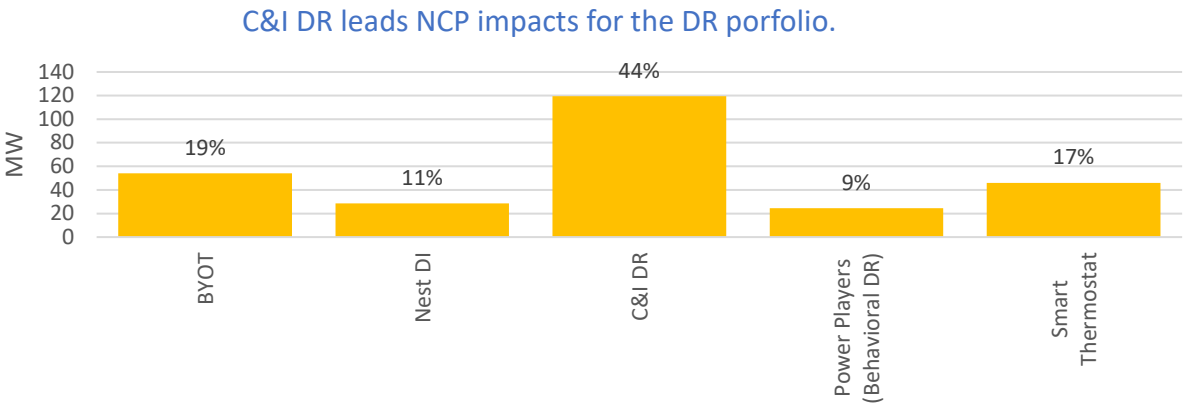


Figure 6-2: Summary of Demand Response Impacts – Non-Coincident Peak Demand (MW) by Program

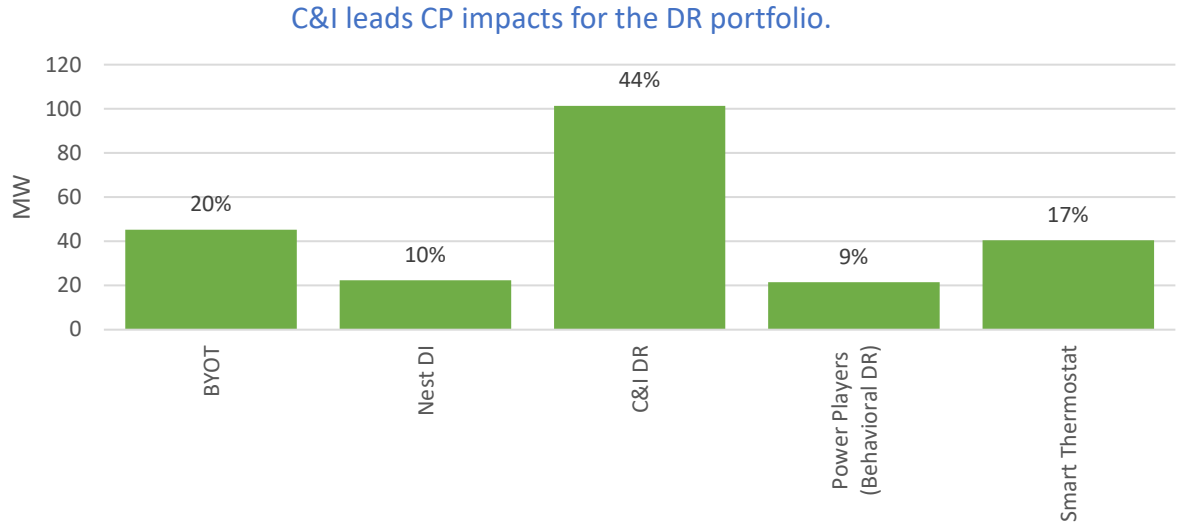


Figure 6-3: Summary of Demand Response Impacts – Coincident Peak Demand (MW) by Program

6.2 COMMERCIAL AND AUTO DEMAND RESPONSE PROGRAMS

6.2.1 Overview

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

Before FY 2019, the Commercial DR programs consisted of Options 1, 2, and 3, and 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. Table 6-1 summarizes these differences.

Table 6-1: Commercial DR Program Characteristics

Measure	Performance Period	Time Period	Event Days	Max Events	Total Hours Avail.	Advance Notice (hrs)
Option 1	Jul 1 - Aug 31	1300 - 1900	Weekdays	18	55	2
Option 2	Jun 1 – Sep 30	1300 - 1900	Weekdays	25	75	2
Option 3	Jun 1 – Sep 30	1300 - 1900	Weekdays	6	25	1
Option 4	Jun 1 – Sep 30	1300 - 1900	Weekdays	25	75	0.5
ADR.[19]	Jun 1 – Sep 30	24/7	All Days	N/A	50	0

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

6.2.2 Program Participation

As can be seen in the following figures, the total number of sponsors (i.e., participating entities) and participating sites increased in FY 2021, while contracted kW decreased. Compared with the previous year, the number of sponsors grew from 139 to 152,.[20] the number of sites went from 745 to 754, and contracted kW dropped from 103.2 MW to 96.3 MW.

[19] There is also a non-summer ADR program offering that runs for the rest of the year, but its impacts are not evaluated herein. Also, one ADR event was called on July 3rd, 2020, which was a federal holiday.
[20] A few sponsors with multiple sites took part in more than one program in both FY 2020 and FY 2021 and are therefore counted multiple times.

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

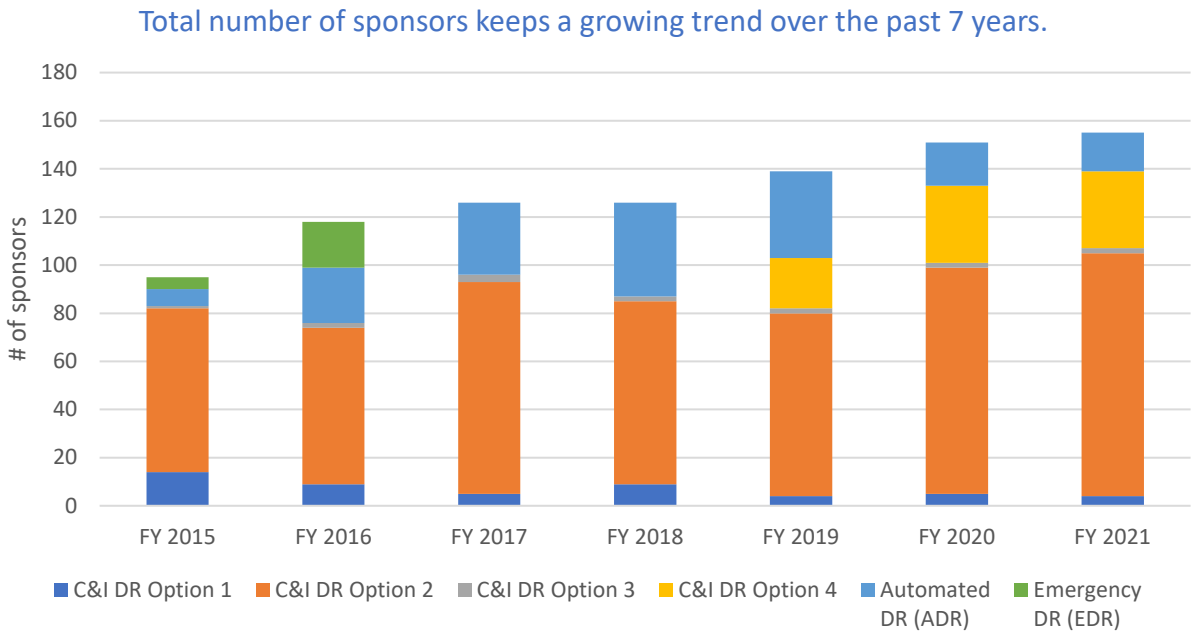


Figure 6-4: Commercial DR Sponsor Counts, FY 2015 – FY 2021

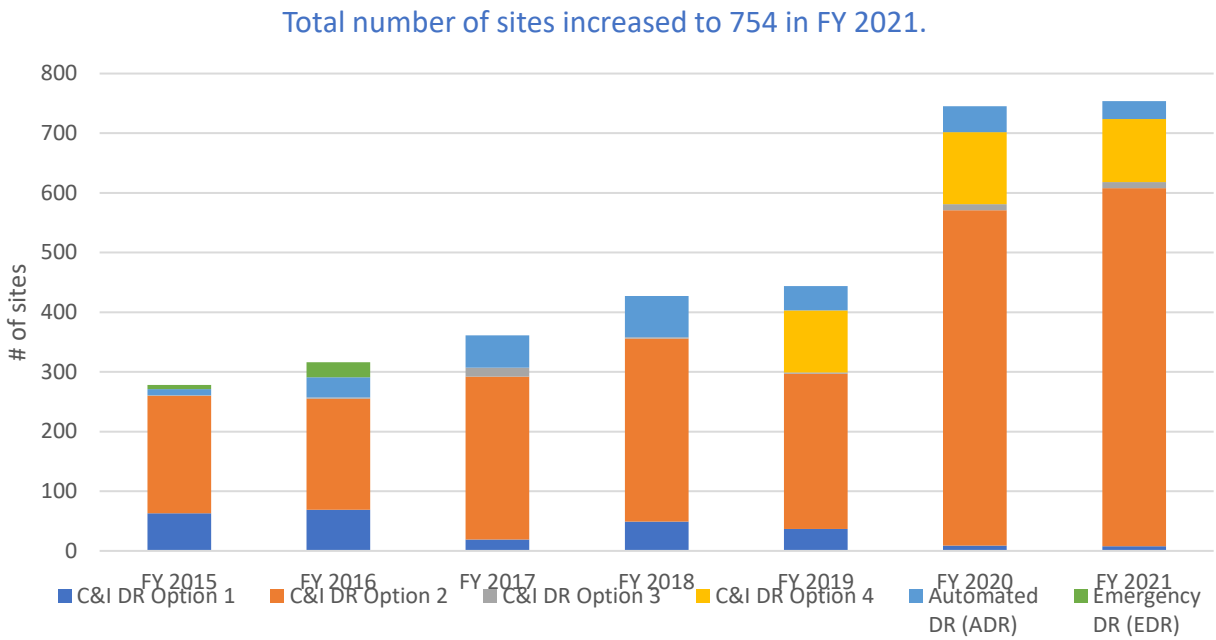


Figure 6-5: Commercial DR Site Counts, FY 2015 – FY 2021

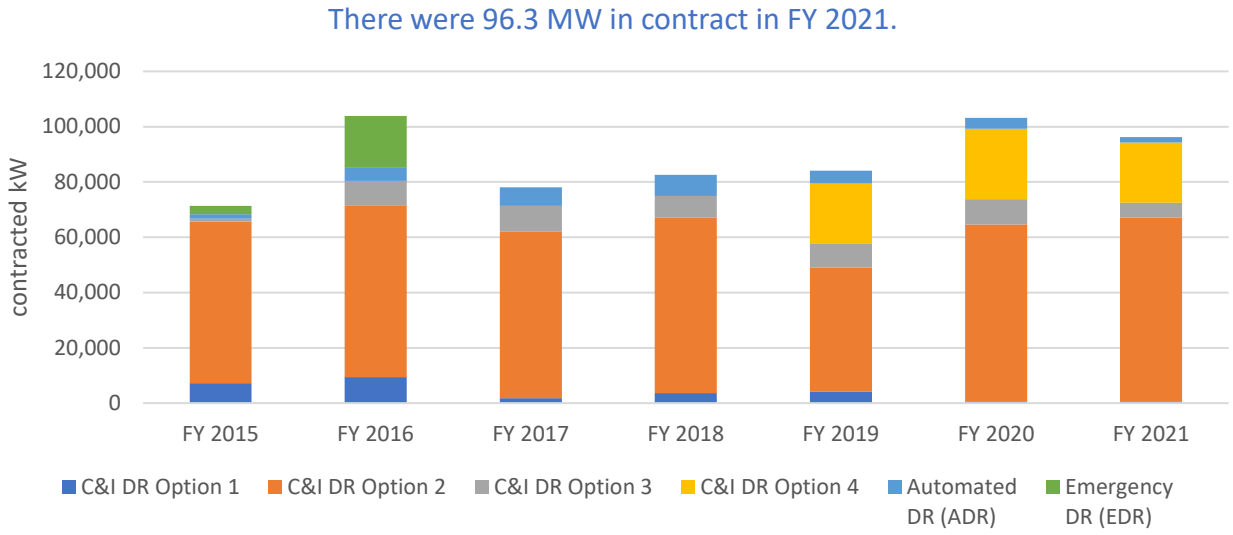


Figure 6-6: Commercial DR Contracted kW, FY 2015 – FY 2021

CPS Energy deployed its Commercial DR programs on 19 days in FY 2021. As can be seen in Table 6-2, Option 2, 4, and the ADR programs were called most frequently, while Option 3 was called only five times due to a limit on the maximum number of events that could be called under that program.

The four days highlighted in orange (June, July, and August 4CP days are highlighted in dark orange and the September 4CP day is highlighted in light orange) are 4CP days in FY 2021. On July 13th and August 13th, all the C&I DR programs hit the 4CP event. On June 8th, three of the C&I DR programs (option 2, 4 and ADR) hit the 4CP event. Two of the C&I DR programs (option 2 and option 4) called DR events on September 1st, which is also a 4CP day. However, the 4CP 15-minute interval on September 1st occurred unusually early—2:30 pm ~ 2:45 pm.[21] As a result, even though events were called for these two programs, neither of them hit the 4CP interval in September 2020.

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

Month	Jun		Jul						Aug									Sep		Total
Day	8	9	2	3	10	13	14	16	3	6	10	11	12	13	14	28	31	1	16	
Option 1			X		X	X			X	X	X	X	X	X	X	X	X			12
Option 2	X	X	X			X	X		X	X	X	X	X	X	X	X	X	X	X	16
Option 3			X			X								X	X	X				5
Option 4	X	X	X			X	X	X	X	X	X	X	X	X	X	X		X	X	16
ADR.[22]	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X			16

[21] All of the 4CP events occurred between 15:45 – 17:00 in the past 11 years (between 2009 and 2019). However, this pattern changed in summer 2020, with 4CP intervals as early as 14:15 – 14:30 (September 4CP) or as late as 17:30 – 17:45 (June 4CP). All the 4CP records can be found here: http://www.ercot.com/mktinfo/data_agg/4cp.

[22] Two separate events were called for the ADR program on August 26th, 15:45 – 17:30 and 18:15 – 19:00 respectively, in order to cover both the ERCOT peak and the CPS Energy peak. They were counted as one event in this table.

Table 6-3 tabulates the total number of events called as well as the number of events called for each program for the past 6 years.

Table 6-3: Commercial DR Total Number of Events called, FY 2016 – FY 2021

C&I DR Program/ Option	FY 2021	FY 2020	FY 2019	FY 2018	FY 2017	FY 2016
Option 1	12	11	14	12	11	10
Option 2	16	19	19	22	19	13
Option 3	5	6	6	6	6	6
Option 4	16	17	19	NA	NA	NA
ADR	16	16	19	19	18	13
EDR	NA	NA	NA	NA	NA	1
Total number of days that C&I DR program(s) occurred	19	22	22	23	21	17

The following figure compares the average event duration from FY 2016 to FY 2021. Event durations for all the programs are longer in FY 2021 compared with previous years. The average event duration for all C&I programs in FY 2021 was 2.46 hours.

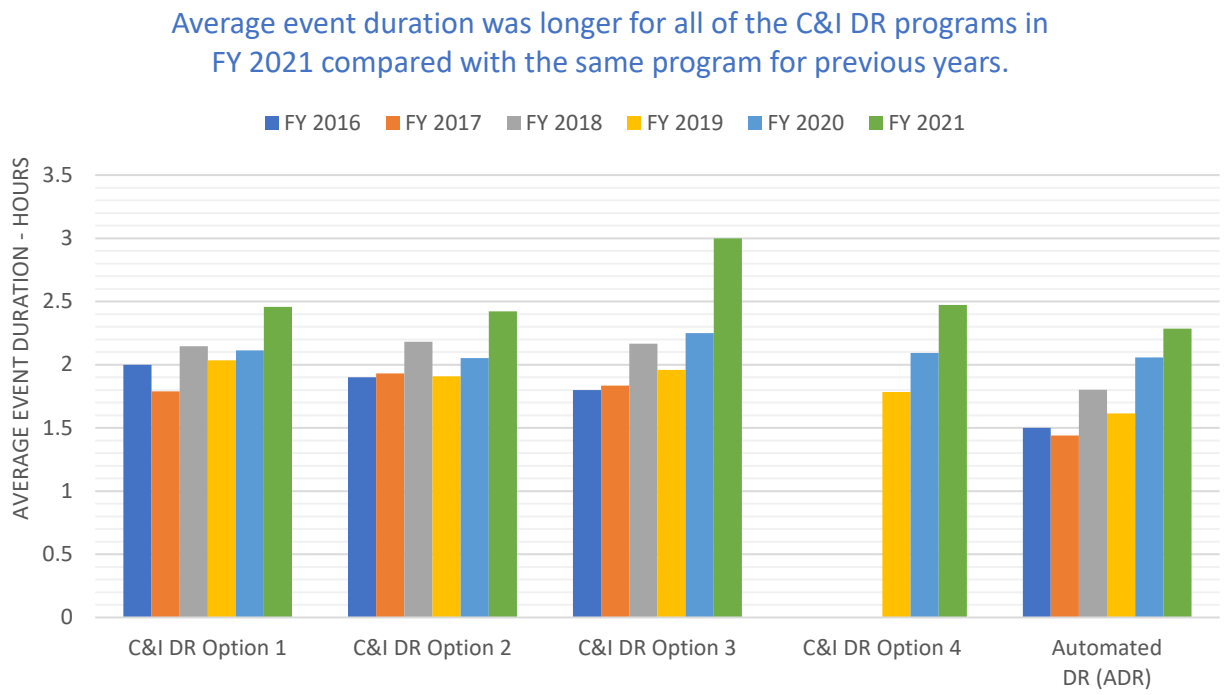


Figure 6-7: Commercial DR Average Event Duration, FY 2016 – FY 2021

6.2.3 Savings Calculation Methods

CPS Energy used the AutoGrid platform for M&V during the Summer 2020 DR season. Savings were generally based on three baseline estimation methods:

- High 3 of 10
- Middle 8 of 10
- Matching Day Pair.[23]

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 2021. 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.

[23] 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,[24] 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.[25] The method with the top ranking (lowest score) is selected.

6.2.3.1 Energy Savings (kWh)

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

6.2.3.2 Coincident Peak (CP) Demand Savings (kW)

To estimate coincident peak demand kW savings, Frontier estimated per event demand savings using "multiple-baselining" analysis for each customer. For each option/program, an average kW savings of all events in summer 2020 was then calculated. This is the number used to report achieved CP savings.

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

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

6.2.3.4 ERCOT 4CP Demand Savings (kW)

ERCOT 4CP demand savings obtained from the Commercial DR programs are directly estimated by evaluating the average load reductions delivered when each month's 4CP event occurred, multiplied by the 4CP success rate[26] for each program in FY 2021.

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

[25] 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 points. At the end of this process, for each method respectively, the RMSE, bias, and standard deviation score are added together.

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

6.2.4 Results

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

1) Estimated program impacts during summer 2020 DR events.

2) End-of-year (EOY) program capability based on program enrollment at the end of FY 2021; this information is useful for planning purposes.

3) End-of-year (EOY) program capability based on incremental enrollment during FY 2021; 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.

6.2.4.1 Estimated Impacts During Summer 2020 DR Events

During summer 2020, C&I DR events were called on 19 days. The aggregated kW savings estimates are shown in the following figure.

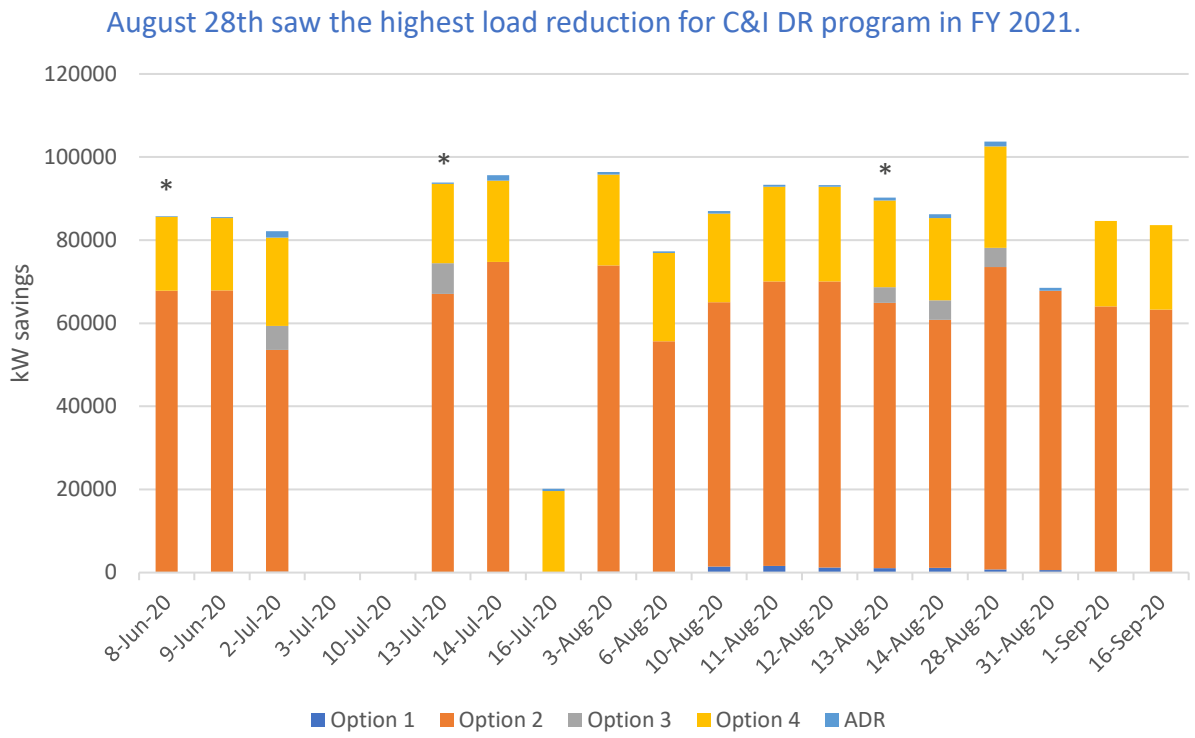

Figure 6-8: Commercial DR Delivered Demand Savings, Summer 2020

Figure Notes: Events coinciding with ERCOT 4CP intervals are designated with an asterisk (*).
On July 3 only option 1 was called and on July 10 only ADR was called, returning very small savings.

Maximum total demand reduction was achieved on August 28th. The total demand reduction on this day, from all C&I DR programs, was 103.7 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 Figure 6-9 to Figure 6-13.

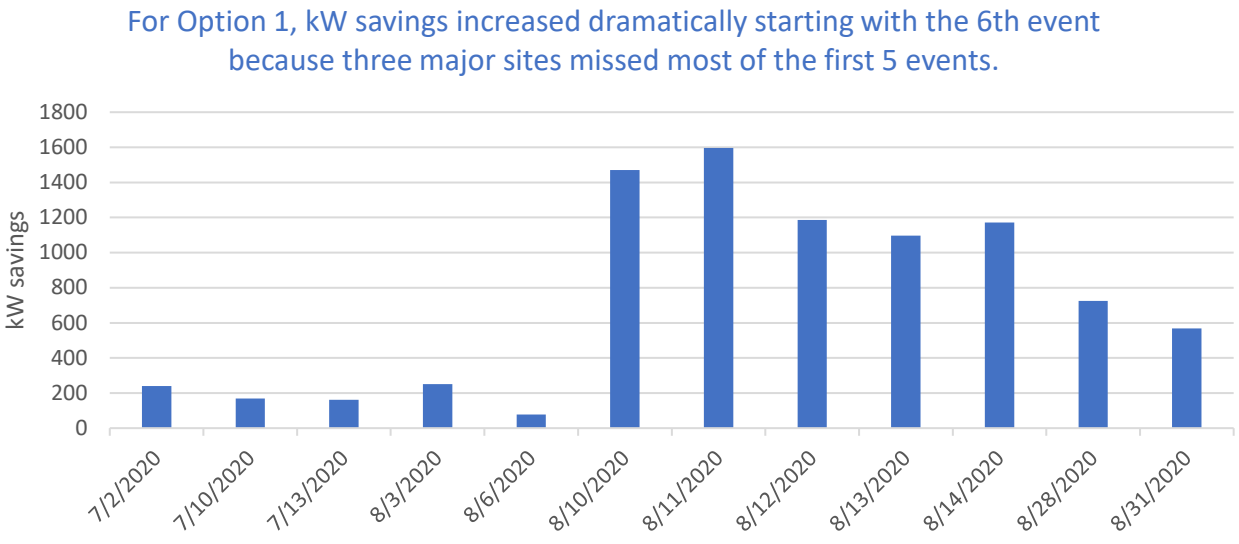

Figure 6-9: Commercial DR Option 1 Demand Savings by Event

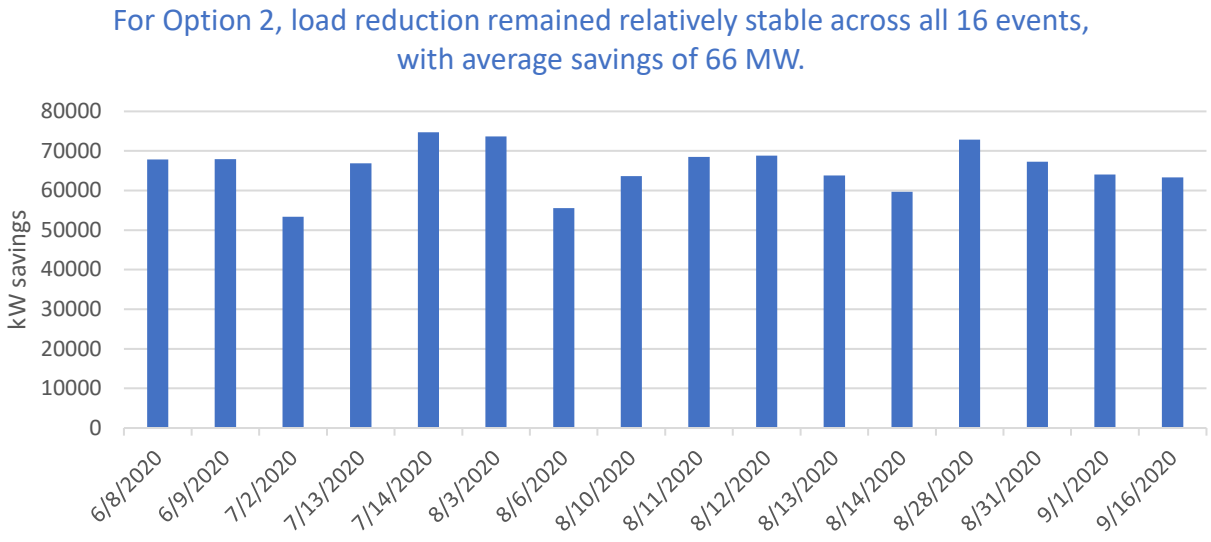

Figure 6-10: Commercial DR Option 2 Demand Savings by Event

For Option 3, average load reduction in summer 2020 was 5.2 MW.

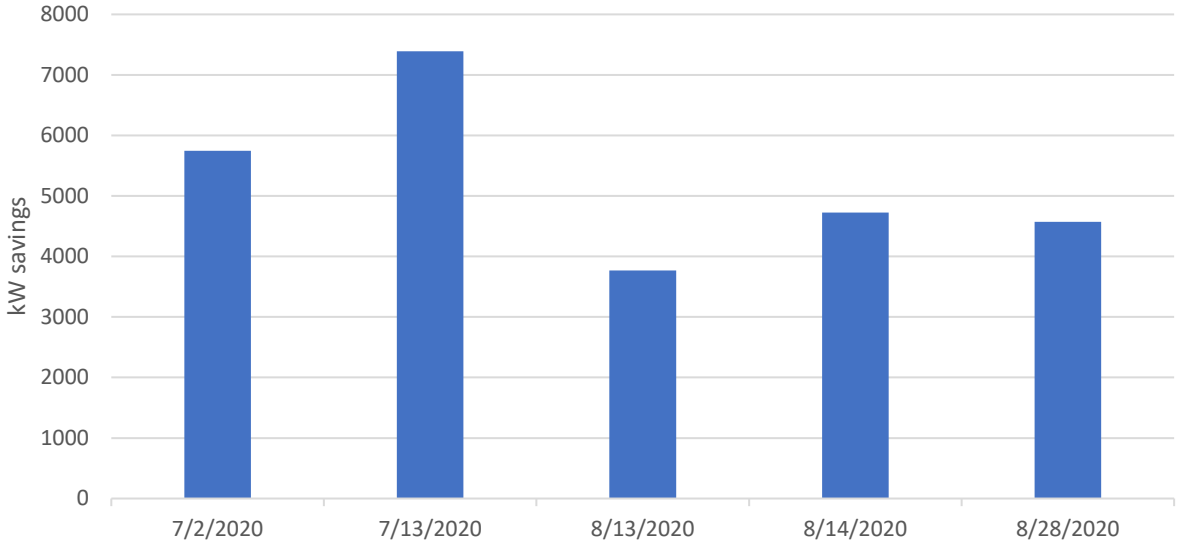

Figure 6-11: Commercial DR Option 3 Demand Savings by Event

For option 4, load reduction remained relatively stable across all 16 events, with average savings of 20.7 MW.

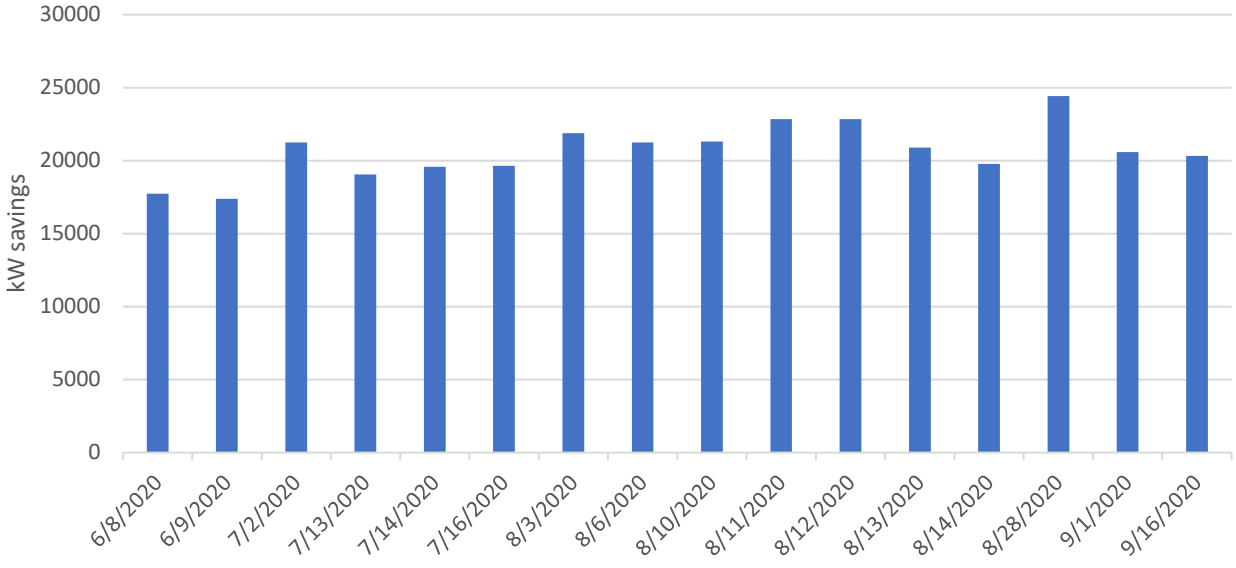

Figure 6-12: Commercial DR Option 4 Demand Savings by Event

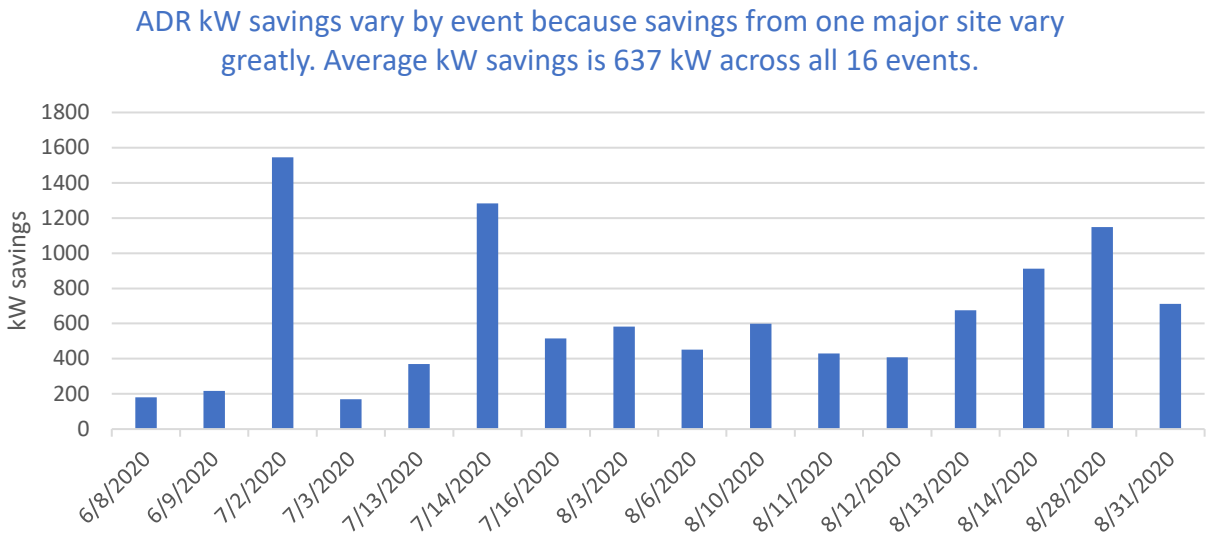

Figure 6-13: Commercial DR Automated DR Demand Savings by Event

A comparison of the estimated impacts from FY 2016 to FY 2021 is shown below:

Table 6-4: Commercial DR Estimated Achieved kW Impacts Comparison, FY 2016 – FY 2021

C&I DR Program/ Option	FY 2021 Average Savings (kW)	FY 2020 Average Savings (kW)	FY 2019 Average Savings (kW)	FY 2018 Average Savings (kW)	FY 2017 Average Savings (kW)	FY 2016 Average Savings (kW)
Option 1	726	964	3,900	5,373	994	11,441
Option 2	65,746	57,302	43,216	56,103	66,010	67,317
Option 3	5,240	5,016	4,998	4,265	7,860	6,609
Option 4	20,671	22,877	20,647	NA	NA	NA
ADR	637	2,510	3,662	7,239	5,684	3,707
EDR	NA	NA	NA	NA	NA	17,903
Total	93,020	88,669	76,423	72,980	80,548	106,977

Rows may not sum to total due to rounding.

FY 2021 Delivered Savings

The following table presents the estimates of savings delivered by the Commercial DR programs for FY 2021.

Table 6-5: Commercial DR Gross Energy and Demand Savings – FY 2021 Delivered

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Option 1	21,737	726	1,596	314
Option 2	2,545,596	65,746	74,757	49,638
Option 3	77,095	5,240	7,391	2,789
Option 4	818,562	20,671	24,416	14,422
Automated DR	24,281	637	1,545	306
Total	3,487,271	93,020	109,705	67,470

Rows may not sum to total due to rounding.

6.2.4.2 End-of-year Program Capability

Unlike residential DR programs which see recurring annual participation, most C&I DR programs are short and contract-based, lasting only 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 2020 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 six fiscal years to estimate end-of-year program capability for ERCOT 4CP demand savings.

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

Measure	Success Rate							Average Success Rate	Achieved FY 2021 ERCOT 4CP Demand Savings (kW)	EOY FY 2021 ERCOT 4CP Demand Savings (kW)
	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021			
Option 1	25%	50%	50%	25%	50%	25%	50%	39%	314	247
Option 2	75%	75%	100%	75%	100%	75%	75%	82%	49,638	54,366
Option 3	50%	75%	25%	75%	50%	50%	50%	54%	2,789	2,988
Option 4	NA	NA	NA	NA	100%	100%	75%	92%	14,422	17,627
Automated DR	75%	100%	100%	100%	100%	100%	75%	93%	306	379
								Total	67,470	75,608

Rows may not sum to total due to rounding.

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

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

Measure	Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	ERCOT 4CP Demand Savings (kW)
Option 1	21,737	726	1,596	247
Option 2	2,545,596	65,746	74,757	54,366
Option 3	77,095	5,240	7,391	2,988
Option 4	818,562	20,671	24,416	17,627
Automated DR	24,281	637	1,545	379
Total	3,487,271	93,020	109,705	75,608

Rows may not sum to total due to rounding.

6.2.4.3 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 2021. As such, the analysis of incremental impacts of these programs is no different from the analysis of total impacts.

6.3 SMART THERMOSTAT PROGRAM

6.3.1 Overview

The Smart Thermostat direct load control program has been available to residential sector participants in single-family homes since 2003. It was expanded to include multifamily and small commercial customers in 2010. Through the program, Honeywell installs a programmable, controllable thermostat (PCT) at a participant's home or place of business at no cost to the customer. In return, CPS Energy is permitted to remotely control 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 (during which units are cycled off for 10 minutes during each half hour) or a 50% cycling rate (during which units are cycled off for 15 minutes during each half hour). Customers can choose either a pager-style thermostat or a WiFi-enabled thermostat. Pager thermostats are available on either a 33% or 50% cycling rate, while WiFi Thermostats are only available for a 50% cycling rate.

In FY 2018, a small portion of single family WiFi-enabled thermostats were selected as a pilot trial for a new 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 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."

6.3.2 Program Participation

The following figure shows overall participation in the Smart Thermostat program at the beginning and end of FY 2021 and at the time of DR events from June through September 2020.

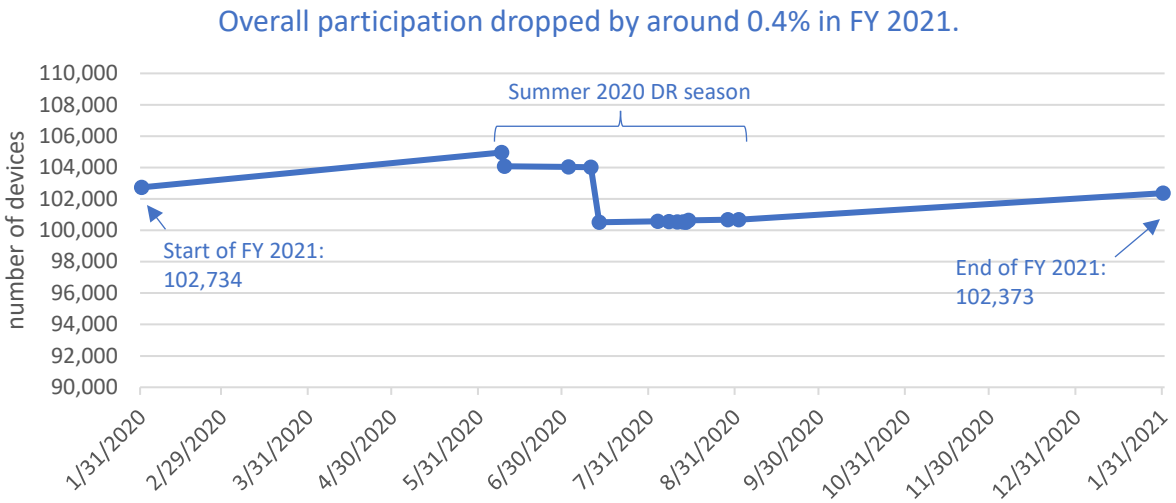

Figure 6-14: Smart Thermostat Participation Trend (FY 2021) – Total Thermostat Count[27]

There is a slight overall participation drop by the end of FY 2021 compared with the start of FY 2021 (~0.4%). This is because there were very few newly installed devices throughout FY 2021 due to COVID-19 pandemic. As COVID-19 cases surged across United States and locally, all indoor installations were paused. The slight drop between the start of FY 2021 and end of FY 2021 therefore generally reflected the natural decay of the program. However, as can be seen from the figure above there was a participation drop in the middle of the DR season. This was mainly caused by the decrease of participating traditional cycling thermostats.

Figure 6-15 shows participation trends by customer dwelling type over the past eight years. Device numbers stayed almost the same by the end of FY 2021 compared with the end of FY 2020, with only a slight drop in the residential sector (from 99,426 devices to 99,051 devices, as shown in Figure 6-15). Also, similar to the pattern in previous years, the majority of participating thermostats in the Smart Thermostat program are in the residential sector, with commercial sector comprising around 3% of total devices.

[27] The sudden drop of ~3,500 devices from 7/10/2020 to 7/13/2020 is due to a few Multifamily properties coming off the Smart Thermostat program. Note that the drop of 3,500 traditional cycling thermostats only led to about 1 MW decrease in savings.

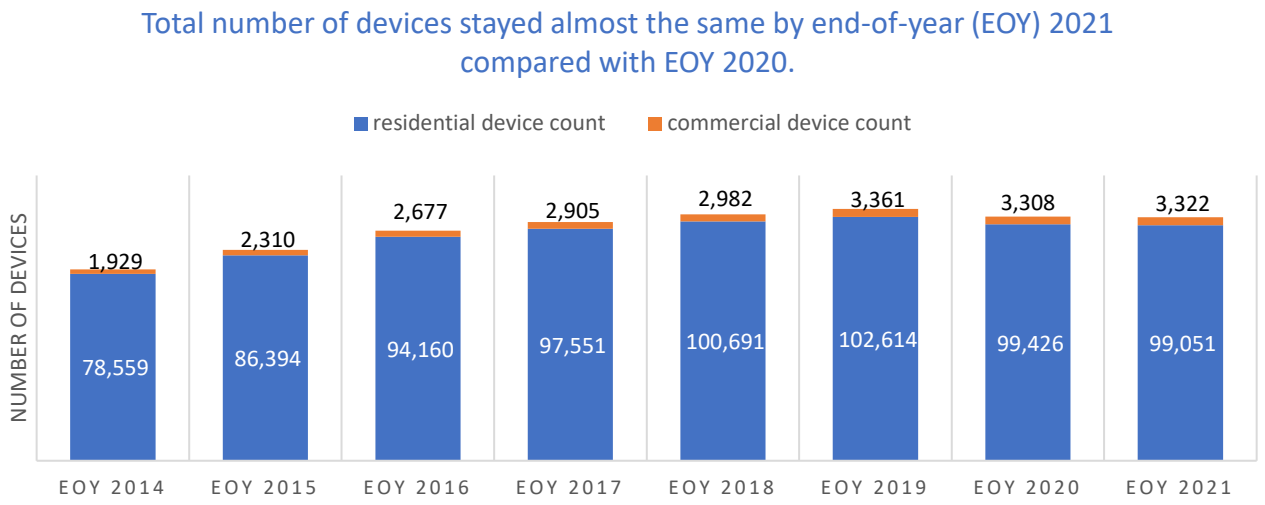

Figure 6-15: Smart Thermostat Participation Trends (FY 2014-FY 2021) by Segment

Figure 6-16 shows the participation share by thermostat type (pager or WiFi) from FY 2017 to FY 2021. The percentage of WiFi thermostats increased slightly from 8.5% to 11.9% for the past five fiscal years.

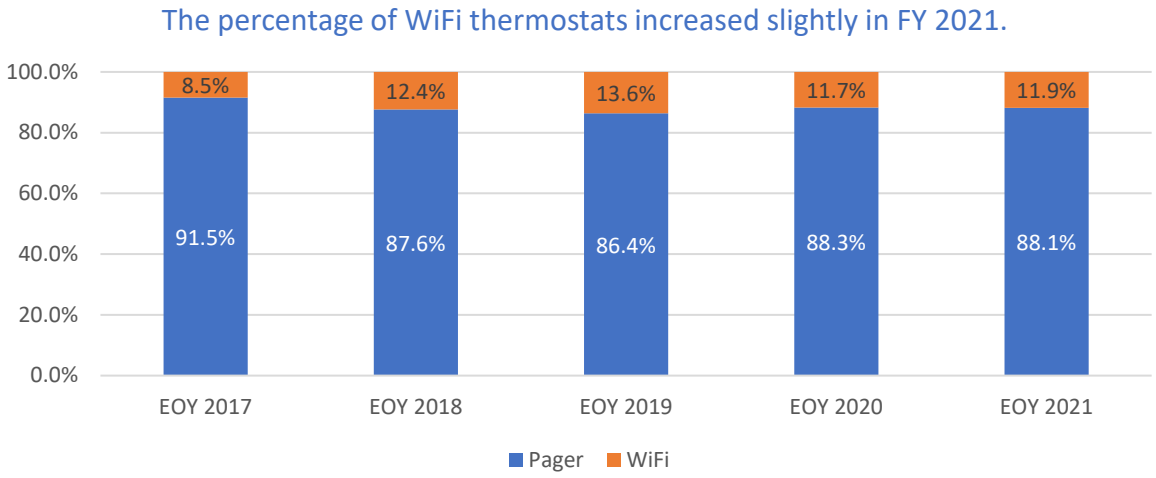

Figure 6-16: Smart Thermostat Participation Share (FY 2017 through FY 2021) by Thermostat Type

Figure 6-17 shows the breakdown by segment of all newly installed devices in FY 2021. Due to the COVID-19 pandemic, all indoor installations were paused after mid-March in 2020. As a result, there were only 81 newly installed thermostats in total during FY 2021. All of these devices are WiFi thermostats, with 36 installed in residential dwellings and 45 installed in commercial dwellings (shown as pie chart in Figure 6-17). In comparison, there were 1,142 newly installed thermostats in FY 2020, so the installation pause due to the pandemic is the main reason for the drastic drop.

There were only 81 newly installed thermostats in FY 2021 due to COVID-19, and all of them are WiFi thermostats.

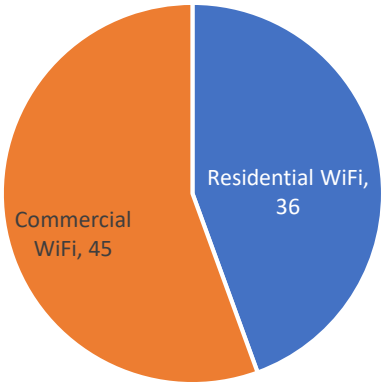

Figure 6-17: Smart Thermostat Breakdown by Thermostat Type – FY 2021 New Installs

Table 6-8 summarizes end of FY 2021 participation levels by customer segment and cycling strategy.

Table 6-8: Smart Thermostat Program Participation by Group, End of FY 2021

Thermostat Type	Dwelling Type	Cycling/Temperature Setback Strategy	Device Count Number
Pager	Residential	33%	78,510
		50%	9,465
	Commercial	33%	2,238
		50%	3.[28]
WiFi	Residential	Resideo	11,076
	Commercial	Resideo	1,081
		Total	102,373

[28] There were three AMI accounts in the commercial 50% cycling category in summer 2020. This number is therefore used as an estimate for the end of FY 2021 device count for this category.

Smart thermostats are run on two different kinds of platforms, and event schedules also differ slightly in FY 2021. Table 6-9 summarizes the total number of events called and average event duration of traditional Smart Thermostat cycling and the Resideo platform:

Table 6-9: Smart Thermostat - Traditional Cycling vs Resideo Platform: Number of Events and Average Duration

	Traditional Cycling	Resideo Platform
Total Number of Events Called	17	13
Average Event Duration	2.00 hours	2.10 hours

6.3.3 Savings Calculation Methods

6.3.3.1 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 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[29] have shown that residential load profiles may have changed due to the COVID-19 pandemic beginning in 2020, as more people tended to stay at home. Given that the pre-pandemic data (temperature bins developed in FY 2017 and 2018) certainly cannot cover this issue, we used the actual interval consumption data to estimate kW and kWh savings instead of applying the pre-pandemic temperature bins in FY 2021.

There were two separate data sources of FY 2021 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 a 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.[30]
- 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.

[29] Example studies regarding possible changes of residential load profiles due to COVID-19 include but 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.

[30] Resideo platform hosted thermostats from both Smart Thermostat and BYOT programs in summer 2020. So, savings results generated from "Resideo" category on CPS residential DR dashboard not only apply to residential WiFi thermostats from Smart Thermostat program but also the thermostats on residential Resideo platform from BYOT program as well.

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[31] 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,[32] 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 - $\beta_2 - \beta_3$ * 2 hours.

[31] For 6/8/2020 and 6/9/2020 events on residential DR dashboard, there were only 5 previous eligible days (6/1/2020, 6/2/2020, 6/3/2020, 6/4/2020 and 6/5/2020) due to the fact that the available interval data started from 6/1/2020.

[32] *Precool* dummy variable only existed in the regression model for Resideo platform WiFi thermostats. There was no obvious precooling consumption pattern for traditional cycling thermostats and this dummy variable was therefore not included.

(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 test period and select the results generated by the methodology that has the lower RMSE. Here, "test period" consists of four separate periods: 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 6/8/2020 4:00 - 6:00 pm, and the "top previous 3 days" are 6/3/2020, 6/4/2020 and 6/5/2020. The test period would therefore be: 6/3/2020 4:00 - 6:00 pm, 6/4/2020 4:00 - 6:00 pm, 6/5/2020 4:00 - 6:00 pm and 6/8/2020 10:00 - 2:00 pm combined.

Take residential WiFi customers on Resideo platform during the 8/10/2020 15:15 – 17:15 event as an example. Table 6-10 shows the savings estimate using the two methodologies – regression and CPS Energy high 3-of-10 baseline analysis:

Table 6-10: 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	RMSE
Regression	1.18	0.21	0.36	1.43	0.2261
High 3-of-10	1.28	0.27	0.27	1.75	0.0699

As shown, the RMSE of "high 3-of-10" methodology is obviously lower than that of regression methodology (0.0699 vs 0.2261), 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 1.28 kW and 1.75 kWh.

Figure 6-18 shows the residential Resideo event day versus baseline load profile on 8/10/2020 event day:

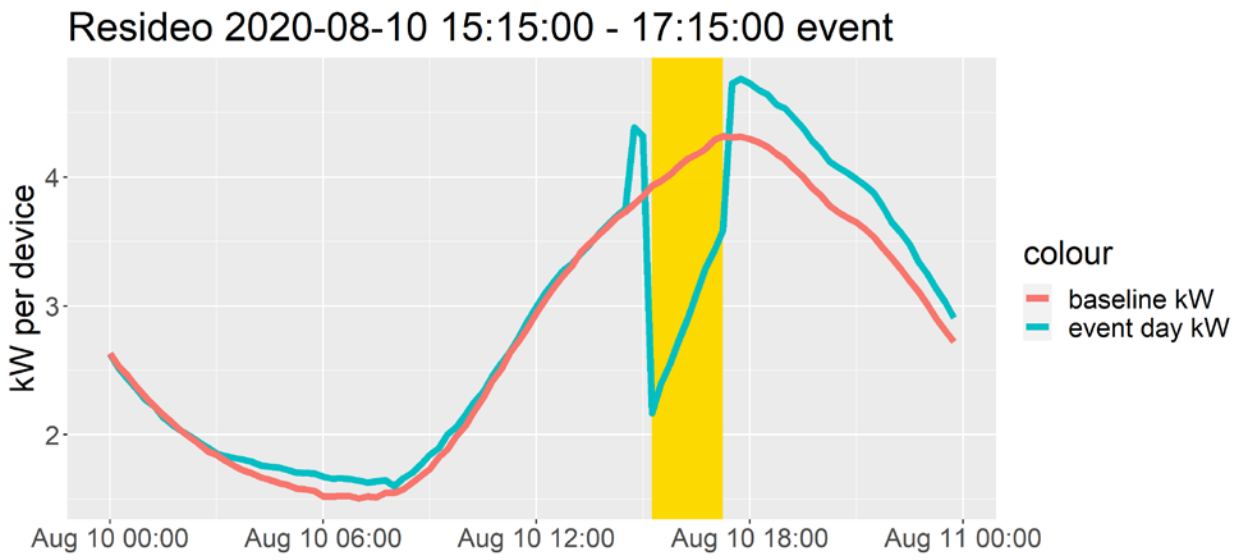

Figure 6-18: Smart Thermostat - example Resideo per device load profile vs baseline profile – 8/10/2020 event

Other categories and events are calculated in a similar manner.

6.3.3.2 Coincident Peak (CP) Demand Savings (kW)

To estimate coincident peak demand kW savings, we estimated total demand savings using the per device kW savings multiplied by the total number of devices by category for each event. Average kW savings across high temperature events [33] in summer 2020 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 2021 and to the number of new thermostats installed in FY 2021, respectively.

6.3.3.3 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 2021 events. In summer 2020, all residential DR programs reached maximum program level demand reduction during the 7/2/2020 event, so the kW savings value from 7/2/2020 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 2021.

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

6.3.3.4 ERCOT 4CP Demand Savings (kW)

During summer 2020, both traditional cycling and WiFi thermostats on the Resideo platform hit three of the four ERCOT 4CP events, with a success rate of 75% program-wide.[34] To estimate ERCOT 4CP demand savings, we estimated the total demand savings for each event, selected the three events which coincided with ERCOT 4CP, and multiplied the result by the ERCOT 4CP success rate, which is 75%. For the year-end capability and incremental calculations, we scaled the result to the number of thermostats at the end of FY 2021 and to the number of newly installed thermostats throughout FY 2021.

6.3.4 Results

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

1) Estimated per device kW and kWh savings during summer 2020 DR events.
2) Estimated program impacts during summer 2020 DR events.
3) End-of-year program capability based on program enrollment at the end of FY 2021; this information is useful for planning purposes.
4) End-of-year program capability based on incremental enrollment during FY 2021; this information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

6.3.4.1 Estimated per device kW and kWh savings during summer 2020 DR events

The table below summarizes average per device kW and kWh savings for each category across all summer 2020 DR events:

Table 6-11: Smart Thermostat - Average per Device kW and Net kWh Savings during Summer 2020 DR Events

Thermostat Type	Dwelling Type	Cycling/Temperature Setback Strategy	Average kW savings per device	Average net kWh savings per device per event
Pager	Residential	33%	0.20	0.37
		50%	0.45	0.78
	Commercial	33%	0.44	0.90
		50%	0.51	0.38
WiFi	Residential	Resideo	**1.30**	2.28
	Commercial	Resideo	0.55	0.56

[34] It is noted that although DR event was called on September 4CP day (9/1/2020), neither traditional cycling thermostats nor WiFi thermostats on Resideo platform hit the 4CP interval because this interval occurred very early in the afternoon (14:15 – 14:30).

6.3.4.2 Estimated Impacts During Summer 2020 DR Events

During summer 2020, there were 17 events called for thermostats with traditional cycling and 13 events called for WiFi thermostats on the Resideo platform. Both traditional cycling and Resideo WiFi thermostats hit three of the four ERCOT 4CP events, with a success rate of 75% program-wide. These demand reduction estimates are shown in Figure 6-19.[35] For summer 2020, total kW reduction ranged from 4,309 kW (9/15/2020) to 45,437 kW (8/28/2020).

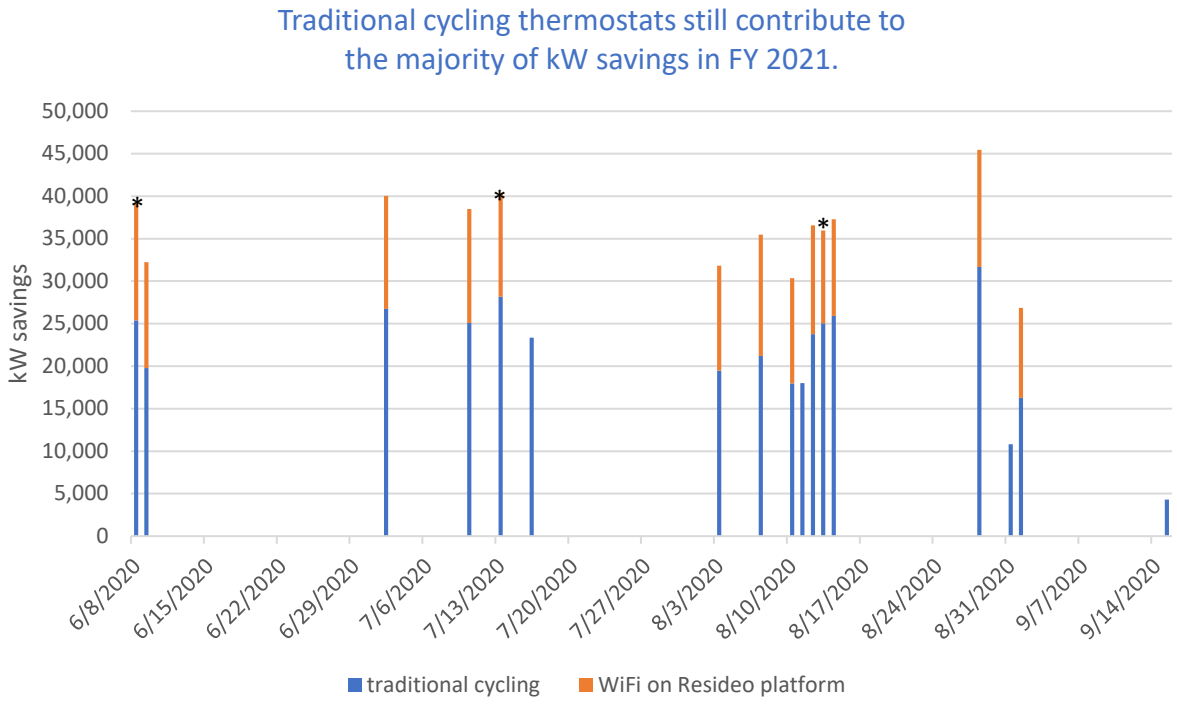

Figure 6-19: Smart Thermostat – Achieved Demand Reduction during Summer 2020 Events

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 2021. 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 7/2/2020, which is the day when maximum demand savings of all residential DR programs occurred among all FY 2021 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.

[35] For traditional cycling thermostats during 9/1/2020 16:00 – 18:41 event, interval consumption data showed that the actual event did not start until 17:15. Therefore actual event duration (17:15 – 18:41) savings estimate for traditional cycling thermostats is used in the figure instead of scheduled event period (16:00 – 18:41) for this event.

Table 6-12: Smart Thermostat Gross Energy and Demand Savings – FY 2021 Delivered

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Traditional Cycling	666,083	22,413	26,726	19,656
Resideo Cycling	282,043	12,593	13,307	9,251
Total	948,126	35,006	40,033	28,907

6.3.4.3 End-of-year Program Capability

End-of-year program capability is based on end-of-year enrollment. Table 6-13 shows the end of FY 2021 program capability values.

Table 6-13: Smart Thermostat Gross Energy and Demand Savings – End-of-year Capability

Measure	Device Count	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Traditional Cycling	90,216	658,636	22,162	26,427	19,436
Resideo Cycling	12,157	335,572	14,983	15,833	11,007
Total	102,373	994,208	37,145	42,260	30,443

6.3.4.4 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 6-14: Smart Thermostat Gross Energy and Demand Savings – Incremental Impacts

Measure	Device Count	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Traditional Cycling	0	0	0	0	0
Resideo Cycling	81	1,394	72	87	52
Total	81	1,394	72	87	52

6.4 BRING YOUR OWN THERMOSTAT (BYOT) PROGRAM

6.4.1 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.[36]

Starting in FY 2016, CPS Energy began incorporating existing Nest RHR customers into a more broadly-defined BYOT program,[37] 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.

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 all year round.

To summarize, the FY 2021 BYOT program included several types of thermostats that operate as follows:

- Google Nest BYOT thermostats run on the Google Nest platform;
- Honeywell BYOT WiFi thermostats and Emerson thermostats run on the Resideo platform;
- ecobee thermostats run on 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.

In FY 2021, CPS Energy passed these savings on to the customer via an $85 one-time bill credit upon enrollment in the program. The customer also received a $30 bill credit at the end of the summer for participating in the program.

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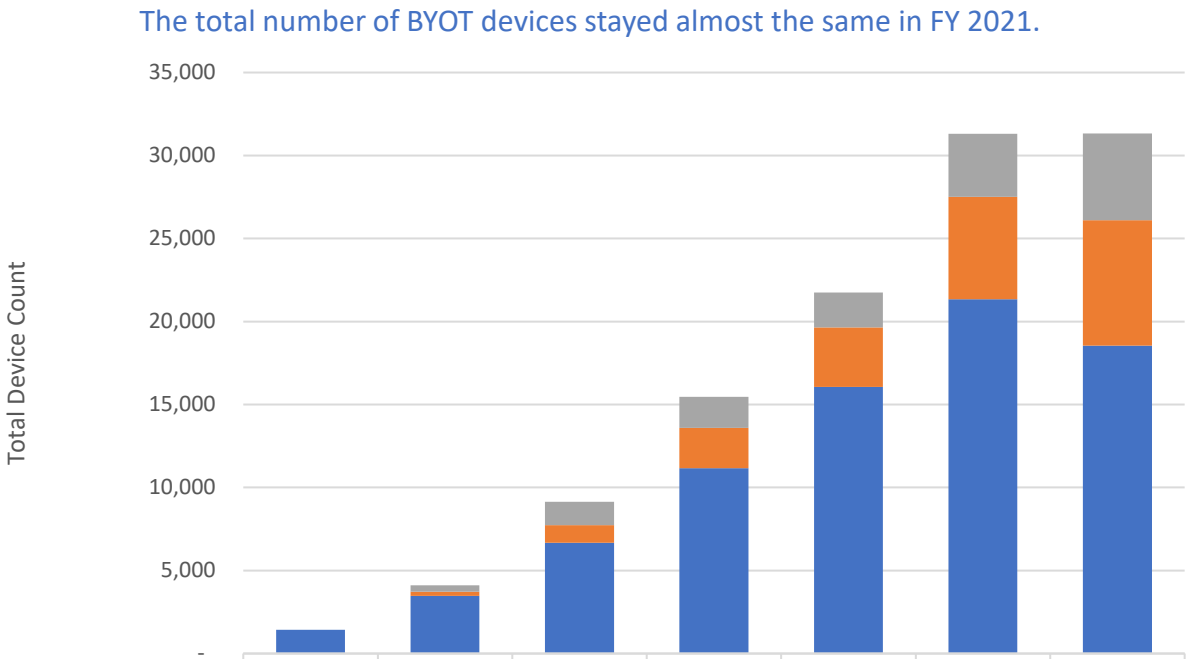
[36] Google Nest Support. *Learn more about Rush Hour Rewards.* Online. Available: https://support.google.com/googlenest/answer/9244031?hl=en.
[37] CPS Energy has marketed this program as the My Thermostat Rewards program, and most recently, WiFi Thermostat Rewards: https://cpsenergy.com/wifithermostatrewards.

6.4.2 Program Participation

6.4.2.1 BYOT Program Level Overall Participation Trends

Figure 6-20 shows the number of enrolled BYOT devices by thermostat brand from FY 2015 to FY 2021.



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

Figure 6-20: Bring Your Own Thermostat – Participation Trend (FY 2015 – FY 2021)

As can be seen in Figure 6-20, unlike the rapid growth trend from FY 2015 to FY 2020, the total number of BYOT devices stayed almost the same in FY 2021 (total devices of 31,315 by end of FY 2020 vs 31,333 by end of FY 2021). This stalling in grow is mainly due to account cleaning for Google Nest thermostats in November 2020. Specifically, account cleaning applies to thermostats which lost WiFi connection, accounts showing zero devices, and disconnected thermostats due to customer account closures. Nevertheless, as also shown in Figure 6-20, counts of thermostats on both the Resideo and EnergyHub platforms continued to grow in FY 2021. Figure 6-21 further breaks down end of FY 2021 participating BYOT thermostat counts by category. Residential thermostats account for 99% of the total end of FY 2021 BYOT thermostats.

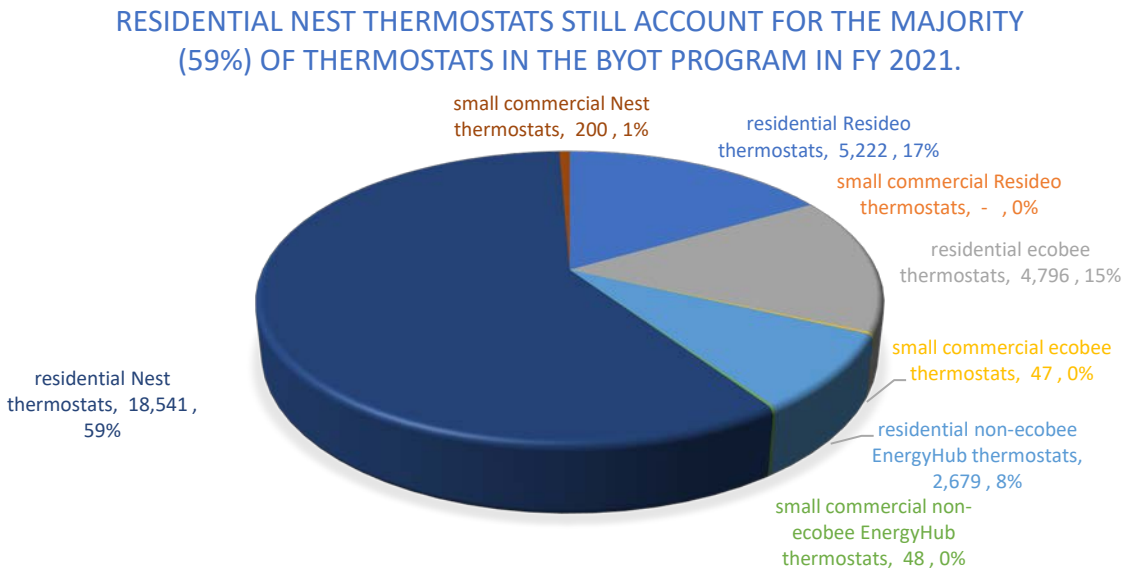


Figure 6-21: BYOT EOY 2021 Participating Thermostats by Category

The pie chart in Figure 6-22 shows incremental BYOT thermostat counts in FY 2021.

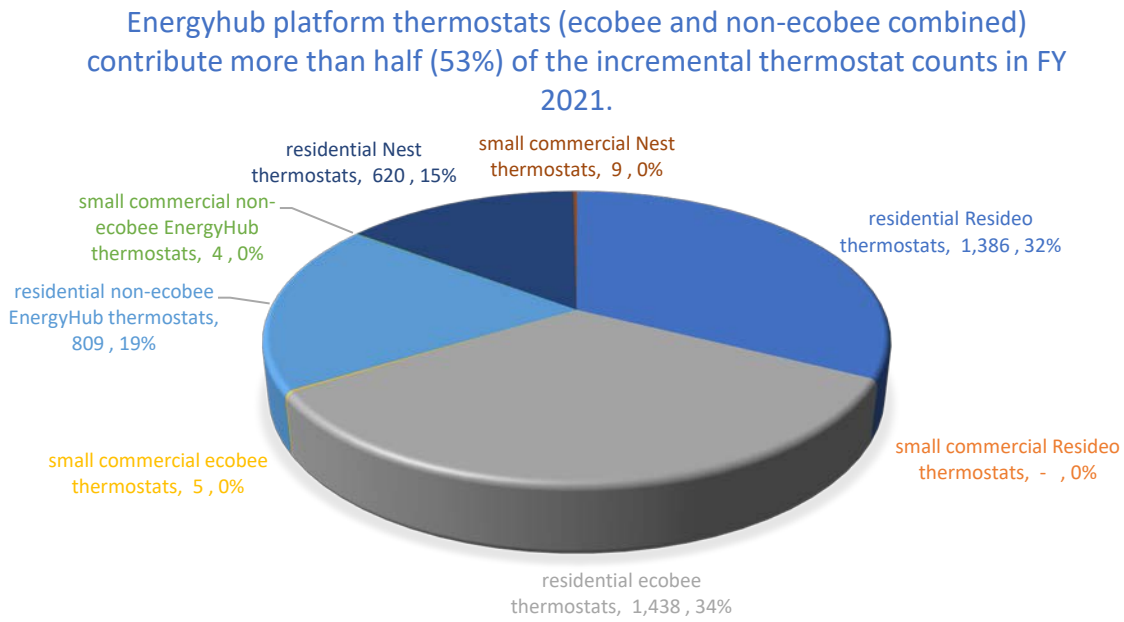


Figure 6-22: BYOT Incremental Participating Thermostats by Category – FY 2021

6.4.3 Savings Calculation Method

6.4.3.1 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 BYOT WiFi thermostats on the Resideo platform, Emerson BYOT thermostats on the Resideo platform, and 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 Smart Thermostat program section 6.3.3.1, BYOT program kW and kWh savings were estimated using actual interval consumption data from summer 2020 instead of applying pre-pandemic TTM and temperature bins.

Similar to the Smart Thermostat program, there were also two separate sources of FY 2021 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,[38] residential/small commercial Google Nest thermostats, and residential/small commercial thermostats on the Resideo platform.[39]

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 6.3.3 in 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 all year round, so deemed annual savings of 1,274[40] kWh per thermostat were applied for these two brands of thermostats.

6.4.3.2 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

[38] In FY 2021, residential ecobee thermostats and residential non-ecobee thermostats on EnergyHub platform were combined together to conduct the kW savings analysis, due to the fact there were only around 20 ecobee thermostats on residential DR dashboard in summer 2020. Savings estimate with a sample size of 20 might not be able to provide sufficient confidence. kW savings for residential ecobee thermostats can be estimated within its own category once there are sufficient number of devices available on the residential DR dashboard and those devices can adequately represent the whole population of residential ecobee BYOT thermostats.

[39] Resideo platform hosted thermostats from both Smart Thermostat and BYOT programs in summer 2020. So, savings results generated from "Resideo" category on CPS residential DR dashboard not only apply to residential WiFi thermostats from Smart Thermostat program but also the residential thermostats on Resideo platform from BYOT program as well.

[40] Deemed annual savings of 1,274 kWh per thermostat is from <CPS Energy Technical Guidebook for Energy Efficiency and Demand Response> - section 5.7 - Smart Thermostats.

the EOY customer count and newly installed customer count yield EOY and incremental CP demand savings.

6.4.3.3 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 2021 events. In summer 2020, all residential DR programs reached maximum program level demand reduction during the 7/2/2020 event, so the kW savings on 7/2/2020 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.

6.4.3.4 ERCOT 4CP Demand Savings (kW)

In summer 2020, thermostats on the Resideo and Google Nest platforms successfully hit three of the four 4CP intervals, with a success rate of 75%. Thermostats on EnergyHub platform hit two of the four, with a success rate of 50%.[41] 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 2021 and to the number of newly installed devices added during FY 2021, respectively.

6.4.4 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 2020.
2) Estimated program impacts during summer 2020 DR events.
3) End-of-year program capability based on program enrollment at the end of FY 2021.
4) End-of-year program capability based on incremental enrollment during FY 2021. This information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

[41] It is noted that although DR event was called on September 4CP day (9/1/2020) on all of the three platforms (EnergyHub, Google Nest and Resideo), none of them hit the 4CP interval because this interval occurred very early in the afternoon (14:15 – 14:30).

6.4.4.1 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 2020 BYOT program.

Table 6-15: 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	1.35	1.72
	Small commercial non-ecobee	0.63	-0.42
	Residential ecobee	1.35	1.72
	Small commercial ecobee	1.42	1.11
Google Nest	Residential	1.29	1.29
	Small commercial	0.75	0.42
Resideo	Residential	1.30	2.28
	Small commercial	NA	NA

6.4.4.2 Estimated Impacts during Summer 2020 DR Events

Event schedules vary under different platforms. Table 6-16 summarizes the number of events called and the average event duration in summer 2020 for Google Nest, EnergyHub and the Resideo platform.

Table 6-16: BYOT Event Number and Duration Summary by Platform

Platform Name	Number of Events called	Average Event duration
Nest	14	2.09
EnergyHub	13	1.85
Resideo	13	2.10

BYOT program-level total achieved impacts of FY 2021 events ranged from 5,603 kW (7/10/2020 event) to 47,064 kW (7/2/2020), with the Google Nest thermostats group contributing most of the kW savings

across all events except on 7/10/2020 and 8/10/2020 when no Google Nest DR events were called. These demand reduction estimates are shown in Figure 6-23.

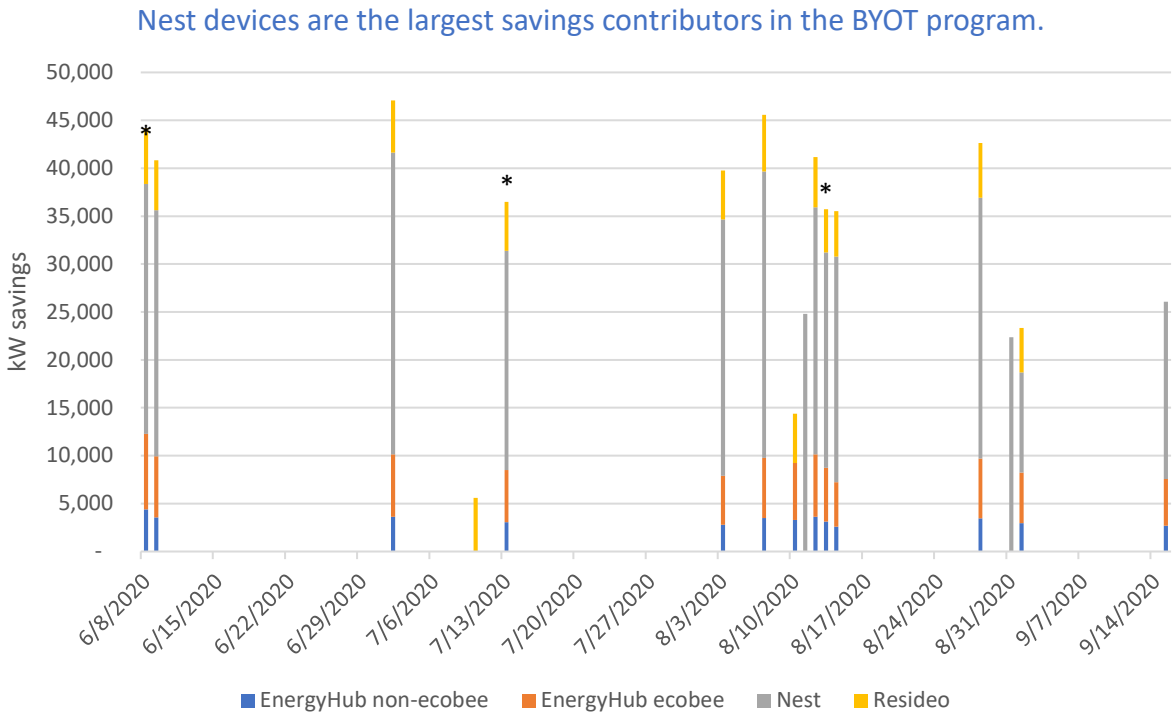


Figure 6-23: BYOT – Achieved Demand Reduction in Summer 2020

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

Table 6-17 shows estimated energy, peak demand, non-coincident peak demand, and ERCOT 4CP demand savings delivered by the program in FY 2021. 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 7/2/2020, which is the maximum demand savings day for all residential DR programs combined among all FY 2021 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 6-17: BYOT Gross Energy and Demand Savings – FY 2021 Delivered

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Google Nest	23,981,594	24,572	31,491	17,859
EnergyHub – Non-ecobee	53,571	3,335	3,628	1,546
ecobee	3,334,313[42]	5,981	6,508	2,763
Resideo	**119,459**	**5,245**	**5,438**	**3,861**
Total	27,488,937	39,133	47,064	26,027

Rows may not sum to total due to rounding.

6.4.4.3 End-of-year Program Capability

End-of-year program capability is based on end-of-year enrollment and is shown in Table 6-18.

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

Measure	End-of-year Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Nest	18,741	23,876,034	24,460	31,350	17,777
EnergyHub – Non-ecobee	2,727	59,543	3,704	4,029	1,716
ecobee	4,843	6,169,982	6,641	7,226	3,067
Resideo	**5,222**	**154,489**	**6,783**	**7,033**	**4,993**
Total	31,533	30,260,048	41,588	49,638	27,553

Rows may not sum to total due to rounding.

[42] For achieved annual energy savings estimate of ecobee thermostats, here we used 0.6 * 1274 = 764.4 kWh per device as an estimate instead of the full 1,274 kWh deemed value. This is because eco+ program wasn't implemented till May 2020. As a result, an estimated factor of 0.6 was applied to account for the estimate of annual energy savings.

6.4.4.4 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 6-19.

Table 6-19: BYOT Gross Energy and Demand Savings – Incremental Impacts

Measure	Gross Incremental Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Google Nest	629	801,346	820	1,051	595
EnergyHub – Non-ecobee	813	18,038	1,112	1,212	514
ecobee	1,443	1,838,382	1,978	2,156	913
Resideo	**1,386**	**41,004**	**1,800**	**1,867**	**1,325**
Total	4,271	2,698,770	5,710	6,285	3,348

Rows may not sum to total due to rounding.

6.5 GOOGLE NEST THERMOSTATS

6.5.1 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 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 launched in FY 2020. For HEA and Wx program customers (see section 4.5.2.3 and section 3.1.2.1 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 free Google Nest Thermostat E devices instead.

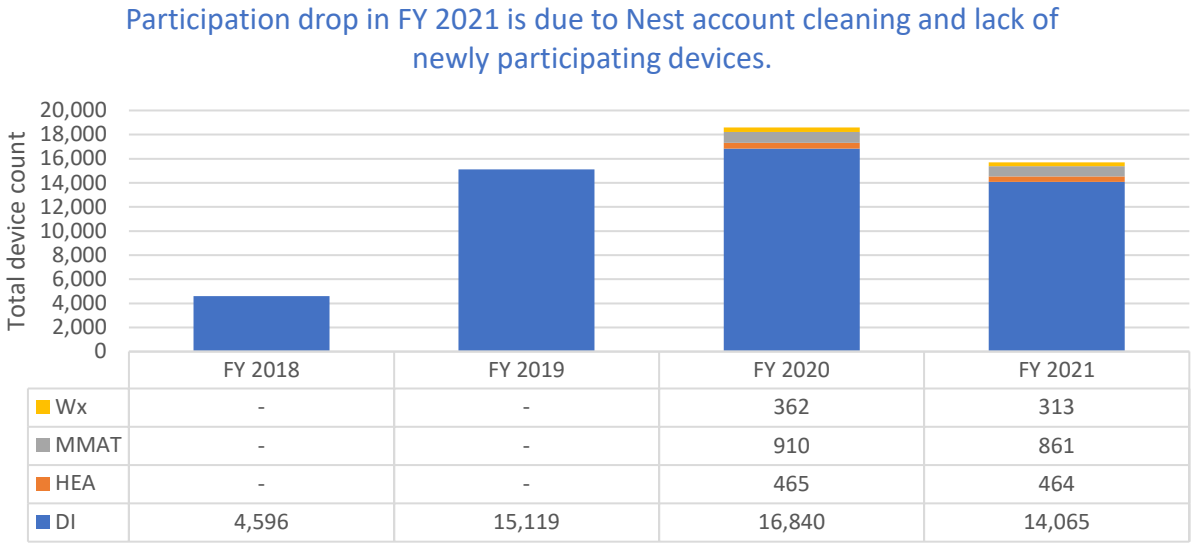
After the customers have installed Nest(s), they are automatically enrolled in Google Nest RHR (Rush Hour Rewards) in synchronization with all the other Google Nest thermostats on the Google Nest platform. As with Google Nests in the BYOT program, at the end of each DR season, a $30 bill credit is applied 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 have residential Google Nest devices run by the Nest platform, which arranged the identical event schedule.

6.5.2 Program Participation

Figure 6-24 shows Nest participation trends from FY 2018 to FY 2021. The drop in total participation in FY 2021 as seen in the bar chart is mainly due to three reasons:

- All Google Nest thermostats experienced an account cleaning process in November 2020. Specifically, these thermostats include those which lost WiFi connection, accounts showing zero devices, and disconnected thermostats due to customers moving or other situations.
- All potential Home Manager customers had been converted to Nest DI in FY 2020. So, there was no room for new installs in the Nest DI category.
- Apart from the Nest DI category, there were also very few newly installed devices for other programs. All indoor installations were paused in March 2020 because of the COVID-19 pandemic.



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

Figure 6-24: Google Nest Participation Trends from FY 2018 to FY 2021

There were only 78 newly installed Google Nest thermostats in total for the Nest program throughout FY 2021, as shown in Figure 6-25.

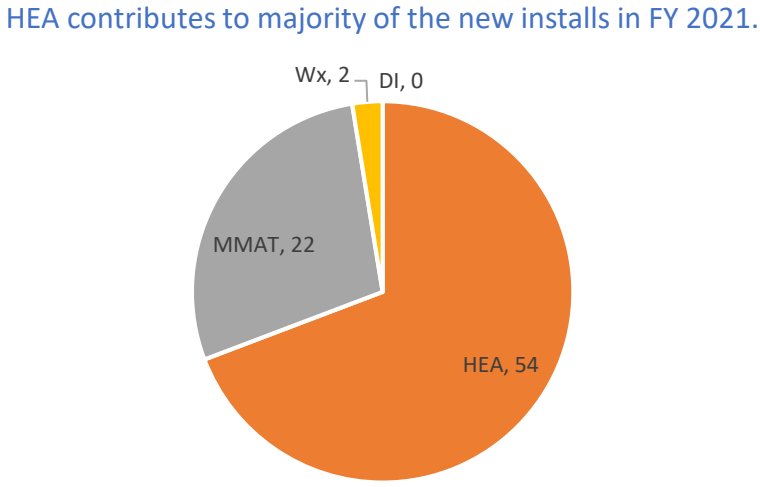


Figure 6-25: Breakdown of Newly Installed Devices by Category in FY 2021 for Google Nest Program

6.5.3 Savings Calculation Method

6.5.3.1 Per Device kW and kWh Savings

Since Google Nest thermostats are incorporated in the Google Nest platform along with other Google Nest thermostats in BYOT programs, savings from this program are calculated the same way. Section 6.4.3 explained in detail how CP, NCP, 4CP and energy savings are calculated for Nest BYOT; those per device savings will be directly applied to the Nest program:

Table 6-20: Nest DI/HEA/MMAT/Wx per Device Savings

Category	Savings per device
CP/Average per device kW savings	1.31 kW
NCP per device kW savings	1.68 kW
4CP per device kW savings	0.95 kW
Annual energy (kWh) per device savings	1,274 kWh

6.5.3.2 Coincident Peak (CP) Demand Savings (kW)

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

6.5.3.3 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 2021 events. Multiplying the NCP per device demand savings in Table 6-20 by the total number of devices in the summer of 2020 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.

6.5.3.4 ERCOT 4CP Demand Savings (kW)

During the summer of 2020, three of the Google Nest DI events coincided with ERCOT 4CP events, yielding a 75% success rate in hitting the 4CPs. To estimate ERCOT 4CP demand savings, we estimated the kW savings for each event, selected the events which coincided with the ERCOT 4CPs, and multiplied the result by the ERCOT 4CP success rate. In this case, 4CP savings can also be generated simply by multiplying the 4CP per device demand savings in Table 6-20 by the total number of devices in the summer of 2020. For the year-end capability and incremental calculations, we scaled the result to the number of devices at the end of FY 2021 and to the number of new devices added during FY 2021.

6.5.4 Results

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

1) Estimated program impacts during summer 2020 DR events.

2) End-of-year program capability based on program enrollment at the end of FY 2021.

3) End-of-year program capability based on incremental enrollment during FY 2021.
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 2020 DR Events

As in other Google Nest-related DR programs, 14 events were called in summer 2020 for the Nest DI program. Event impacts ranged from 8,773 kW (9/1/2020 event) to 26,465 kW (7/2/2020 event). These demand reduction estimates are shown below.

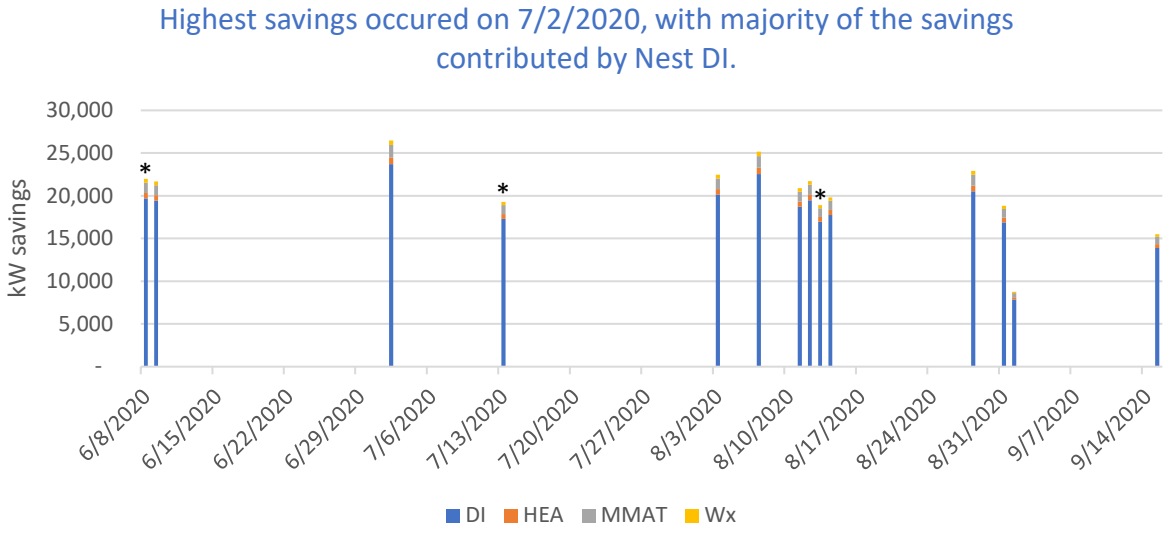


Figure 6-26: Google Nest DI/HEA/MMAT/Wx – Achieved Demand Reduction during Summer 2020 DR Events

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 2021.

Table 6-21: Google Nest Gross Energy and Demand Savings – FY 2021 Delivered

Measure	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Nest DI	18,003,167	18,531	23,705	13,481
Nest MMAT	1,102,101	1,134	1,450	825
Nest Wx	400,673	412	528	300
Nest HEA	594,048	611	782	445
Total	20,099,989	20,689	26,465	15,052

Rows may not sum to total due to rounding.

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 Table 6-22.

Table 6-22: Google Nest Gross Energy and Demand Savings – End-of-year Capability

Measure	End-of-year Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Nest DI	14,065	17,918,810	18,444	23,594	13,418
Nest MMAT	861	1,096,914	1,129	1,444	821
Nest Wx	313	Attributed to EE program	410	525	298
Nest HEA	464	Attributed to EE program	608	778	443
Total	15,703	19,015,724	20,592	26,341	14,981

Rows may not sum to total due to rounding.

6.5.4.3 Incremental Impacts

Incremental impacts used in benefit-cost analysis are based on gross incremental enrollment during the program year. FY 2021 Nest DI/HEA/MMAT/Wx incremental savings are shown in Table 6-23

Table 6-23: Google Nest Gross Energy and Demand Savings – Incremental Impacts

Measure	End-of-year Enrollment	Gross Energy Savings (kWh)	Gross CP Demand Savings (kW)	Gross NCP Demand Savings (kW)	Gross ERCOT 4CP Demand Savings (kW)
Nest DI	0	0	0	0	0
Nest MMAT	22	28,028	29	37	21
Nest Wx	2	2,548	3	3	2
Nest HEA	54	68,796	71	91	52
Total	78	99,372	102	131	74

Rows may not sum to total due to rounding.

6.6 POWER PLAYERS (BEHAVIORAL DEMAND RESPONSE)

6.6.1 Overview

CPS Energy partnered with Oracle to implement a program called "Power Players".[43] for residential customers beginning in summer 2017. Power Partner 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). Participating households/accounts were all equipped with AMI meters and did not participate in other CPS Energy DR programs.

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

Throughout the summer 2020, nine events were called. Each event lasted from 3:00pm to 7:00pm except the first two events (6/9/2020 and 7/2/2020 events), which lasted from 3:00pm to 6:00pm.

6.6.2 Program Participation

Participation in FY 2021 was a combination of participants enrolled in summer 2017, 2018, 2019 and 2020 separately. Participation of each year is described as a "wave." For example, participants enrolled in summer 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.[44]

[43] 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.

[44] In summer 2020, there were indeed several (<10) control group participants who were accidentally selected into the treatment group in 2019 and then showed an intention to remain in the treatment group. This situation is not considered here due to the fact that there were less than 10 households.

Table 6-24 tabulates the number of active customers throughout summer 2020 by waves:

Table 6-24: Power Players (BDR) - Participation in Summer 2020

	Treatment Group # of Households	Control Group # of Households
2017 Wave	80,524	18,185
2018 Wave	14,701	4,276
2019 Wave	159,967	20,110
2020 Wave	81,401	20,399
Total	336,593	62,970

In the summer of 2020, there were 81,401 additional households participating who remained active in the Power Players program as the treatment group of the 2020 wave. However, the biggest share of treatment group participation was contributed by 2019 participants (159,967 remained active in summer 2020).

6.6.3 Savings Calculation Method

6.6.3.1 Per Household kW and kWh Savings

CPS Energy provided Frontier with aggregated 15-minute interval AMI meter level data from 06/01/2020 to 09/30/2020 for almost all participants[45] 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.) 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.

[45] Around 98% of all active customers were included in the aggregated 15-minute interval AMI data for analysis.

Take the first event (6/9/2020) of the 2020 wave as an example. The load per account by group and time period is tabulated below.

Table 6-25: Power Players (BDR) - Example: Average Load by Group, Wave and Time Period for 6/9/2020 – 2020 wave

Event period (3p.m. – 6p.m.) (kW per household)		Pre-event period (9a.m. – 3p.m.) (kW per household)	
Treatment Group	Control Group	Treatment Group	Control Group
2.89	2.95	2.01	2.03

For the 6/9/2020 event, per household kW savings for the 2020 wave is estimated at 2.95 – 2.89 = 0.06 kW. Total kW savings for the 2020 wave is 0.06 * 81,401 = 4,617 kW.[46] Energy savings during the event period is calculated as 4,617 kW * 3 hours = 13,851 kWh.

kW savings during the pre-event period can be calculated in the same manner: (2.03 kW – 2.01 kW) * 81,401 = 1,417 kW.[47]

Energy savings during the pre-event period is calculated as 1,417 kW * 6 = 8,502 kWh.

Total energy savings for the 2020 wave during 6/9/2020 event is the combination of savings from the pre-event period and event period: 13,851 + 8,502 = 22,353 kWh.

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

6.6.3.2 Coincident Peak (CP) Demand Savings (kW)

Coincident peak demand savings are estimated by the average kW savings across all high temperature events.[48] Since participants are recruited each year, the EOY and incremental savings are identical to the FY 2021 achieved savings.

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

Achieved non-coincident peak savings represent the maximum event demand savings among FY 2021 events. Similar to CP savings, EOY and incremental NCP savings are equivalent to achieved maximum savings in FY 2021.

6.6.3.4 ERCOT 4CP Demand Savings (kW)

During the summer of 2020, 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

[46] Numbers do not sum up exactly due to rounding.
[47] Numbers do not sum up exactly due to rounding.
[48] 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.

6.6.4 Results

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

1) Estimated program impacts during summer 2020 DR events.
2) End-of-year program capability based on program enrollment at the end of FY 2021.
3) End-of-year program capability based on incremental enrollment during FY 2021.
   This information is used for program benefit-cost analysis, consistent with the methods used for energy efficiency programs.

6.6.4.1 Estimated Impacts During Summer 2020 DR Events

In FY 2021, kW savings per account by wave is tabulated in Table 6-26: below:

Table 6-26: Power Players (BDR) kW savings per household by wave – FY 2021

Wave	Average kW savings per household
2017 wave	0.044
2018 wave	0.079
2019 wave	0.060
2020 wave	0.067

There were 9 events called in summer 2020 for the Power Players program. Event impacts ranged from 16,524 kW (9/1/2020 event) to 22,498 kW (7/13/2020 event). These demand reduction estimates are shown in Figure 6-27.

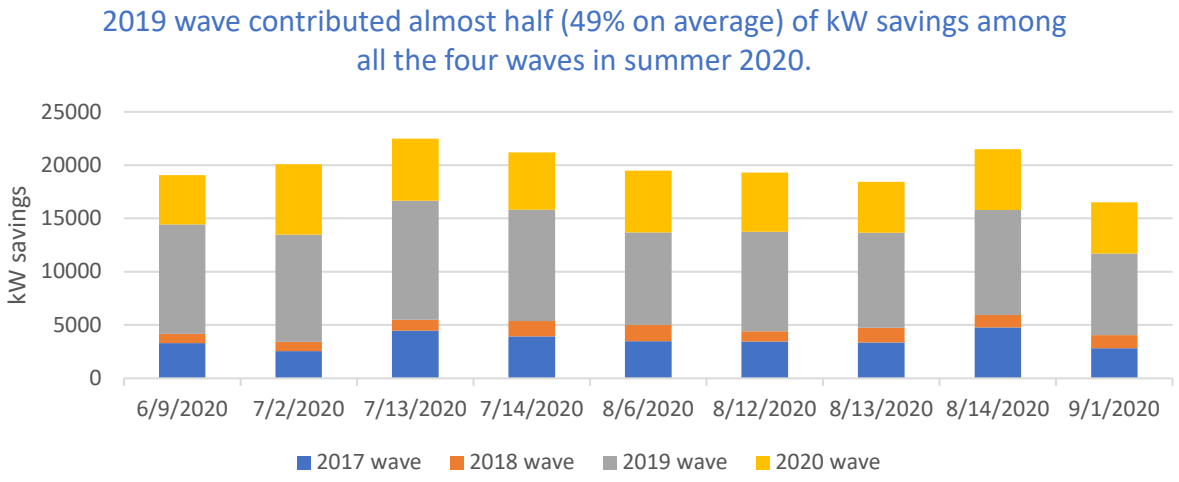


Figure 6-27: Power Players (BDR) FY 2021 kW Reduction by Event

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 2021.

Table 6-27: Power Players (BDR) Program Energy and Demand Savings – FY 2021 Delivered

Measure	Energy Savings (kWh)	CP Demand Savings (kW)	NCP Demand Savings (kW)	ERCOT 4CP Demand Reduction (kW)
Power Players	1,152,219	19,787	22,498	10,231

6.6.4.2 End-of-year Program Capability

End-of-year program capability is based on end-of-year enrollment and is shown in Table 6-28. These values are the same as the achieved savings.

Table 6-28: Power Players (BDR) Program Energy and Demand Savings – End of FY 2021

Measure	End-of-year Enrollment	Energy Savings (kWh)	CP Demand Savings (kW)	NCP Demand Savings (kW)	ERCOT 4CP Demand Reduction (kW)
Power Players	336,593	1,152,219	19,787	22,498	10,231

6.6.4.3 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 6-29: Power Players (BDR) Program Energy and Demand Savings – Incremental Impacts

Measure	Gross Incremental Enrollment	Energy Savings (kWh)	CP Demand Savings (kW)	NCP Demand Savings (kW)	ERCOT 4CP Demand Reduction (kW)
Power Players	336,593	1,152,219	19,787	22,498	10,231

6.7 DEMAND RESPONSE PROGRAM RECOMMENDATIONS

6.7.1 General Recommendations for All DR Programs

Frontier provides the following recommendations that apply to all CPS Energy DR programs:

- To reduce uncertainty brought on by COVID-19, we recommended continuing to use actual meter data to quantify savings. COVID-19 presents challenges in forecasting the potential electricity consumption patterns in FY 2022. Using actual data instead of temperature bin/TTM or other deemed numbers is the most accurate way to quantify savings and account for all the variations every year.

- In order to balance the multiple goals of DR programs, we recommended continuing to call events more flexibly and creatively, perhaps more than once within a day. The goals of DR programs are the following: reducing 4CP transmission cost, reducing cost from high Real-Time Market (RTM) prices, and cutting the CPS Energy load zone peak. Finding the appropriate time slot to balance these three goals or even the first two goals can be challenging. This was especially true in FY 2021, when the ERCOT 4CP in June 2020 was unusually late (17:30 - 17:45) while the 4CP in September 2020 was unusually early (14:15 – 14:30)..[49] See the comparison in the table below between the CPS Energy peak interval versus the ERCOT 4CP interval by month in FY 2021.

Table 6-30: CPS Energy Summer 2020 Peak Interval vs ERCOT 4CP Interval by Month

	June 2020	July 2020	August 2020	September 2020
CPS Energy Peak Interval	17:45 – 18:00	18:45 – 19:00	15:15 – 15:30	16:15 – 16:30
ERCOT 4CP Interval	17:30 – 17:45	16:30 – 16:45	16:30 – 16:45	14:15 – 14:30

As can be seen in the table above, the CPS Energy peak was sometimes quite different from the ERCOT 4CP peak in summer 2020, thus causing challenges in DR event scheduling.

6.7.2 Smart Thermostat Program

Frontier provides the following recommendation for the Smart Thermostat program:

- To continue generating incremental savings during COVID-19-restricted operations, we recommend structuring the program to enable non-contact installs. Due to the pause on indoor installations during the pandemic, there were very few newly installed devices in the Smart Thermostat program in FY 2021.

[49] Here “unusual” means these 4CPs in FY 2021 didn’t fall into the normal 4CP time range, which was always during 15:45 – 17:00 during the past 11 years.

BYOT Program & Nest Program

Frontier provides the following recommendations for all the Nest-related programs:

- We recommend performing the account cleaning process every year. Conducting account cleaning regularly can capture the natural program decay on an ongoing basis and avoid a sharp drop in the device count due to several years of cumulative inactive devices. Upcoming migration to the Resideo platform will help closer track customers devices that are inactive.
- To capture unique savings for ecobee's "eco+" temperature offset algorithm and increase evaluation accuracy, we recommend increasing the sample size and incorporating a group of ecobee thermostats to represent the population of this category.
- To increase incremental savings and counter the pause on thermostat installation during the pandemic, we recommend focusing on the growth strategy of the BYOT program.

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 2021:

- Residential Solar – Offers incentives for the installation of solar photovoltaic (PV) systems.
- Commercial 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 peak demand, NCP demand, and energy savings are shown in Figure 7-1, Figure 7-2, and Figure 7-3.

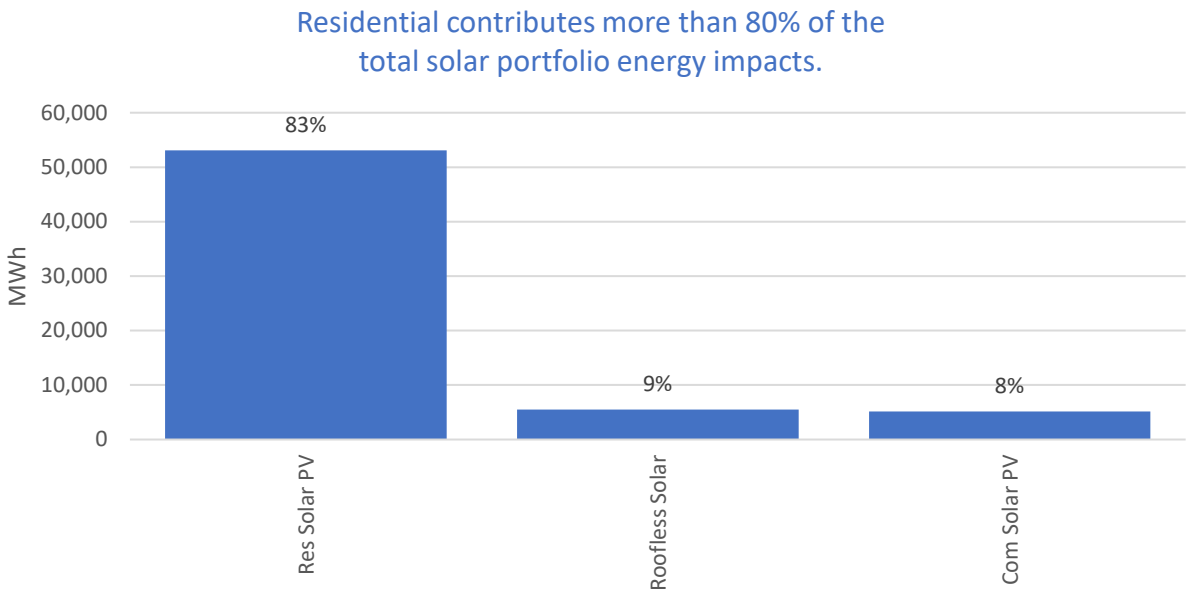


Figure 7-1: Summary of Solar Energy Impacts – Energy (MWh) by Program

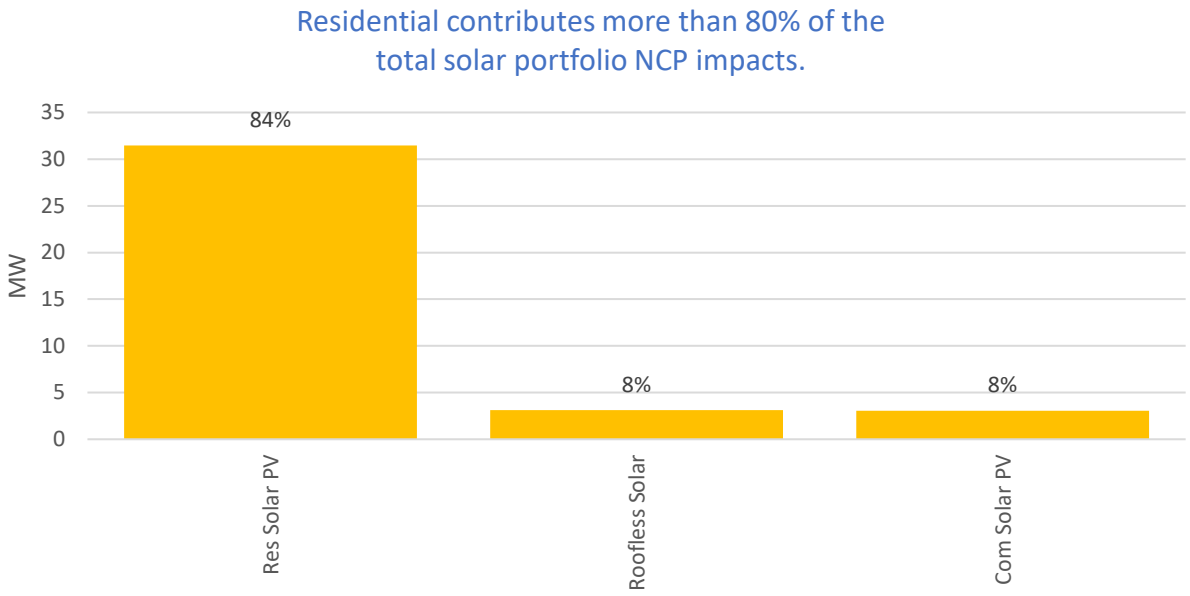


Figure 7-2: Summary of Solar Energy Impacts – Non-Coincident Peak Demand (MW) by Program

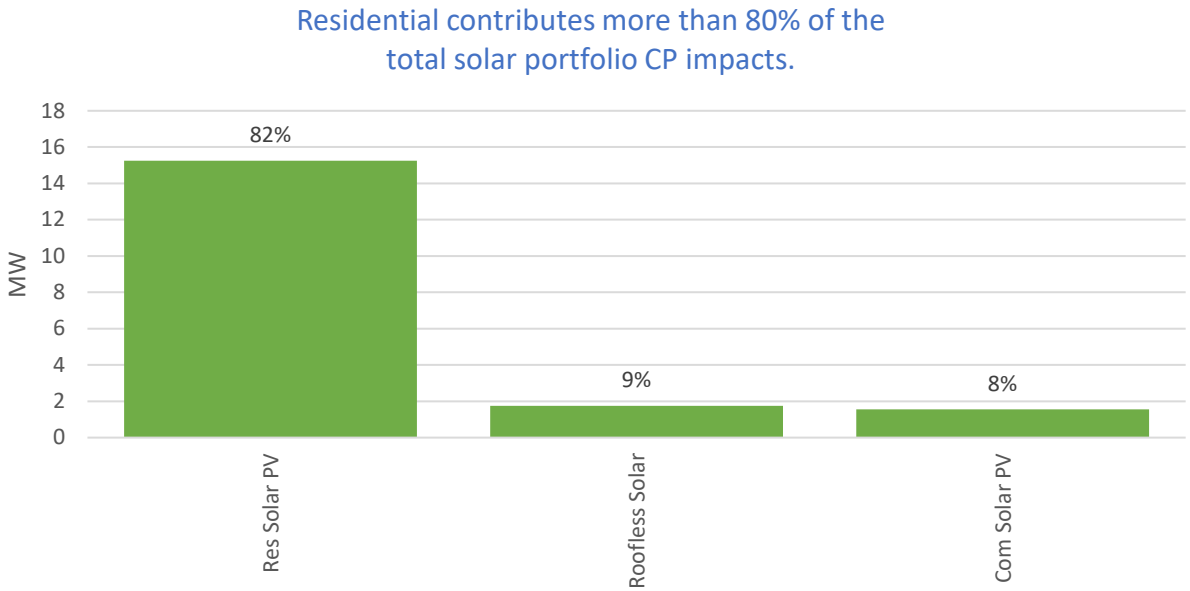


Figure 7-3: Summary of Solar Energy Impacts – Coincident Peak Demand (MW) by Program

7.2 RESIDENTIAL SOLAR PROGRAM

7.2.1 Overview

CPS Energy has offered rebates for residential solar PV systems for more than 14 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 2021 were paid under a rebate design that offered a fixed rebate amount ranging from $1,875 to $3,000 per project, with differences dependent on the use of local installers and locally manufactured components. This resulted in an effective average rebate level of $0.32/$W_{DC}$, an 11% decrease from FY 2020's $0.36/$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. Rebates are not available for leased equipment.

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 2021 there were 4,416 residential solar PV systems installed through the program, totaling 35,929 kW_{DC} and $11.7 million in rebates distributed. The average residential solar PV system size was 8.1 kW_{DC}, but the median system size was around 7.7 kW_{DC}.[50] Figure 7-4 summarizes the Residential Solar program history in terms of capacity installed, average installed system prices and average rebate levels annually.

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

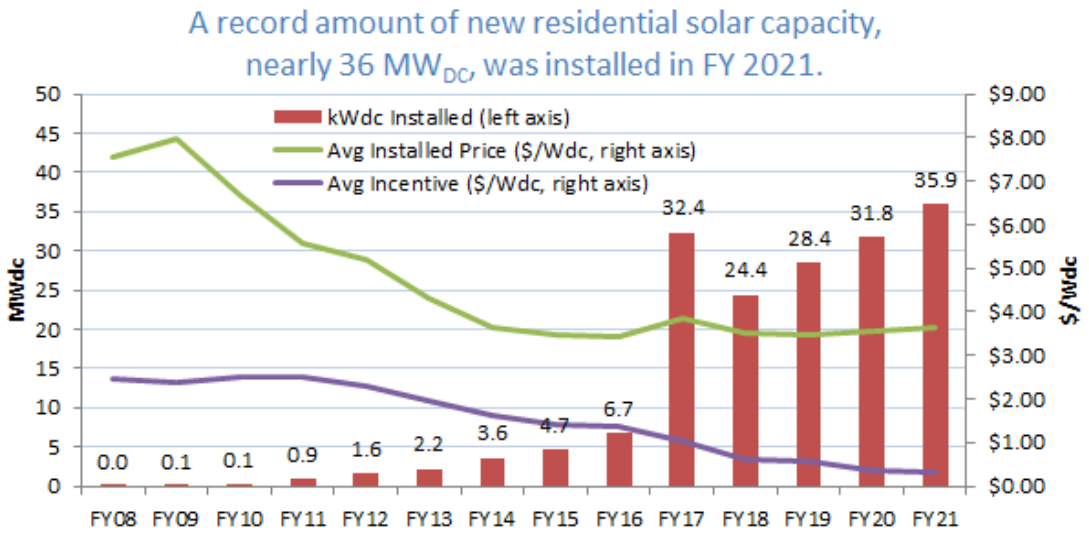


Figure 7-4: Residential Solar Program History – Annual Capacity Installed, Average System Price, and Average Rebate Levels

CPS Energy's contribution to the total installation costs of residential solar has diminished greatly over the program life. Utility rebates now cover just 9% of installed costs, a record low in the program's history.

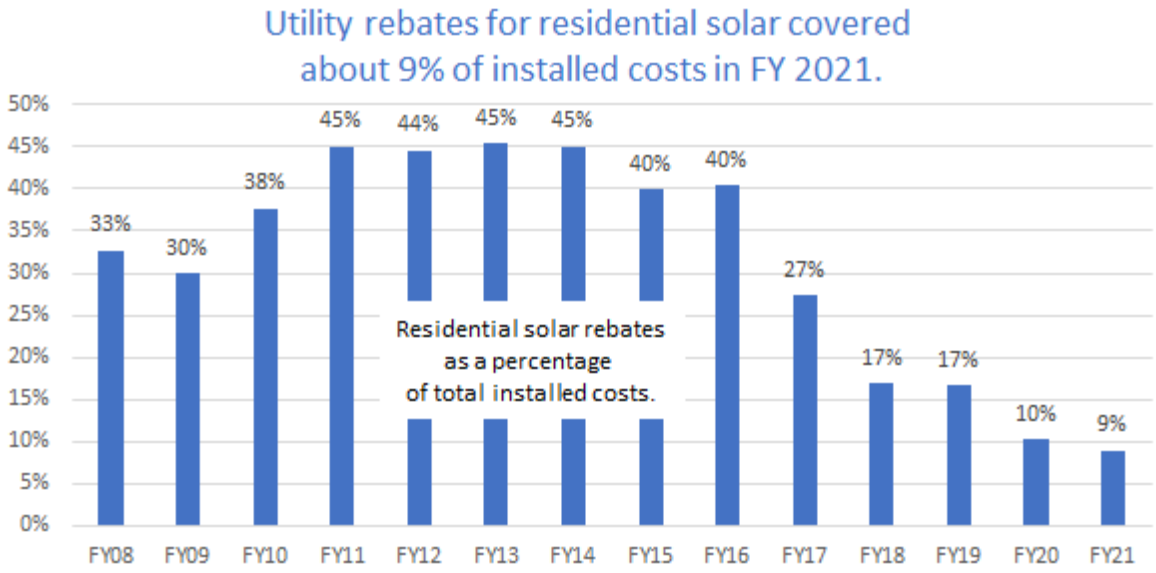


Figure 7-5: Percentage of Residential Solar Installed System Costs Paid by CPS Energy Rebates

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* provided by Frontier Energy. The method assumes an average production index of 1,402 kWh per kW_{DC} installed among a variety of residential PV systems at various tilts and orientations.

The method is based on modeling the annual energy production from a representative fleet of residential PV systems using NREL PVWatts Version 5 (released in November 2014) and TMY3 weather data from the San Antonio Kelly Field Air Force Base (Kelly AFB) station..[51] The representative fleet was constructed from a weighted average of seven different array tilt and orientation combinations, with weightings conforming to expected residential distributions and producing an annual energy production estimate that was consistent with the sum of production estimates for individual systems produced by CPS Energy and stored in the CPS Energy program database.

7.2.2.2 Coincident Peak (CP) Demand Savings (kW)

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

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

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

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

7.2.2.4 ERCOT 4CP Demand Savings (kW)

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

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

7.2.3 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	Energy Savings (kWh)	CP Demand Savings (kW)	NCP Demand Savings (kW)	ERCOT 4CP Demand Savings (kW)
Residential Solar PV	50,372,229	14,012	28,887	12,611

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. Further levels of verification involve reviewing paper files stored at CPS Energy's offices and conducting site visits to further verify the accuracy of solar information collected.

Deemed savings values originally developed by Frontier in FY 2017 were validated via desk and field reviews during FY 2019. In that year, Frontier conducted desk reviews of 56 residential rebate files to confirm consistency of key data in the files and in the CPS Energy solar program database. The desk review process confirmed the accuracy of energy and demand savings methodologies and did not uncover any issues that necessitate updates to current administrative procedures. The key baseline metric of installed system capacity – kWdc – and the method for determining it are shared, and all of Frontier's savings estimations are derived from this key baseline metric.

Due to health concerns associated with the COVID-19 pandemic, on-site reviews were not conducted during FY 2021. 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 11 years. During FY 2021, a new tiered rebate structure was introduced, with new commercial projects paid out at higher rebate levels ($0.70/$W_{AC}$ or $0.60/$W_{AC}$) for the first 25 kW installed, and at lower levels for capacity greater than 25 kW ($0.50/$W_{AC}$ or $0.40/$W_{AC}$, respectively). All rebates were limited to $80,000 or 50% of total project costs. No school projects were completed during FY 2021.

Commercial solar systems varied in size from less than 5 kW_{DC} to greater than 800 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 2021.

Table 7-2: Commercial and Schools Solar Program Rebates in FY 2021

System Size (kWDC)	# of Projects	Total Capacity (kWDC)	Rebated Amount
<10	9	61	$44,029
10-24	12	183	$101,331
25<99	9	542	$264,626
100-<249	6	904	$363,381
250+	3	1,844	$240,000
Total	39	3,534	$1,013,367

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 2021, there were 39 commercial solar PV systems installed through the program, totaling 3,534 kWdc and $1.0 million in rebates distributed. The average commercial system size was 80 kWdc.

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

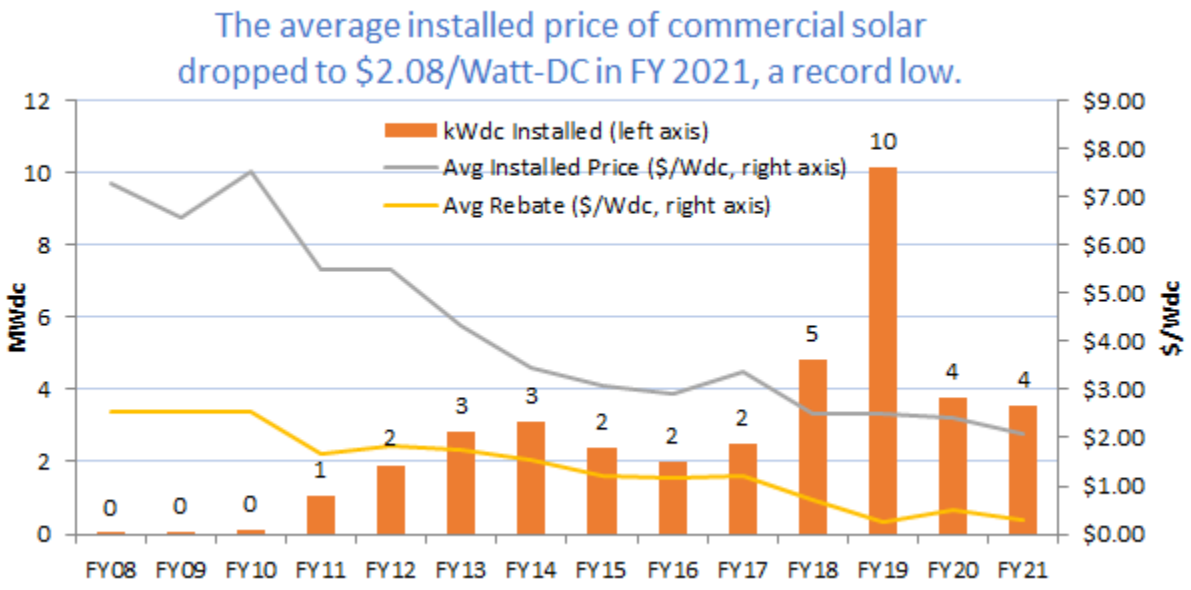


Figure 7-6: Commercial and Schools Solar Program History: Annual Capacity Installed, Average System Price, and Average Rebate Levels

CPS Energy's contribution to the total installation costs of commercial solar has diminished greatly over the program life. Utility rebates now cover about 14% of installed costs.

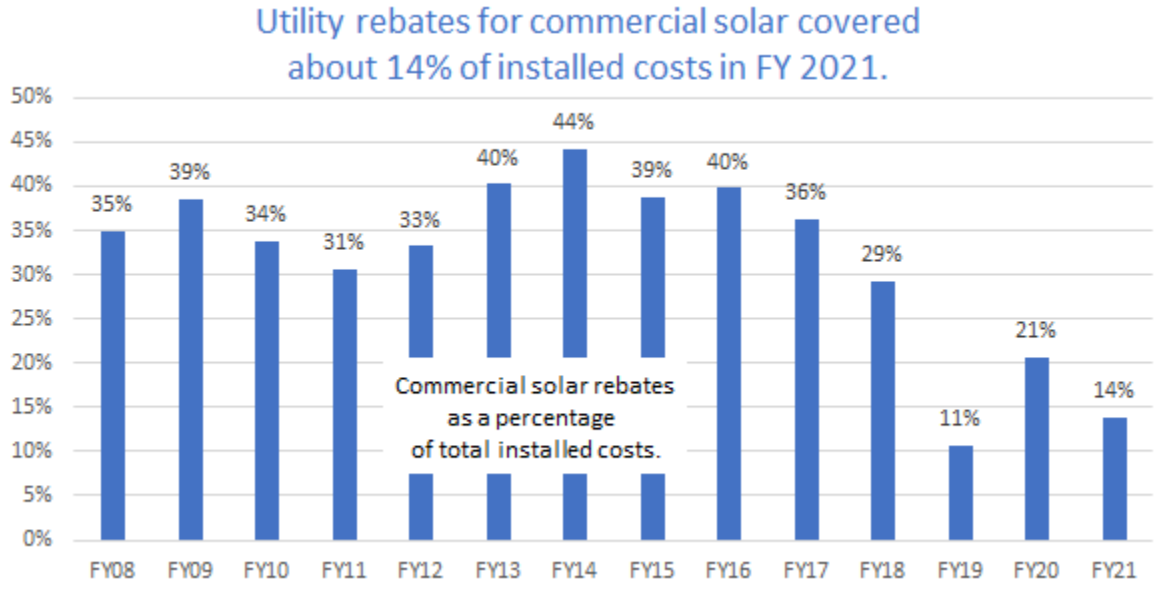


Figure 7-7: Commercial and Schools Solar Program History: Annual Capacity Installed, Average System Price, and Average Rebate Levels

7.3.2 Savings Calculation Method

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

7.3.2.1 Energy Savings (kWh)

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

The method is based on modeling the annual energy production from a representative fleet of commercial/school PV systems using NREL PVWatts Version 5 (released in November 2014) and TMY3 weather data from the San Antonio Kelly Field Air Force Base (Kelly AFB) station.[52] The representative fleet was constructed from a weighted average of seven different array tilt and orientation combinations, with weightings conforming to expected commercial/school distributions and producing an annual energy production estimate that was consistent with the sum of production estimates for individual systems produced by CPS Energy and stored in the CPS Energy program database.

7.3.2.2 Coincident Peak (CP) Demand Savings (kW)

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

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

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

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

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

7.3.2.4 ERCOT 4CP Demand Savings (kW)

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

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	Energy Savings (kWh)	CP Demand Savings (kW)	NCP Demand Savings (kW)	ERCOT 4CP Demand Savings (kW)
Commercial & Schools Solar PV	4,894,375	1,424	2,816	1,240

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. Further levels of verification involve reviewing paper files stored at CPS Energy's offices and conducting site visits to further verify the accuracy of solar information collected.

Deemed savings values originally developed by Frontier in FY 2017 were validated via desk and field reviews during FY 2019. In that year, Frontier conducted desk reviews of 29 commercial rebate files to confirm consistency of key data in the files and in the CPS Energy solar program database. The desk review process confirmed energy and demand savings methodologies and did not uncover any issues that necessitate updates to current administrative procedures. Frontier further conducted onsite reviews of nine commercial systems and observed installed equipment consistent with that reported in every case.

Due to health concerns associated with the COVID-19 pandemic, on-site reviews were not conducted during FY 2021. 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.

Nine new commercial carport systems totaling 3,618 kW_{DC} were constructed during FY 2021 by a third party developer. These new systems join four that were constructed during FY 2020 to bring the program total to 4,740 kW_{DC}. Shares of these systems were sold by the developer to CPS Energy customers at $2.40/Wdc – a price significantly less than the average $3.56/Wdc seen in the Residential Solar Program. 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 2021 Roofless Solar impacts are from the newest nine solar installations.

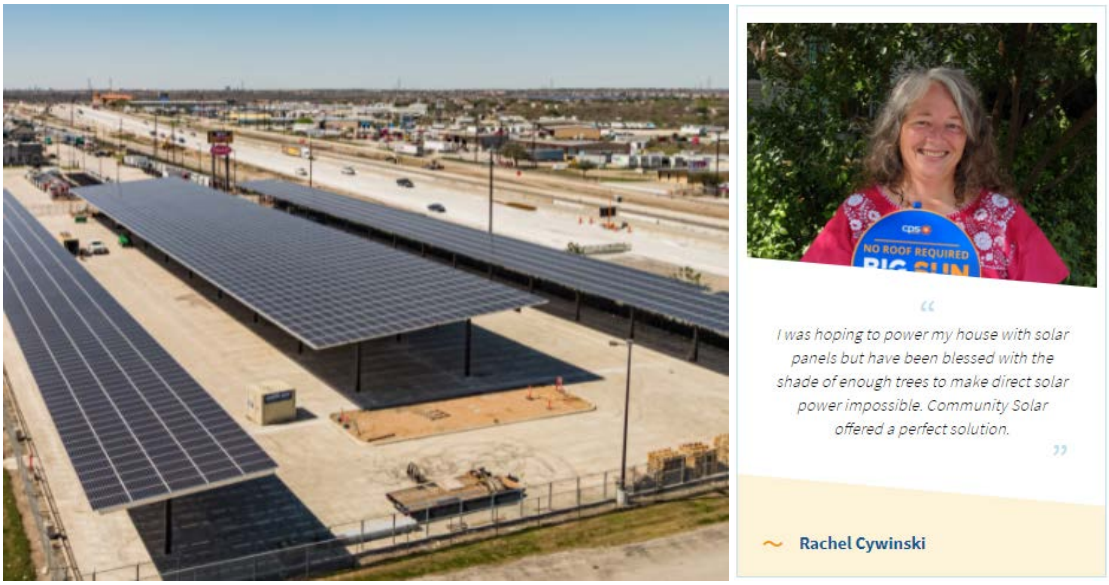


Figure 7-8: One of the Big Sun Commercial Carport Systems; a Big Sun Customer

Frontier Energy's analysis of energy and demand savings did not utilize the commercial solar deemed savings methodology as described in the *CPS Energy Guidebook* provided by Frontier. The deemed savings values and methods described there are more suitable for a large and varied fleet of commercial solar energy systems; in this case, Frontier was provided with detailed specifications of each of the nine new Big Sun systems installed, enabling more precise modeling and estimation of energy and demand savings in a manner consistent with *CPS Energy Guidebook* principles. These subsections describe Frontier's approach to estimating savings for the FY 2021 Roofless Solar program.

7.4.1.1 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 TMY weather data. Energy savings estimates represent the sum of estimated energy from all new Big Sun systems.

7.4.1.2 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.

7.4.1.3 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.

7.4.1.4 ERCOT 4CP Demand Savings (kW)

The ERCOT 4CP demand savings estimate represents the 90^{th} percentile of combined estimated output from all new Big Sun systems during the hour ending 17 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.

7.4.2 Results

The gross energy and demand savings for the FY 2021 incremental additions to the Roofless Solar program are presented in Table 7-3. These represent the estimated annual energy and demand savings that would have been produced had all systems installed during FY 2021 been operational throughout the fiscal year, which is consistent with how savings are estimated for all energy efficiency programs.

Table 7-4: Big Sun Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	CP Demand Savings (kW)	NCP Demand Savings (kW)	ERCOT 4CP Demand Savings (kW)
Big Sun	5,222,390	1,601	2,861	1,358

7.5 OTHER SOLAR PROGRAMS

CPS Energy continues to support existing solar programs, including SolarHostSA. This program added no new capacity during FY 2021, so no impact assessment is included in this report.

7.6 SOLAR ENERGY PROGRAM RECOMMENDATIONS

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

- CPS Energy should consider leveraging site visits that are already conducted by the distribution services department during system commissioning by including a checklist to help verify key installation details. This would serve as an additional quality assurance check on submitted data.
- For FY 2022 the evaluation team plans to incorporate real world performance of solar projects using solar PV meter data to increase evaluation accuracy. The current evaluation methodology involves modeling assumptions sourced from secondary research. Using customer solar meter data would provide primary data to inform model inputs. This project will require some CPS Energy staff time to pull solar meter data, and evaluation activities include mapping meter data to weather data, data cleaning, management, sampling, and interval analysis.

8. TOTAL IMPACTS AND COST-EFFECTIVENESS

8.1 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 below table. These values were provided by CPS Energy and based on previous evaluations, except for the Weatherization program. Based on Frontier experience and industry standards used in Texas, a 100% NTG factor was used for this program.

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

1. Cost of Saved Energy (includes DR) ($/kWh) = $0.0287/kWh
2. Reduction in Revenue Requirements (includes DR) = $128,127,563
3. Benefit-Cost Ratio = 3.27

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

Table 8-1: FY 2021 Net Portfolio Impacts and Cost-Effectiveness

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Weatherization Program									
Weatherization	100%	4,968,904	2,380	5,028	2,276	$6,177,180	$1,083,502	$7,260,683	0.87**
Energy Efficiency Programs									
Residential HVAC	95%	18,214,192	7,658	7,658	6,486	$4,182,478	$194,952	$4,377,430	4.52
Home Efficiency	93%	2,789,309	1,221	2,397	1,002	$1,100,537	$51,298	$1,151,836	2.96
New Home Construction	100%	3,138,039	1,823	2,702	2,192	$3,233,368	$150,712	$3,384,080	1.71
Retail Channel Partnerships	77%	3,970,777	466	1,973	730	$914,437	$42,623	$957,060	1.62
Energy Savings Through Schools	95%	769,982	57	289	74	$160,666	$7,489	$168,154	1.33
Home Energy Assessments	84%	553,429	49	216	72	$142,335	$6,634	$148,970	1.44**
Cool Roof	100%	45,232	47	72	66	$20,852	$972	$21,824	4.84
Residential Subtotal		29,480,961	11,321	15,309	10,623	$9,754,673	$454,680	$10,209,354	3.05

Table continues on next page.

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Energy Efficiency Programs (cont.)									
C&I Solutions	96%	47,226,815	8,121	11,269	8,040	$7,649,735	$356,566	$8,006,301	3.31
Schools & Institutions	96%	20,928,901	4,436	7,829	4,268	$4,190,218	$195,313	$4,385,531	2.21
Small Business Solutions	93%	18,691,258	3,425	4,295	3,438	$2,025,586	$94,416	$2,120,002	4.34
Commercial Subtotal		86,846,974	15,983	23,393	15,746	$13,865,538	$646,295	$14,511,833	3.13
Energy Efficiency Subtotal		116,327,935	27,303	38,703	26,369	$23,620,212	$1,100,975	$24,721,187	3.10
Demand Response Programs***									
Smart Thermostat	100%	1,082,426	40,441	46,010	33,144	$534,255	$24,892	$559,147	1.79
Power Players (Behavioral DR)	100%	1,254,458	21,542	24,494	11,139	$1,002,072	$46,688	$1,048,760	2.65
Google Nest Thermostats	100%	20,703,020	22,419	28,678	16,311	$380,479	$17,727	$398,206	2.19
Bring Your Own Thermostat	100%	32,945,071	45,278	54,042	29,998	$1,954,457	$91,061	$2,045,518	5.86
C&I DR	100%	3,796,702	101,274	119,440	73,457	$5,579,094	$452,614	$6,031,708	2.37
Demand Response Subtotal		59,781,678	230,954	272,664	172,908	$9,450,357	$632,982	$10,083,339	2.96

Table continues on next page.

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net CP Demand Savings (kW)	Net NCP Demand Savings (kW)	Net ERCOT 4CP Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program $	Program Administrator Benefit-Cost Ratio*
Solar Energy Programs*									
Residential Solar	100%	53,068,088	15,255	31,450	13,730	$11,621,941	$2,634,837	$14,256,778	4.59
Commercial Solar	100%	5,156,316	1,551	3,066	1,350	$769,128	$178,076	$947,204	6.84
Roofless Solar	100%	5,501,886	1,743	3,115	1,478	$0	$57,734	$57,734	4.79
Solar Energy Subtotal		63,726,290	18,549	37,631	16,559	$12,391,069	$2,870,647	$15,261,717	4.74
Grand Total		244,804,807	279,187	354,027	218,112	$51,638,818	$5,688,106	$57,326,924	3.27

*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 benefit, divided by the program's incentives and administrative costs, expressed as:

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

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

** Demand savings for Google Nest thermostats installed through the Weatherization and Home Energy Assessment residential energy efficiency programs are included in the impacts for the Demand Response programs. We have allocated material costs to the DR programs and labor costs to the EE programs in order to align costs to impacts for purposes of cost-effectiveness calculations. For this reason, the PACT ratio cannot be directly calculated from data presented in the table.

*** 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 1.44 and 1.72, respectively. In a parallel manner, 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 1.48.

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

8.2 EMISSIONS REDUCTION

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).

The first year avoided emissions reported in Table 8-2 include avoided CO_2 emissions attributable to the gross number of participants in FY 2021. The lifetime avoided emissions include avoided CO_2 emissions attributable to program impacts across the estimated useful lifetime (EUL) of each measure within each program. Individual measure EULs are documented in the *CPS Energy Guidebook.* Program-level average EULs are listed in Table 8-2.

Table 8-2: FY 2021 CO_2 Emissions Reduction Impacts by Program (tons)

Program	1st Year Avoided CO_2 Emissions (ton)	Lifetime Avoided CO_2 Emissions (tons)	EUL
Weatherization	1,988	23,178	17.03
Residential HVAC	7,286	88,294	16.67
Home Efficiency	1,116	12,955	17.19
New Home Construction	1,255	17,523	23.00
Retail Channel Partnerships	1,588	14,132	9.60
Energy Savings Through Schools	308	2,550	9.30
Home Energy Assessments	221	2,022	10.88
Cool Roof	18	206	15.00
Residential Subtotal	13,738	160,328	
C&I Solutions	18,891	209,497	14.26
Schools & Institutions	8,372	62,049	9.80
Small Business Solutions	7,477	73,127	12.02
Commercial Subtotal	34,739	344,672	
Smart Thermostat	433	3,852	10.00
Power Players (Behavioral DR)	502	502	1.00
Nest DI	8,281	73,682	10.00
BYOT	13,178	117,252	10.00
C&I DR	1,519	1,519	1.00
Demand Response Subtotal	23,913	196,806	
Residential Solar PV	21,227	340,538	30.00
Commercial and Schools Solar PV	2,063	33,088	30.00
Roofless Solar	2,201	32,032	25.00
Solar Energy Subtotal	25,491	405,658	
Grand Total	97,922	1,107,997	

Commercial EE programs lead first-year avoided CO_2 emissions as they delivered the most energy impacts. Due to the 25 and 30 year program 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.

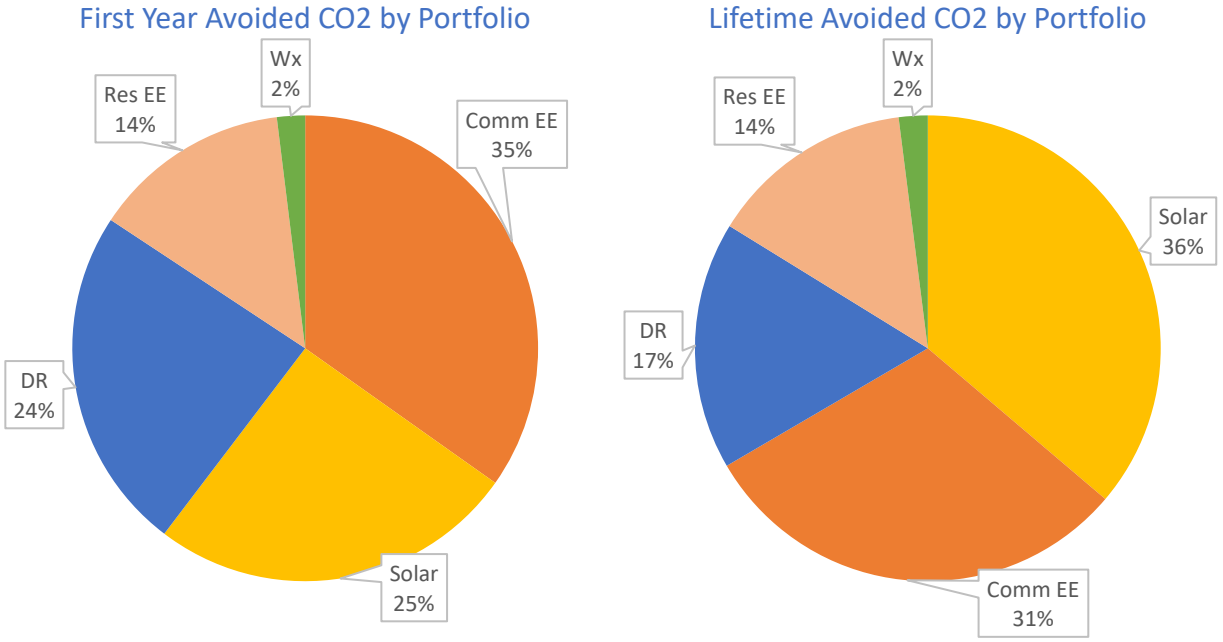


Figure 8-1: First Year and Lifetime Avoided CO_2 Emissions

Although Weatherization contributes only 2% of avoided emissions, it has a higher avoided emission value per participating home than residential EE or DR programs (see Table 8-3). Solar leads avoided emissions per program participant both in first-year and lifetime avoided emissions. Commercial EE programs follow solar due to the larger overall energy savings opportunity per site for commercial program participants compared with residential customers. Program participation counts are provided in section 1.2.

Table 8-3: FY 2021 Avoided CO_2 Emissions per Program Participant

Portfolio	1st Year CO2 Emissions (tons) per Participant	Lifetime CO2 Emissions (tons) per Participant
Solar	653.60	10,401.49
Commercial Energy Efficiency	40.97	406.45
Weatherization	0.71	8.31
Residential Energy Efficiency	0.25	2.88
Demand Response	0.05	0.43
Total	0.19	0.78

Additional avoided emissions for Nitrous Oxide (NOx), Sulfur Dioxide (SO_2) and Total Suspended Particles (TSP) are presented in Table 8-4.

Table 8-4: FY 2021 Avoided NOx, SO_2, and TSP Emissions

Program	NOx (lbs)	SO_2 (lbs)	TSP (lbs)
Weatherization	1,640	298	199
Residential HVAC	6,011	1,093	729
Home Efficiency	920	167	112
New Home Construction	1,036	188	126
Retail Channel Partnerships	1,310	238	159
Energy Savings Through Schools	254	46	31
Home Energy Assessments	183	33	22
Cool Roof	15	3	2
Residential Subtotal	9,729	1,769	1,179
C&I Solutions	15,585	2,834	1,889
Schools & Institutions	6,907	1,256	837
Small Business Solutions	6,168	1,121	748
Commercial Subtotal	28,660	5,211	3,474
Smart Thermostat	357	65	43
Power Players (Behavioral DR)	414	75	50
Nest DI	6,832	1,242	828
BYOT	10,872	1,977	1,318
C&I DR	1,253	228	152
Demand Response Subtotal	19,728	3,587	2,391
Res Solar PV	17,512	3,184	2,123
Com Solar PV	1,702	309	206
Roofless Solar	1,816	330	220
Solar Energy Subtotal	21,030	3,824	2,549
Grand Total	80,786	14,688	9,792

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