EVALUATION, MEASUREMENT & VERIFICATION OF CPS ENERGY'S FY 2015 DSM PROGRAMS

June 11, 2015

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1. EXECUTIVE SUMMARY

CPS Energy retained Frontier Associates (“Frontier”) to conduct a comprehensive, independent evaluation, measurement, and verification (EM&V) of CPS Energy’s Fiscal Year (FY) 2015 demand side management (DSM) programs. This report describes the EM&V methodology and process and presents the findings of the evaluation.

The evaluation focused primarily on calculating the energy and demand savings achieved by CPS Energy’s FY 2015 DSM programs on an annualized basis. Additionally, the evaluation reviewed program expenditures to calculate program cost-effectiveness and recommended enhancements to program design and implementation for CPS Energy’s consideration.

1.1 SUMMARY OF ENERGY AND DEMAND IMPACTS

Net energy and demand savings are listed in Table 1.2-1. The savings are represented on an annualized basis in order to simplify the reporting structure and for easy comparison from year to year.

1.2 SUMMARY OF ECONOMIC IMPACTS

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

- Cost of Saved Energy (CSE), which represents the levelized program cost per annual kWh saved, was $0.06.
- Net Reduction in Revenue Requirements (RRR), which represents the net reduction in utility costs due to the impact of the energy efficiency improvements, was $48,581,436.

Table 1.2-1: FY 2015 Net Energy and Demand Savings

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net Peak Demand Savings (kW)	Net Non-Coinc. Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program Spending	Benefit-Cost Ratio
Energy Efficiency Programs								
Home Efficiency	93%	1,920,450	549	736	$844,194	$98,383	$942,578	1.74
Air Flow	90%	858,815	392	525	$750,280	$66,875	$817,155	1.03
Residential HVAC	95%	14,275,837	4,368	5,836	$3,403,050	$240,343	$3,643,393	3.33
Solar Initiative	100%	7,018,005	2,476	4,144	$6,482,046	$502,714	$6,984,760	1.12
New Homes	100%	11,738,507	2,490	2,490	$1,777,100	$118,576	$1,895,676	6.00
Refrigerator Recycling	63%	497,482	66	70	$53,740	$67,946	$121,686	1.52
Weatherization	100%	12,935,654	3,198	13,365	$13,382,366	$1,693,265	$15,075,631	0.60
Residential Lighting	85%	1,906,720	59	4,556	$1,000,000	$76,072	$1,076,072	1.10
Residential Subtotal		**51,151,470**	**13,599**	**31,722**	**$27,692,776**	**$2,864,174**	**$30,556,950**	**1.45**
Commercial Lighting[1]	85%	36,208,070	3,704	8,444	$4,427,913	$448,155	$4,876,068	2.85
Commercial HVAC	96%	9,921,735	4,089	5,009	$2,660,635	$250,158	$2,910,793	3.52
Solar Initiative – Commercial & Schools	100%	3,524,325	1,281	2,044	$2,811,929	$253,561	$3,065,490	1.30
Commercial Custom	96%	2,343,510	635	638	$315,052	$35,898	$350,950	3.67
Commercial New Construction	100%	20,547,891	2,946	2,946	$1,799,501	$158,362	$1,957,863	6.73
Commercial Subtotal		**72,545,532**	**12,655**	**19,082**	**$12,015,030**	**$1,146,134**	**$13,161,164**	**3.23**
Energy Efficiency Subtotal		**123,697,002**	**26,254**	**50,804**	**$39,707,806**	**$4,010,308**	**$43,718,114**	**1.99**

[1] Includes net energy and non-coincident demand savings from LED streetlights.

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net Peak Demand Savings (kW)	Net Non-Coinc. Demand Savings (kW)	Rebate $	Admin and Marketing $	Total Program Spending	Benefit-Cost Ratio
Demand Response Programs								
Smart Thermostat	100%	931,047	39,851	39,851	$6,176,118	$487,662	$6,663,780	0.50
Home Manager	100%	325,611	34,058	34,058	$7,615,747	$1,941,292	$9,557,039	1.04
Commercial Demand Response	100%	1,749,042	82,050	82,050	$5,463,450	$498,042	$5,961,492	1.47
Auto Demand Response	100%	20,237	1,868	1,868	$913,358	$83,261	$996,618	0.36
Emergency Demand Response	100%	4,476	4,476	4,476	$109,148	$9,950	$119,098	2.83
Nest Program	100%	15,569	1,412	1,412	$202,249	$89,057	$291,306	1.48
Think Eco Room AC	100%	2,426	128	128	$337,538	$82,825	$420,363	0.10
Demand Response Subtotal		**3,048,408**	**163,842**	**163,842**	**$20,817,607**	**$3,192,089**	**$24,009,696**	**0.89**
Grand Total					**$60,525,413**	**$7,202,396**	**$67,727,810**	**1.51**

Note: Net savings = gross savings * NTG ratio / (1 – line loss factor)

For Demand Response (DR) programs, the above table includes estimated savings from all active participants as of the end of FY 2015, including those who signed up in previous years, as this most accurately represents DR capabilities in FY 2016 and beyond.

For DR program benefit-cost calculations, Frontier analyzed only the cohort of participants added in FY 2015. This approach is consistent with other program benefit-cost calculations, but caution is advised when comparing these results to benefit-cost calculations from prior years. This is especially the case where there are significant differences between cohorts from FY 2015 and other years. For example, in FY 2015, the Smart Thermostat program enrolled a much higher percentage of multifamily customers than in other years, and these sites have a significantly lower kW savings than the program's historical average kW per site. Adjustments to the Effective Useful Life (EUL) for certain residential DR devices also reduced the benefit-cost ratio for the Smart Thermostat and Home Manager programs.

2. EVALUATION METHODS

2.1 ENERGY IMPACTS

Frontier's approach to this project has been to leverage existing EM&V work previously conducted for CPS Energy and other electric utilities in Texas. For the past fifteen 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 has culminated in the publication of the *Texas Technical Reference Manual*,[2] a compendium of algorithms, baseline efficiency data, efficiency standards, energy savings calculations and data tables. By utilizing the TRM, Frontier can provide 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.

For the demand response and commercial custom and new construction projects, Frontier's approach has been to utilize the work performed by the previous EM&V consultant during FY 2015. Frontier reviewed the previous consultant's work and has found their impact estimates to be reasonable.[3] As a result, the methods and impact estimates utilized for this review will be consistent with those used in previous years. For future CPS Energy reports, Frontier will review and update all methods and algorithms to incorporate new baselines, efficiency standards and analytical tools.

2.2 PEAK DEMAND IMPACTS

The peak demand savings values in Texas Technical Reference Manual version 2.1 (TRM v. 2.1) have been adopted from a variety of sources and peak period definitions. To apply a more consistent method for calculating coincident peak demand savings Frontier employed a probabilistic analysis using San Antonio TMY3 hourly weather data. [4] This approach uses TMY3 hourly data correlated to Electric Reliability Council of Texas (ERCOT) zonal peak conditions, and calculates a probability-weighted estimate of the average kW savings during the twenty hours with the highest probability of occurring during CPS Energy's system peak. This approach has been adopted for use in the Texas TRM v3.0, to be used by all investor-owned electric utilities beginning in 2016. Based on Frontier's analysis, the twenty hours presented in Table 2.2-1 have the highest probability of occurring during CPS Energy's peak (listed in order of probability, from highest to lowest.

[2] Public Utility Commission of Texas (PUCT) Technical Reference Manual (TRM) v. 2.1. Available for download at: http://texasefficiency.com/index.php/regulatory-filings/deemed-savings

[3] Note: While Frontier has reviewed prior work performed by other consulting/engineering firms as part of this project, Frontier makes no representations or claims about the accuracy of this work, nor the methods, models, algorithms or processes used to evaluate these projects or measures.

[4] 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.

Table 2.2-1: Top 20 Hours from Probabilistic Analysis

Month	Day	Hour Start
August	27	15
August	27	16
June	28	16
August	27	17
June	28	15
August	27	14
June	27	16
June	24	14
August	26	16
June	24	15
June	25	15
June	28	17
June	24	16
June	25	16
June	28	14
August	30	15
August	20	16
August	21	16
August	30	16
June	27	15

The coincident peak savings are calculated using an average of the kW in each of these time periods, weighted by the probability that each of those hours will occur during the system peak. This approach was used for all measures, except where noted.

2.3 NET IMPACTS

To derive net impacts, Frontier utilized Net-to-Gross (NTG) ratios provided by CPS Energy. A line loss factor was also applied to each measure's gross energy and peak demand impacts.

2.4 AVOIDED COST BENEFITS

2.4.1 Avoided Capacity and Energy

Avoided cost benefits were calculated using CPS Energy avoided capacity and energy costs, as well as CPS Energy's standard discount rate. The Estimated Useful Life (EUL) values from the Texas TRM were utilized for all measures, except where noted. For the purposes of calculating avoided energy benefits, annual kWh were allocated into one of the following time periods, based on season, day of the week and hour of the day:

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

Frontier developed or adopted appropriate 8760-hour load shapes for each CPS Energy program's measures, in order to assign annual kWh to the appropriate cost periods. The non-coincident peak for each measure is also based on these load shapes.

2.4.2 Avoided Transmission Charge (ERCOT 4CP TCOS)

ERCOT recovers the costs of transmission incurred by transmission service providers via a charge on distribution utilities, including CPS Energy. The charge is allocated to distribution utilities based on each utility'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.

To estimate gross demand reduction during FY 2015 4CP events, within each demand response program/subprogram we multiplied the estimated load reduction per participant by the number of active participants and the FY 2015 actual "deployment success rate," the rate at which CPS Energy correctly anticipated and deployed each resource during FY 2015 4CP events.[5]

To estimate demand reduction for the purpose of cost/benefit analysis, within each program/subprogram we multiplied the estimated load reduction per participant by the number of net new participants in FY 2015 and an anticipated "deployment success rate," or the average rate at which we estimate CPS Energy will correctly anticipate and deploy each resource during future ERCOT 4CP events. We then translated capacity savings estimates into estimates of avoided ERCOT transmission charges by multiplying the avoided capacity by current and estimated future values of ERCOT's Transmission Cost of Service (TCOS), which range from about $46/kW currently to $66/kW in 2025. These calculations are performed over the estimated average duration of participation in each program/subprogram.

[5] Please note, CPS Energy's Commercial Demand Response offering for Emergency Demand Response is not eligible for pursuing 4CP benefits. This section and the resulting benefit calculations exclude that program offering.

2.4.3 Avoided Price Spikes Savings (kWh)

Another potential benefit of demand response programs derives from avoiding intervals of especially high energy prices in the ERCOT market. New ERCOT market rules coming into play in 2015 will allow energy prices to spike up to $9,000/MWh ($9/kWh), which is over 200 times the average wholesale price of energy from 2010-2013. By reducing demand during price spikes, CPS Energy can benefit by avoiding high prices for energy it needs, or by selling energy from its own or contracted generators into the market.

Price spikes in the ERCOT market have a number of causes, occur irregularly, and are hard to predict. ERCOT prices hit peaks 68 times in CPS' load zone during 2011, but only 7 times in the combined three years that followed. [6] Price spikes are also harder to react to in a timely manner with some demand response resources. For example, CPS Energy's Nest program requires day-ahead notice to the program implementer, which makes rapid response to an unexpected price spike event impossible. For these reasons, Frontier employed a conservative method toward evaluating CPS Energy's demand response programs' contribution toward reducing energy needs during price spike events.

To estimate energy (kWh) saved during FY 2015 price spike events, we compared the actual FY 2015 deployment schedule of each demand response program/subprogram to actual ERCOT price data, and determined that no price spike-related savings were achieved in FY 2015.[7]

To estimate energy (kWh) saved during future price spike events for the purpose of cost/benefit analysis, we multiplied the estimated energy savings during price spike events per participant by the number of net new participants in FY 2015 in each program or subprogram. This product is then multiplied by 1 hour to obtain estimated energy reduction in kWh during price spike events. It is equivalent to assuming that, on average, CPS Energy's demand response programs will successfully reduce energy consumption during price spikes for just 1 hour each year.

We converted avoided energy savings into avoided cost savings by assuming an average energy price during price spike events of $4,500/MWh, one half the 2015 ceiling price of $9,000/MWh. We used half the ceiling price to reflect the fact that ERCOT prices spike to a variety of levels, not always to the ceiling price.

[6] In this example, we define peak as a price of $3,000, the highest price allowed under ERCOT market rules prior to 2015.
[7] All demand response program offerings, including Emergency Demand Response, are included in this calculation of benefits associated with price spike avoidance.

2.5 ECONOMIC ANALYSIS

The following cost-effectiveness metrics were calculated for CPS Energy's programs:

- *Program Administrator Benefit-Cost Ratio*. This 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:

$$Benefit\ Cost\ Ratio = \frac{NPV\ of\ avoided\ cost\ benefit}{Program\ incentives + Admin\ Costs}$$

- *Cost of Saved Energy.* The 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) of the savings (weighted by measure) and an annual discount rate.

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

- *Net Avoided Cost Benefit.* 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.

3. RESIDENTIAL PROGRAMS

3.1 SUMMARY OF RESIDENTIAL IMPACTS

CPS Energy offered the following programs for the residential sector in FY 2015:

- Home Efficiency
- Air Flow Performance
- Heating, Ventilation, and Air Conditioning (HVAC)
- Solar Initiative - Residential
- New Homes Construction
- Refrigerator Recycling
- Weatherization
- Residential Lighting (LEDs)

CPS Energy's portfolio of residential programs addresses all markets and major residential end uses.

To evaluate energy impacts for most program measures, Frontier utilized the current version of the Texas TRM v. 2.1. For programs or measures where other methods were used, those are referenced in each section.

It should be noted that for some envelope measures, the non-coincident peak occurs during the non-summer months, since a significant number of measures were installed on homes with electric heating.

Except where noted, coincident peak values were calculated using the weighted-average 20-hour probability method, as outlined in Section 2.2.

The contribution of each residential program to the portfolio's energy, peak demand, and non-coincident peak savings are shown in the following charts.

All figures in the table and charts below and throughout this section represent energy and demand savings from new FY 2015 program participants as measured at the participant or end-user level. These savings are adjusted in the program portfolio rollup table in the executive summary and in benefit-cost calculations to account for net-to-gross ratios and distribution line losses.[8]

[8] Net-to-gross (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. Distribution line losses 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 on the distribution system.

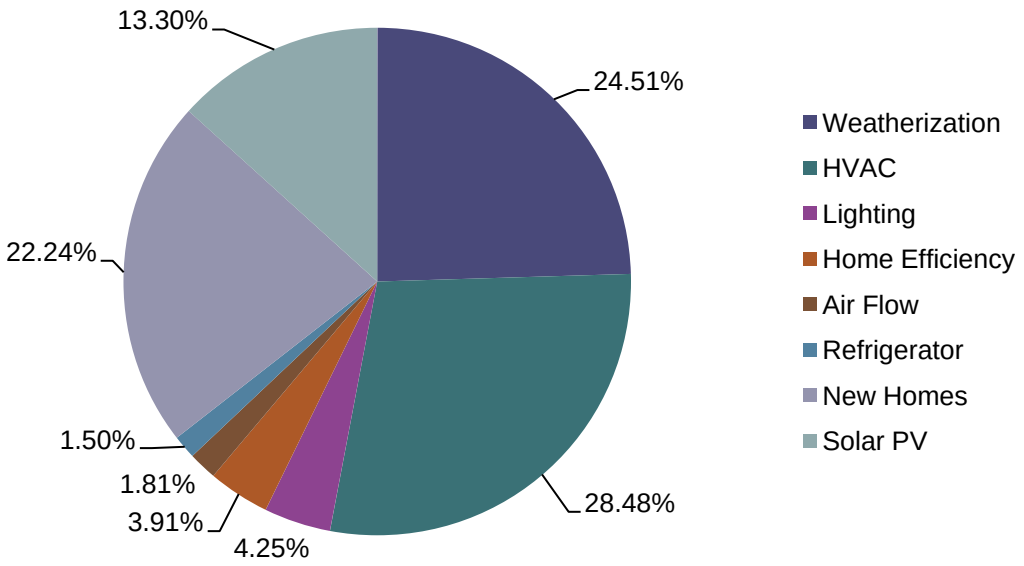


Figure 3.1-1: Summary of Residential Impacts – kWh by Program

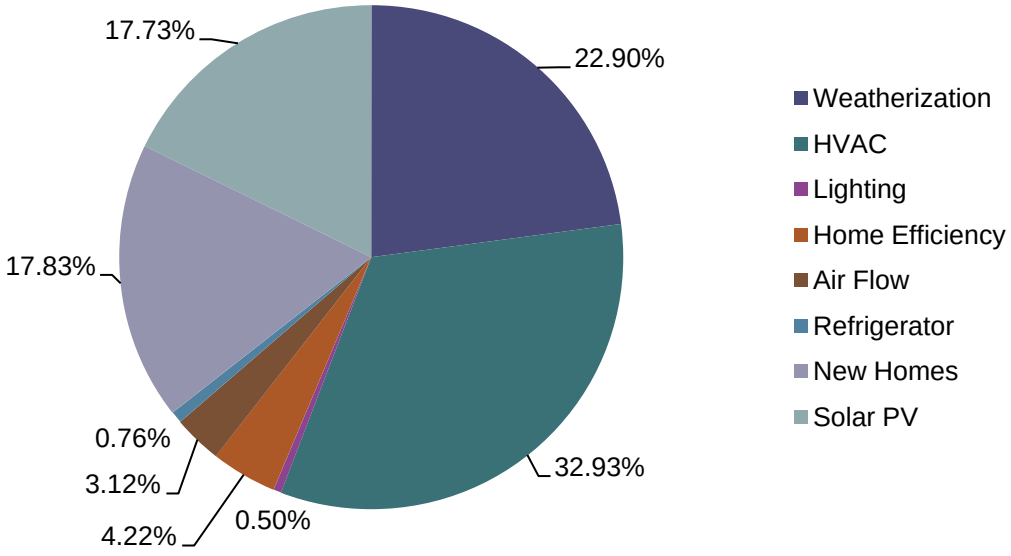


Figure 3.1-2: Summary of Residential Impacts – Coincident kW by Program

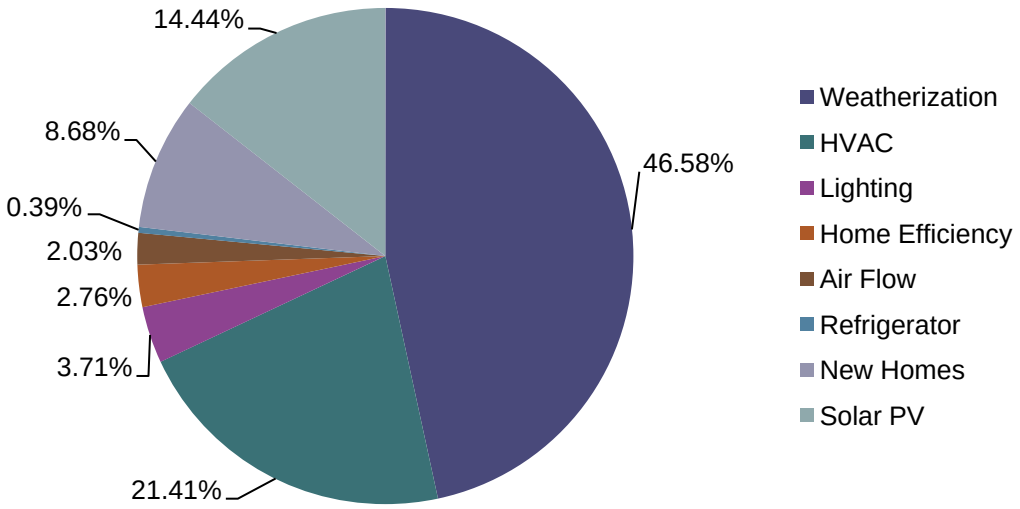


Figure 3.1-3: Summary of Residential Impacts – Non-Coincident kW by Program

3.2 HOME EFFICIENCY PROGRAM

3.2.1 Overview

CPS Energy's Home Efficiency program is composed of three elements:

- Ceiling insulation
- Heat pump water heaters
- Variable-speed pool pumps

Proportion of total energy savings is presented in Figure 3.2-1.

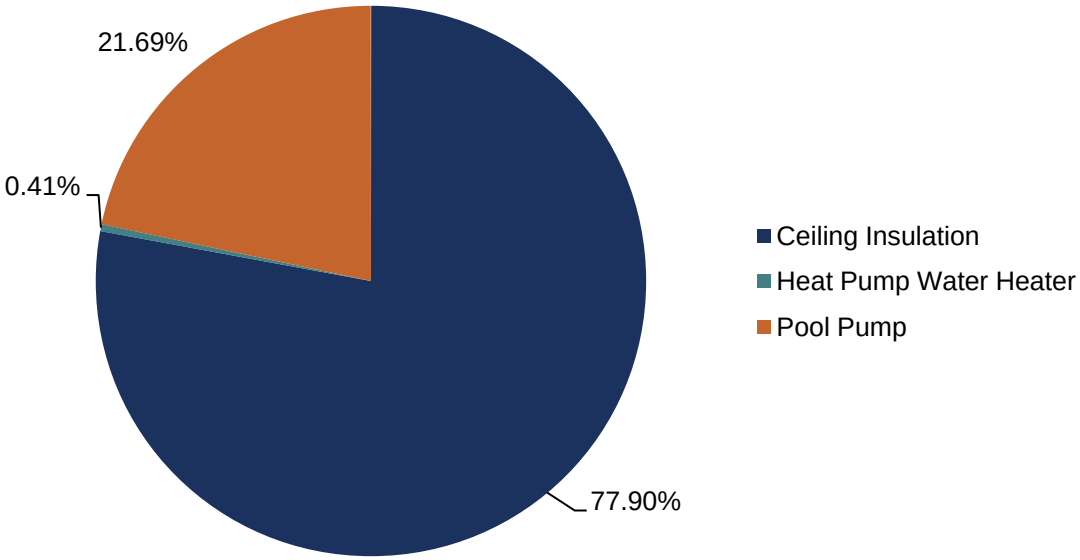


Figure 3.2-1: Home Efficiency Program – kWh by Measure

3.2.2 Savings Calculation Method

3.2.2.1 Ceiling Insulation

CPS Energy incentivized 1,877 ceiling insulation installations in FY 2015.

Energy savings for this measure are calculated using Texas TRM v. 2.1 savings values:

Table 3.2-1: Home Efficiency - Residential Ceiling Insulation Deemed Annual Energy Savings (kWh)

Ceiling Insulation Base R-value	Gas Heat (per sq. ft.)	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	1	4.4	2.14
R-1 to R-4	0.64	2.81	1.4
R-5 to R-8	0.32	1.38	0.7
R-9 to R-14	0.17	0.72	0.36
R-15 to R-22	0.07	0.3	0.15

The savings values in Table 3.2-1 assume that the base R-value is within one of the five ranges listed above, that the final R-value is 30, and that there are three possible heating/cooling fuel types. The CPS Energy program has a much higher number of possible combinations of starting R-values, final R-values, and heating and cooling equipment combinations. In order to apply these savings values, Frontier mapped each of the program's insulation measures into the

above categories, using each measure's estimated Btuh reduction per square foot. For homes listed as having "mixed" heating fuels, Frontier averaged the gas heat and electric heat savings values.

Non-coincident peak demand savings were calculated using residential heating and cooling load profiles developed using US Department of Energy's (DOE) BEopt and EnergyPlus residential simulation modeling software.

The estimated useful life (EUL) for ceiling insulation is 25 years, based on Texas TRM v. 2.1.

Savings for ceiling insulation are highly dependent on the base, or initial R-value, as can be noted in Table 3.2-1. Collecting additional data on the type, thickness, and overall condition of the existing insulation will help improve the process for estimating baseline R-values.

3.2.2.2 Heat Pump Water Heaters

The CPS Energy Home Efficiency program incentivized the installation of five heat pump water heaters (HPWH) in FY 2015. Heat pump water heaters work by using a small direct-exchange refrigeration system to remove heat from the ambient air and use that heat to heat water for domestic use. These units can provide Efficiency Factors (EF) in the 2.2 range, making them over twice as efficient as conventional electric resistance water heaters.

Energy savings for this measure are calculated using Texas TRM v. 1.0:

Table 3.2-2: Home Efficiency - Residential HPWH Deemed Annual Energy Savings (kWh)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	Gas	1,377	1,573	1,893	2,341
	Heat Pump	1,141	1,333	1,647	2,088
	Elec. Resistance	833	1,021	1,327	1,758
Unconditioned Space	N/A	1,202	1,398	1,718	2,167

The installations were assumed to be in unconditioned spaces. From Table 3.2-2, the average annual savings for this measure are estimated at 1,616 kWh per installation.

Non-coincident peak demand savings were calculated using a DHW load profile developed from the Building America Analysis Spreadsheet for existing homes.[9]

The EUL for heat pump water heaters is 13 years, based on Texas TRM v. 1.0.

[9] Building America Analysis Spreadsheet for existing homes, accessed on February 23, 2015 from http://energy.gov/eere/buildings/downloads/building-america-analysis-existing-homes.

3.2.2.3 Variable-Speed Pool Pumps

One of the most significant consumers of energy in a home with a swimming pool is the pool pump. The motors in these pumps are usually single-speed, standard-efficiency motors that are often oversized. Pool pumps can consume upwards of 5,000 kWh per year, depending on the size of the pool and operating conditions. Variable-speed pool pumps (VS Pool Pump) can reduce pool pump energy use by 50% to 75%. Through the Home Efficiency program, CPS Energy provided incentives for the installation of 181 variable-speed pool pumps.

For this measure Frontier utilized the algorithms and assumptions in the ENERGY STAR Pool Pump Calculator.[10] The calculator's default values were used for pool size, turnovers, months per year of operation, and existing pool pump motor horsepower. Using these values, the calculator produced an estimate of 2,338 kWh per year per installation.

To determine coincident peak demand savings, Frontier used load data collected through a metered study conducted by Southern California Edison.[11]

The EUL of this measure is 10 years, based on the California Database of Energy Efficiency Resources (DEER).

3.2.3 Results and Recommendations

The total energy and demand savings for the Home Efficiency Program are as follows:

Table 3.2-3: Home Efficiency Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Ceiling Insulation	1,520,109	473	632
HPWH	8,070	0.66	2
VS Pool Pump	423,246	84	114
Total	1,951,425	558	748

3.3 AIR FLOW PERFORMANCE PROGRAM

3.3.1 Overview

CPS Energy's Air Flow Performance Program offers incentives to promote energy efficiency improvements of heating, ventilation, and air conditioning (HVAC) distribution systems through duct leakage testing and subsequent duct repair or replacement.

[10] Downloaded from http://www.energystar.gov/products/certified-products/detail/pool-pumps. Accessed 3/1/2015.

[11] "Pool Pump Demand Response Potential, Demand and Run-Time Monitored Data." Southern California Edison. June 2008. Table 19. http://www.etcc-ca.com/sites/default/files/reports/dr07_01_pool_pump_demand_response_potential_report.pdf . Accessed 2/24/2015.

The program had 379 projects in FY 2015. This corresponds to a 4% increase in program participation compared to FY 2014 and 17% increase compared to FY 2013.

3.3.2 Savings Calculation Method

Energy and demand savings were estimated using algorithms developed by Frontier for the current version of the state of Texas Technical Reference Manual (TRM v. 2.1).[12] For this measure, Frontier replaced any weather specific assumptions with San Antonio climate data.

The savings calculation method outlined in the TRM relies heavily on pre and post leakage testing results. Therefore, the TRM requires a leakage-to-outside testing strategy rather than a total leakage approach. This data was not available as part of the Air Flow Performance program. To compensate, Frontier applied a leakage-to-outside adjustment factor for homes where a flow hood total leakage test was performed. To develop the adjustment factor, Frontier assumed that 100% of ducts are located in unconditioned space in single-story or split level homes, and that 50% of ducts are located in unconditioned space in two or three-story homes. Applying those assumptions against the estimated distribution of building types yielded a weighted adjustment factor of 0.85.

Starting leakage values were capped at 35% of the total fan flow of the existing HVAC equipment.

The combination of these adjustments reduced Frontier's estimates of both starting and ending leakage values, compared to reported values.

Non-coincident peak demand savings were calculated based on residential heating and cooling load profiles developed using US DOE's BEopt and EnergyPlus residential simulation modeling software.

3.3.3 Results and Recommendations

Total energy and demand savings for duct repairs and replacements are included in Table 3.3-1:

Table 3.3-1: Air Flow Performance Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Duct Sealing/ Replacement	901,756	412	551

CPS Energy may consider the following Frontier recommendation for future implementation of the Air Flow Performance Program:

[12] Public Utility Commission of Texas (PUCT) Technical Reference Manual (TRM) v. 2.1. Available for download at: http://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

- In FY 2015, 98% of projects participating in the program utilized flow hood testing while just 2% utilized duct blaster testing. Frontier recommends that all projects be required to complete leakage-to-outside testing using a combination duct blaster and blower door. This would eliminate the need for a leakage-to-outside adjustment factor and help ensure that the savings are only awarded for the prevention of air leakage to unconditioned space.

3.4 RESIDENTIAL HVAC PROGRAM

3.4.1 Overview

CPS Energy's Residential Heating, Ventilation, and Air Conditioning (HVAC) Program offers incentives to promote the installation of energy efficient HVAC equipment. The program covers the installation of central air conditioners, central heat pumps, window air conditioners, and ground source heat pumps.

The program had 8,501 projects in FY 2015, including 3,323 central air conditioners (ACs), 2,434 central heat pumps (HPs), 2,743 window air conditioners (WACs), and one ground source heat pump (GSHP). This corresponds to a 13% decrease in program participation compared to FY 2014.

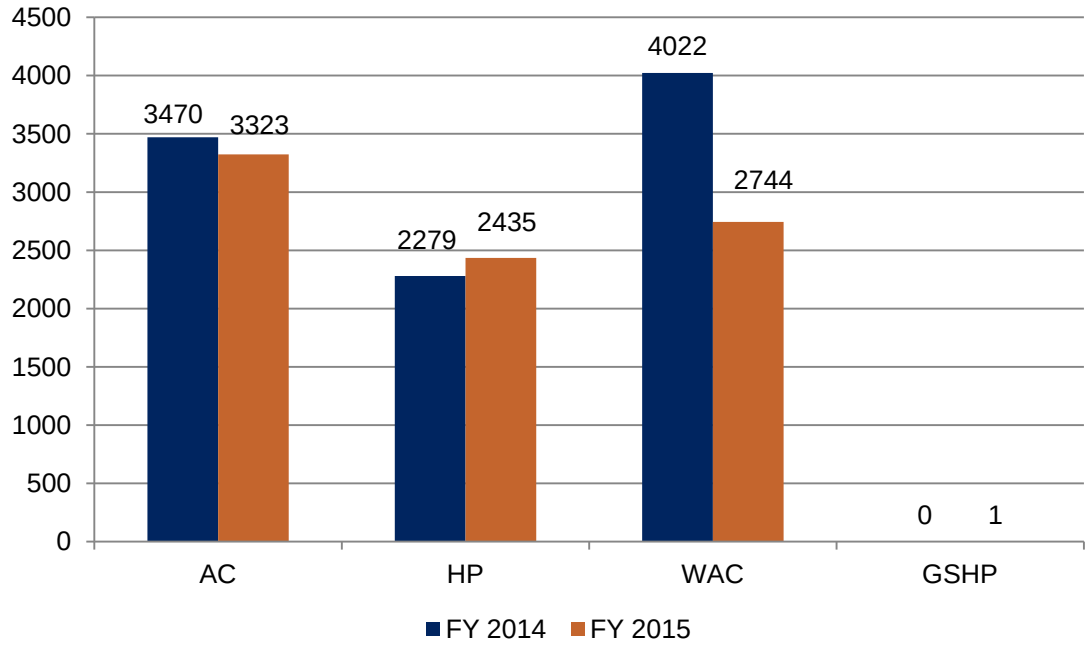


Figure 3.4-1: Residential HVAC - FY 2014-2015 Participation Comparison

3.4.2 Savings Calculation Method

Energy and demand savings for central air conditioners and heat pumps were estimated using algorithms developed by Frontier for the state of Texas Technical Reference Manual (TRM v. 1.0), as approved by the Public Utility Commission of Texas.[13]

Energy savings for window air conditioners and ground source heat pumps were estimated using algorithms developed by Frontier for the current version of the Texas TRM (v. 2.1).

Frontier used approved deemed savings values for TRM climate zone 3 for central air conditioners and heat pumps. Frontier replaced any weather specific assumptions related to the window air conditioner and ground source heat pump measures with San Antonio climate data.

3.4.3 Equipment Verification

To verify the accuracy of the efficiency data listed in the program database, Frontier randomly selected sample projects to validate equipment capacity and efficiency based on manufacturer and model number. Reported AC, HP, and GSHP values were compared against equipment information maintained by the Air Conditioning, Heating, and Refrigeration Institute (AHRI).[14] Reported WAC values were compared to manufacturer specification sheets and/or equipment information maintained by ENERGY STAR.[15] Because CPS Energy conducted their own AHRI review, Frontier reviewed 1% of the overall project portfolio for AC, HP, and WAC.

[13] Public Utility Commission of Texas. Technical Reference Manual Version 1.0. Volume 1. December 13, 2013. http://texasefficiency.com/images/documents/Publications/Reports/trmv1_volume%201%20overviewanduserguide%20dated%2012-13%20final%2012-18-2013.pdf. TRM v. 1.0 was used to reflect the federal standards that were in effect for FY 2015. The current version of the Texas TRM was updated to reflect new residential HVAC efficiency standards that went into effect January 1, 2015.

[14] AHRI Certification Directory: https://www.ahridirectory.org/ahridirectory/pages/home.aspx.

[15] ENERGY STAR Certified Room Air Conditioners: http://www.energystar.gov/productfinder/product/certified-room-air-conditioners/.

- 33 of 33 AC units were verified as having the correct capacity and cooling efficiency ratings.
- 21 of 24 HP units were verified as having the correct capacity and cooling/heating efficiency ratings. The discrepancies were not significant enough to change the deemed savings.
- 27 of 27 WAC units were verified as having the correct capacity and cooling efficiency ratings.

No adjustments were made to the unsampled reported capacity or efficiency values as a result of the equipment verification review.

3.4.4 Results and Recommendations

Total energy and demand savings for the installation of central air conditioners, central heat pumps, window air conditioners, and ground source heat pumps are included in Table 3.4-1.

Table 3.4-1: Residential HVAC Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Heat Pump	6,049,659	1,610	2,150
Central AC	7,597,487	2,381	3,182
Window Air Conditioners	546,763	352	471
Ground Source Heat Pump	6,792	1.66	2.22
Total	14,200,701	4,345	5,805

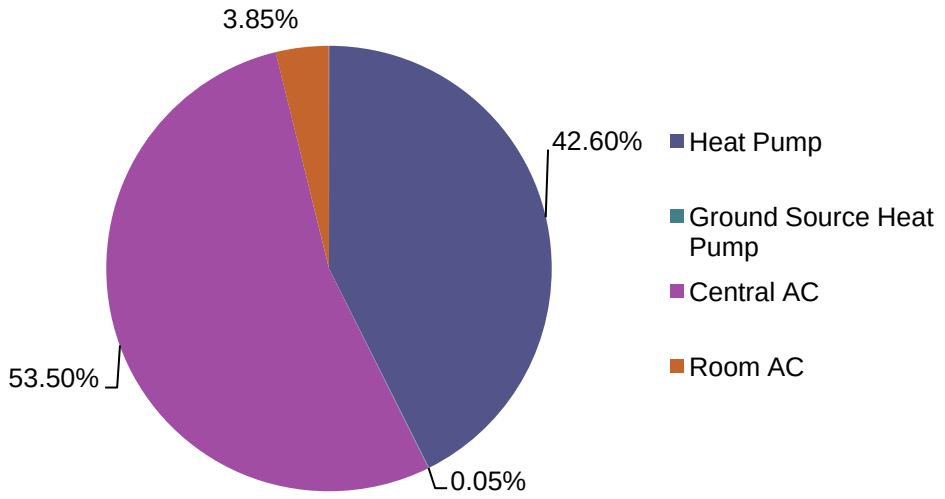


Figure 3.4-2: Residential HVAC Program – kWh by Measure

The following are Frontier's recommendations for future implementation of the Residential HVAC Program:

- An invoice amount should be captured for each project, if possible, to assist in determining appropriate incremental costs for the measure. During FY 2015, an invoice amount was not collected for 37% of project installations.
- Ensure that program minimum efficiency requirements for central and ground source heat pumps are raised to reflect the updated central heat pump efficiency standards effective January 1, 2015.[16] Updated federal efficiency standards for central air conditioners will not be enforced in 2015 based on a settlement between the Department of Energy and the American Public Gas Association that permits distributors and retailers to sell central air conditioners that do not meet regional standards until July 1, 2016 without penalty.
- Ensure that program minimum efficiency requirements for window air conditioners are raised to reflect the updated room air conditioner efficiency standards effective June 1, 2014.[17]

[16] Department of Energy Standards and Test Procedures for Residential Central Air Conditioners and Heat Pumps. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75.
[17] Department of Energy Standards and Test Procedures for Residential Room Air Conditioners. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/41.

3.5 SOLAR INITIATIVE - RESIDENTIAL PROGRAM

3.5.1 Overview

CPS Energy offers rebates for residential solar photovoltaic (PV) and solar thermal (hot water) systems; however, during the FY 2015 program year there were no solar thermal systems installed. Residential solar PV rebates were offered at $1.60 per AC watt up to the lesser of $25,000 or 50% of the total installation price; and at $1.30 per AC watt for non-local installers. All residential solar PV systems were required to be installed by a CPS Energy certified contractor. Rebates were 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 in a net metering arrangement. Systems must be permitted, pass all required inspections, and comply with CPS Energy's requirements for interconnection.

In FY 2015, 735 residential solar PV systems totaling 4,651 kWdc were installed, and $6.475 million in rebates distributed. The average residential solar PV system size was 6.3 kWdc. The figure below summarizes the residential solar PV program history in terms of capacity installed, average system prices and rebate levels annually.

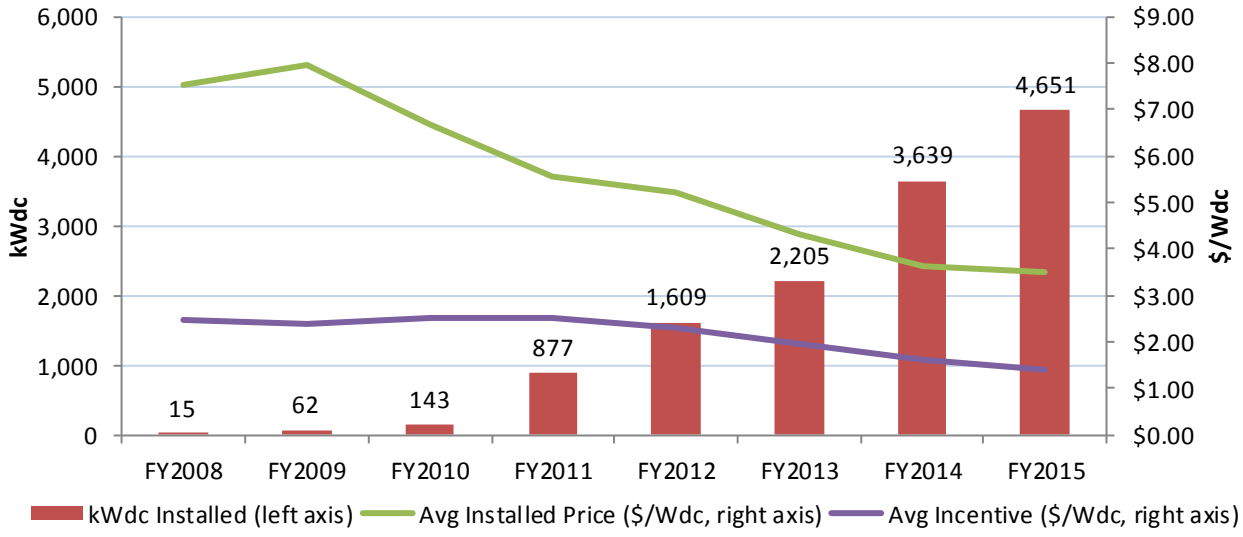


Figure 3.5-1: Residential Solar PV Program History - Annual Capacity Installed, Average System Price, and Average Rebate Levels

3.5.2 Savings Calculation Method

Texas PUC Deemed Savings values are available for solar PV installations.[18] However, it is

[18] Deemed Savings, Installation & Efficiency Standards. Residential and Small Commercial Standard Offer Program. Frontier Associates LLC. January FY 2013.

possible to obtain more accurate savings values for systems installed in the CPS Energy service area. The following subsections describe Frontier's approach to estimating savings for residential PV installations.

3.5.2.1 Energy Savings (kWh)

Energy savings estimates were generated by modeling the annual energy production from a representative fleet of residential PV systems using the National Renewable Energy Laboratory's (NREL) PVWatts version 5 (released in November 2014) and Typical Meteorological Year version 3 (TMY3) weather data from the San Antonio International Airport (SAIA) station.[19]

The representative fleet was constructed from a weighted average of 7 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. Because CPS Energy utilized PVWatts version 1 and TMY2 weather data to produce its estimates of annual energy production from individual systems, Frontier also used PVWatts version 1 and TMY2 to produce the weightings. This approach to fleet modeling was necessary because CPS Energy's database of installed systems does not store tilt, orientation, and shading information necessary to model production from individual systems.

Once the fleet weightings were established, Frontier modeled fleet annual energy production using PVWatts version 5 and TMY3 weather data from the San Antonio International Airport station.[20]

Our method results in an estimate of annual PV production (kWh energy savings) that is about 7-9% greater than CPS Energy's estimate, but approximately 11-12% less than that derived using Deemed Savings values from the Texas TRM v. 2.1.

3.5.2.2 Peak Demand Savings (kW)

Frontier's approach to estimating peak demand savings utilized a probabilistic analysis based on modeled system performance during the 20 highest probability summer peak hours. In essence, the approach relates TMY3 hourly weather data to hourly estimates of CPS Energy's residential PV fleet energy production, selects certain hours most likely to be correlated to ERCOT zonal peak conditions, and calculates a probability-weighted estimate of PV production during those peak hours.

[19] Frontier examined PV production as modeled using three different San Antonio TMY3 data sources and used (SAIA) to be consistent with the probabilistic analysis for Demand Savings. Using an average of three stations would result in estimated kWh savings of about 98% of our reported estimate.

[20] 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. It may also be appropriate to derate both Frontier's and CPS Energy's estimates to account for shading and system downtime. CPS Energy's recorded estimates of system performance assume no shading is present on any system, and its database contains no record of shading estimates produced by certified contractors or of downtime once systems are commissioned. Frontier estimates the appropriate derating factor for shading to be approximately 3-5 percent based on experience with other Texas PV incentive programs, and the derating factor for downtime at approximately 1-3 percent. Frontier did not apply these derating factors to our estimates due to the lack of available data, but recommend additional research to validate appropriate factors.

This method results in an estimate of coincident peak demand savings that is about 60% of the estimate derived using the Texas TRM v. 2.1. The difference is due to the fact that the probabilistic approach places heavier emphasis on late afternoon hours (5-8 pm) in late summer, when PV production tends to be lagging, and takes a weighted average of modeled PV production during those hours, whereas the TRM v. 2.1 approach: 1) casts a wider net in defining peak periods (extending earlier into the afternoon), and 2) utilizes the maximum expected PV production during those periods.

3.5.2.3 Non-Coincident Demand Savings (kW)

Non-coincident demand savings represent the maximum kW produced by the modeled representative fleet of residential PV systems installed in FY 2015 in any non-peak hour. This value is roughly equivalent to that derived using the Texas TRM v. 2.1 method for peak demand savings.

3.5.3 Results and Recommendations

The gross energy and demand savings for the Residential Solar Initiative are presented in Table 3.5-1.

Table 3.5-1: Residential Solar Initiative Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Residential Solar PV	**6,632,015**	**2,340**	**3,916**

CPS Energy is currently investigating options for a new solar initiative in FY 2016 in which developers selected by CPS Energy will install and maintain solar systems on residential and commercial rooftops at no cost to the customer. CPS Energy will buy the output, and the customer would be paid for the use of the roof.

With the understanding that the current program may be discontinued or significantly changed, Frontier makes the following recommendations which may have relevance to future program design and implementation:

- There is considerable room for incentive levels to be reduced, improving program cost-effectiveness while enabling wider participation. CPS Energy's FY 2015 incentive levels were among the highest offered in Texas.
- In addition to values already stored, CPS Energy should record and maintain array tilt, orientation, and shading values in the program database. These values are necessary for accurate modeling and for verification purposes.
- CPS Energy should ensure that interconnection inspectors and/or M&V contractors verify installed equipment and reported shading factors in addition to performing a

backfeed test when they visit the site, at least for larger installations and for a randomly selected sample of smaller installations.

- The accuracy of energy saving validations could be enhanced over time with access to meter data, including data from both solar meters and customer revenue meters.

3.6 NEW HOMES CONSTRUCTION PROGRAM

3.6.1 Overview

CPS Energy's FY 2015 program provided incentives for 2,139 new homes completed in 2015, up significantly from the 1,790 participants in FY 2014. The 2,139 new homes built through the program reflect the participation of at least 17 builders.

CPS Energy provided two participation tiers for its FY 2015 New Homes Construction program. Both can be achieved by either exceeding a threshold level of improvement over the expected performance of a home built to the 2009 International Energy Conservation Code (IECC), or via an ENERGY STAR New Homes path, which requires obtaining a HERS rating.

- Tier 1: $800 incentive, available to homes meeting one of the following two threshold criteria:
  - 15% better than IECC 2009
  - HERS index 75 or lower
- Tier 2: $1,500 incentive, available for homes meeting a higher threshold:
  - 30% better than IECC 2009
  - HERS index 57 or lower

In FY 2015, 2,072 homes (97 percent of projects) met or exceeded the Tier 1 criteria, while 67 homes (3 percent) met or exceeded the threshold for the $1,500 incentive.

3.6.2 Savings Calculation Method

Frontier's evaluation of the New Homes Construction program for FY 2015 consisted primarily of a review of program reporting and CPS Energy's application of previously-derived demand and energy savings estimates:[21,22]

- Demand Savings (kW): Demand savings are estimated to be 1.1 kW per project. It is assumed that there is no difference between peak-coincident demand savings and non-coincident demand savings.

[21] The demand and energy savings estimates detailed in this section were derived for CPS Energy by Nexant, Inc.
[22] Due to time limitations, Frontier was unable to independently verify these relationships for its FY 2015 program assessment. Frontier anticipates applying an independently-developed verification approach for assessing the FY 2016 program.

- Energy Savings (kWh): Energy savings are estimated according to a formula that relates the percent improvement over code to kWh.

$$kWh = {}^{[\,\%\ improvement\ over\ code]}/_{100}\ x\ 23{,}886$$

- Essentially, every percent improvement over IECC 2009 provides approximately 240 kWh in annual energy savings. HERS ratings are similarly related to percent improvement over code by a formula:

$$\%\ improvement\ over\ code = [-1.143\ x\ HERS] + 99.4$$

3.6.3 Results and Recommendations

CPS Energy's New Homes Construction program produced over 11 million kWh of energy savings and 2,300 kW of demand savings in FY 2015.

Table 3.6-1: New Homes Construction Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
New Homes Construction	11,092,889	2,353	2,353

Because CPS Energy has adopted for its own internal use the savings estimates provided by its previous EM&V consultant and Frontier has not implemented a revision to those estimates, claimed and verified savings are the same and the program has been assigned a realization rate of 100 percent.

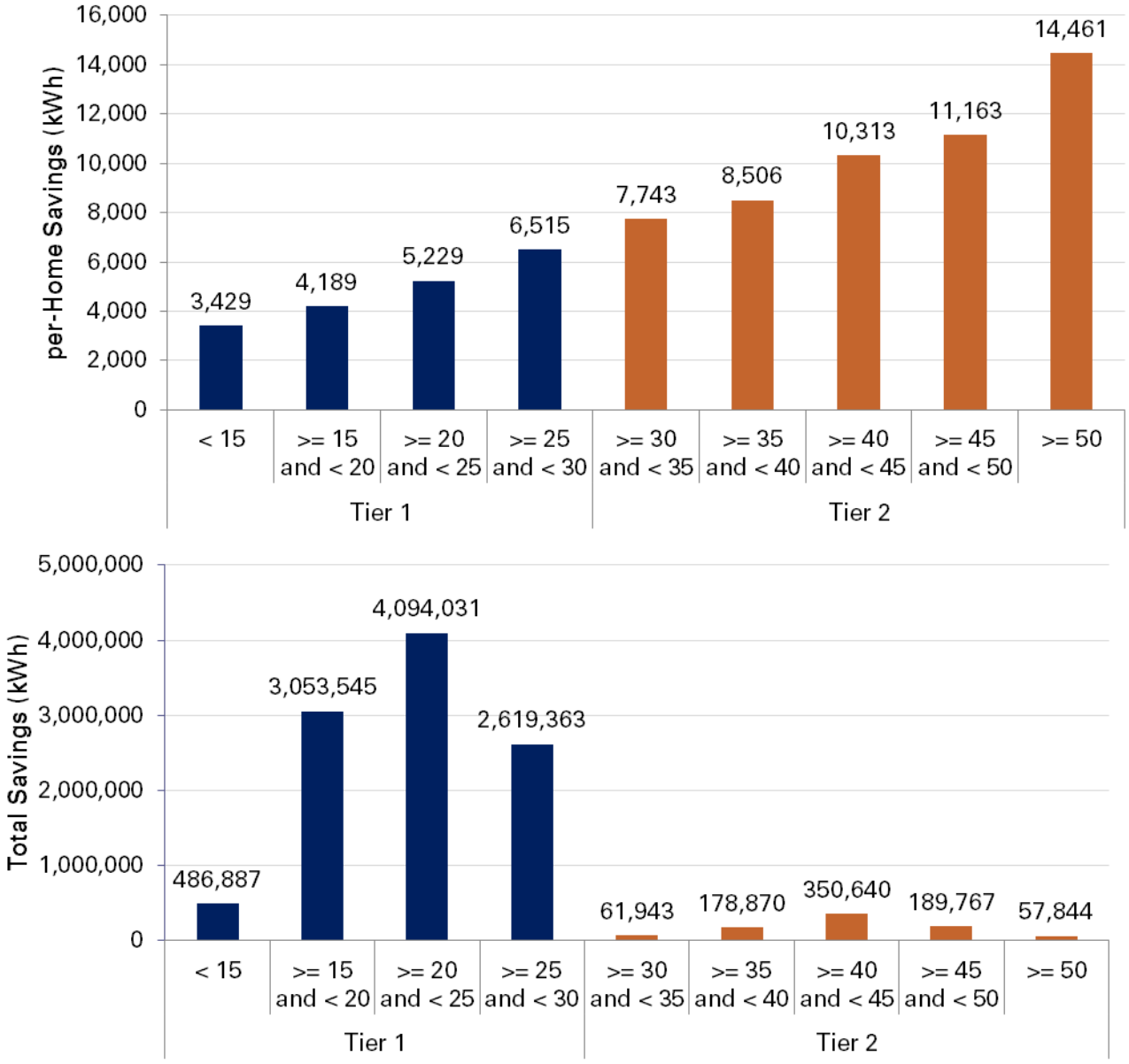


Figure 3.6-1: New Homes Construction - Per-Home and Total Energy Savings by Incentive Tier and % Improvement over IECC 2009

Figure 3.6-1 shows the energy savings obtained from homes according to the extent to which they exceeded IECC 2009, and the total savings the programs derived from homes for each group. Tier 1 homes achieving 15-20 percent improvement over code deliver just over 4,000 kWh of energy savings. Because CPS Energy does not make additional payment for the amount by which the 15 percent threshold is achieved, the savings in excess of 4,000 kWh for the homes providing 20 to 30 percent improvement are essentially 'free.' Similarly, the savings in excess of the 7,700 kWh provided by Tier 2 homes in the ranges above 30 to 35 percent are

also 'free.' However, as the bottom portion of the figure shows, because there were so few Tier 2 projects, overall these homes delivered much less total savings than the Tier 1 homes.

For FY 2016, Frontier recommends re-evaluating the relationships between HERS index, levels of improvement above code specifications, and demand and energy savings.

3.7 REFRIGERATOR RECYCLING PROGRAM

3.7.1 Overview

CPS Energy implements a refrigerator efficiency program that incorporates two elements: (1) a rebate program to encourage the purchase of ENERGY STAR new refrigerators and; (2) a recycling program to remove older, less-efficient units. Customers receive a $65 incentive for recycling a working refrigerator, and $35 for the purchase of an ENERGY STAR model.

Unlike other programs to promote the purchase of energy-efficient products, energy savings from programs to incentivize the purchase of more-efficient refrigerators are not immediately realized upon the installation of the more-efficient unit. This is because older units often are kept operating as secondary units. According to the most recent US EIA Residential Energy Consumption Survey (RECS),[23] 21% of Texas households have two or more refrigerators. These units are often located in unconditioned spaces, which results in increased summer peak demand.

In FY 2015, 620 units were recycled, compared with 619 from FY 2014. In FY 2015, 384 customers received an incentive for the purchase of an ENERGY STAR model, down from 452 in FY 2014.

3.7.2 Savings Calculation Method

For the refrigerator replacement measure, energy savings are estimated using tables from Texas TRM v.1.0, since TRM v. 2.1 references the ENERGY STAR standard that was revised September, 2014. A replace-on-burnout scenario is assumed.

Table 3.7-1: ENERGY STAR Refrigerator Deemed Energy Savings

Replace on Burnout kWh Savings
123

Earlier versions of the Texas TRM did not include savings for refrigerator recycling. As a result, previous versions of this report utilized a method published by the National Renewable Energy Lab.[24] Texas TRM v. 2.1 contains a method for calculating energy and peak demand savings

[23] US Energy Information Administration. "Residential Energy Consumption Survey." Accessed March, 20, 2015. http://www.eia.gov/consumption/residential/index.cfm

[24] National Renewable Energy Lab. "The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures." Golden CO: NREL, April 2013.

associated with refrigerator recycling and refrigerator replacement:

Energy savings are calculated as follows:

$$\boldsymbol{kWh_{savings} = kWh_{existing} \times ISAF \times PUF}$$

Where*:*

$kWh_{existing}$ = *Average annual energy consumption*[25] $= 1{,}308\ kWh$

$ISAF$ = *In Situ Adjustment Factor*[26] $= 0.942$

PUF = *Part Use Factor*[27] $= 0.915$

$kWh_{savings}$ = $1{,}227$

Non-coincident peak demand savings were calculated using a refrigerator load profile developed from the Building America Analysis Spreadsheet for existing homes.[28]

3.7.1 Results and Recommendations

The Estimated Useful Life (EUL) for ENERGY STAR refrigerators is 17 years, based on Texas TRM v. 2.1. For the recycling measure, the EUL is 8 years, based on the assumed remaining service life of the recycled unit.

[25] The Cadmus Group, Inc. "Residential Retrofit High Impact Measure Evaluation Report". Prepared for California Public Utilities Commission Energy Division. February 8, 2010. Average of DOE-Based Full-Year Unit Energy Consumption (weighted by representative utility survey participation).
[26] Ibid. Factor to account for variation between site conditions and controlled DOE testing conditions (90 °F test chamber, empty refrigerator and freezer cabinets, and no door openings). Appliances in warmer climate zones use more energy than those in cooler climate zones; utilized SCE data (highest percentage of warm climate projects) to best approximate Texas climate, p. 139-140.
[27] Ibid. Factor to account for the number of refrigerators that were running, running part time, or not running at the time of recycling, p. 142-143 (weighted by representative utility survey participation, p. 117).
[28] Building America Analysis Spreadsheet for existing homes, accessed on February 23, 2015 from http://energy.gov/eere/buildings/downloads/building-america-analysis-existing-homes.

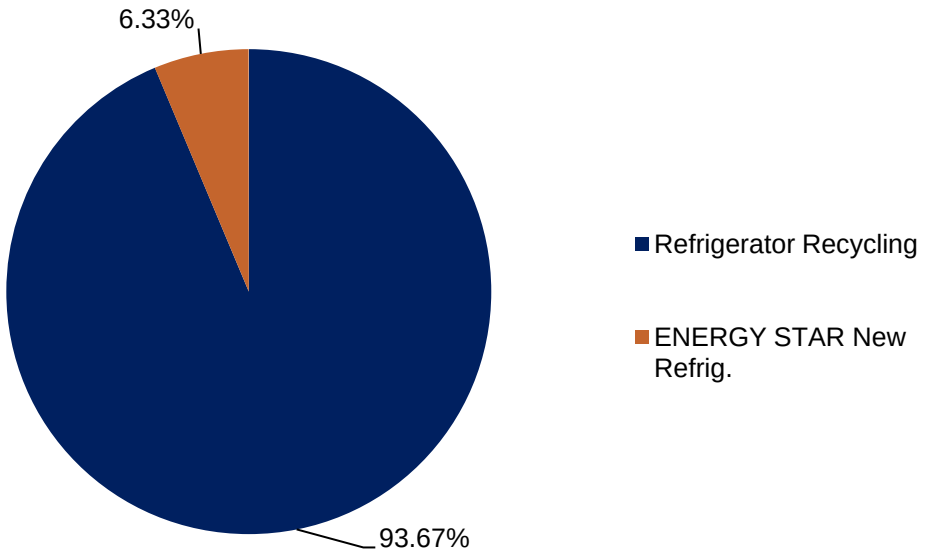


Figure 3.7-1: Refrigerator Recycling – Program kWh by Measure

Savings for refrigerator recycling are highly dependent on the age of the units being recycled. Federal refrigerator efficiency standards were revised in 1994, 2001 and 2011. Per-unit consumption was reduced by approximately 30% in both 1994 and 2001. Older units have higher savings, but a shorter remaining service life. To accurately determine the manufacture date of the units, the serial number for each unit collected should be recorded in the database.

Table 3.7-2: Refrigerator Recycling Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Refrigerator Recycling	698,991	93.32	98.50
ENERGY STAR Replacements	47,232	6.31	6.66
Total	746,223	99.63	105.16

3.8 WEATHERIZATION PROGRAM

3.8.1 Overview

CPS Energy's residential weatherization program provides comprehensive retrofits for income-eligible customers. In FY 2015, the program provided a range of services to 2,957 customers, compared with 3,202 customers in FY 2014. A total of 69,311 individual measures were installed in FY 2015. These measures included repair, health & safety, and energy-saving measures. The energy-saving measures may be categorized as follows:

- CFL light bulbs
- Wall insulation
- Ceiling insulation
- Floor insulation
- Solar screens
- Water heater pipe insulation
- Water heater insulation
- Low-flow showerheads
- Air infiltration reduction
- Duct system improvement

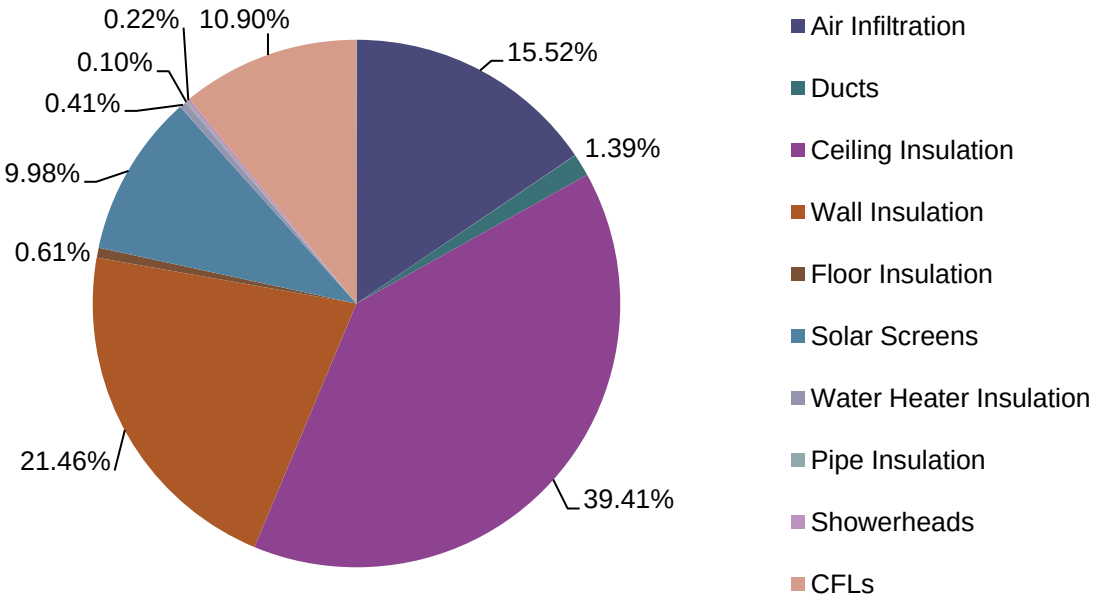


Figure 3.8-1: Weatherization Program – kWh by Measure

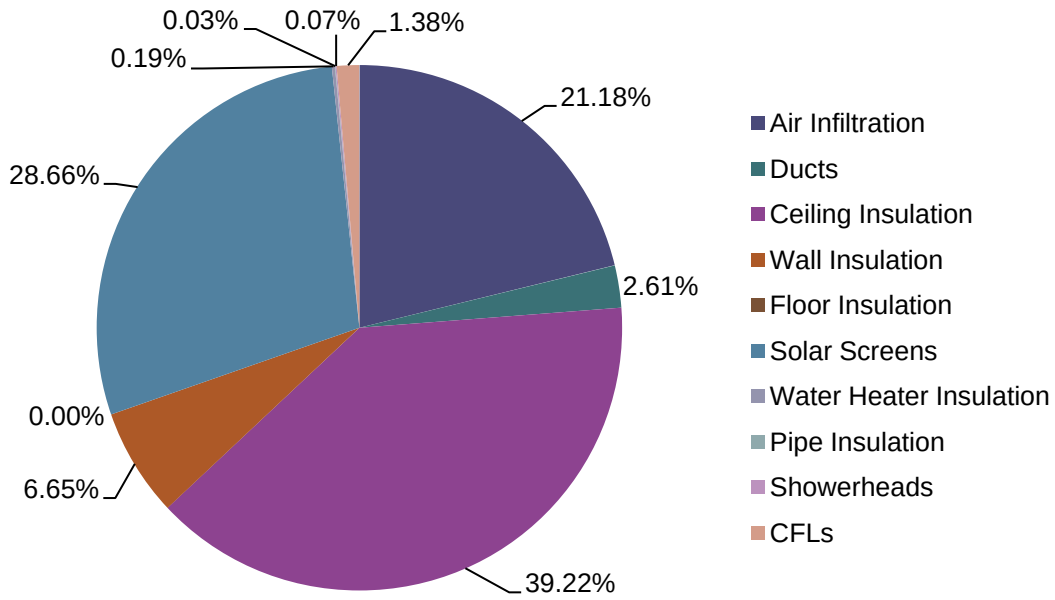


Figure 3.8-2: Weatherization Program – Coincident kW by Measure

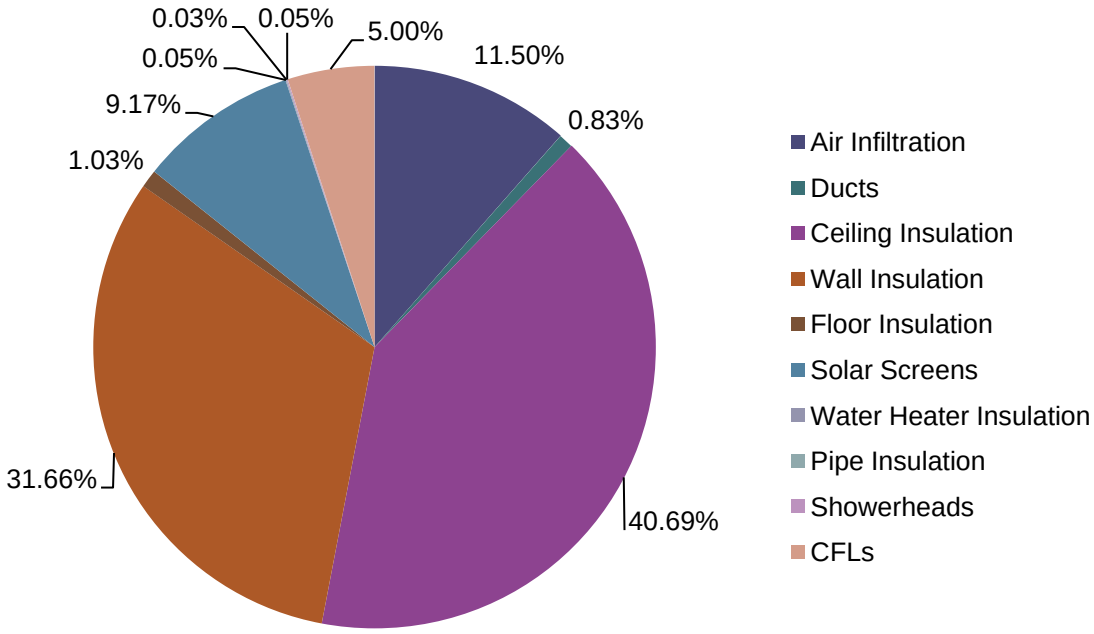


Figure 3.8-3: Weatherization Program – Non-Coincident kW by Measure

3.8.2 Savings Calculation Method

For each of the measures except duct improvement, Frontier calculated energy savings using methods from Texas TRM v. 2.1. For the duct measure, Frontier applied a method from the Arkansas TRM.

Non-coincident peak demand savings were calculated using lighting, water heating, or HVAC load profiles. Coincident peak savings were calculated using the top 20 hour method outlined in Section 2.2, Peak Demand Impacts.

3.8.2.1 Compact Fluorescent Lamps (CFLs)

As part of the program, CPS Energy installed 55,275 thirteen-watt CFLs in FY 2015. Energy savings estimates are based on the assumption that each CFL replaces an incandescent lamp of roughly equivalent lumen output. The baseline wattages for lamps have been reduced over the past several years, to reflect the phase-in of the Energy Security and Independence Act of 2007 (EISA) standards.

Per-unit energy savings are from Texas TRM, v. 2.1:

Table 3.8-1: Weatherization – CFL per-unit Energy Savings

Measure CFL (Watt)	Measure CFL (Range of Watts)	Comparable Incandescent Light (Watt)	Lumen Output	Daily Usage (Hrs/Day)	Annual Energy Savings (kWh)
13	12 to 16	43	750–1049	2.2	24.1

Non-coincident peak demand savings were calculated using a residential lighting load profile developed from the Building America Analysis spreadsheet for existing homes.

The EUL for residential CFLs is 7.7 years, based on Texas TRM v. 2.1.

3.8.2.2 Wall Insulation

CPS Energy installed wall insulation in 1,798 homes in FY 2015. Energy savings for this measure are calculated using Texas TRM v. 2.1 savings values and are based on the assumption that a previously-uninsulated wall cavity is insulated to R-13, typically by blowing in cellulose insulation. The estimated energy savings varies significantly based on reported heating and cooling system combinations:

Table 3.8-2: Weatherization – Wall Insulation Deemed Energy Savings

Electric A/C, Gas Heat (per sq. ft.)	Electric A/C, Electric Heat (per sq. ft.)	Electric A/C, Heat Pump (per sq. ft.)
0.24242	4.529	1.726

Non-coincident peak demand savings were calculated using residential heating and cooling load profiles developed using US DOE's BEopt and EnergyPlus residential simulation modeling software.

The EUL for wall insulation is 25 years, based on Texas TRM v. 2.1.

3.8.2.1 Ceiling Insulation

As part of the weatherization program, CPS Energy installed 3,106 ceiling insulation measures in FY 2015. The number of measures exceeds the number of homes in the program because some homes received multiple insulation measures. For example, if a home had flat attic areas in which blown-in insulation was used, and sloping areas where batt insulation was used, these would be recorded as separate measures.

Energy savings for this measure are calculated using Texas TRM v. 2.1 savings values:

Table 3.8-3: Weatherization – Ceiling Insulation
Deemed Annual Energy Savings (kWh)

Ceiling Insulation Base R-value	Gas Heat (per sq. ft.)	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	1	4.4	2.14
R-1 to R-4	0.64	2.81	1.4
R-5 to R-8	0.32	1.38	0.7
R-9 to R-14	0.17	0.72	0.36
R-15 to R-22	0.07	0.3	0.15

The above savings values assume that the base R-value is within one of the five ranges listed above, the final R-value is 30, and that there are three possible heating/cooling fuel types. The CPS Energy program has a much higher number of possible combinations of starting R-values, final R-values, and heating and cooling equipment combinations. In order to apply these savings values, Frontier mapped each of the program's insulation measures into the above categories, using each measure's estimated Btuh reduction per square foot.

Non-coincident peak demand savings were calculated using residential heating and cooling load profiles developed using US DOE's BEopt and EnergyPlus residential simulation modeling software.

The EUL for ceiling insulation is 25 years, based on Texas TRM v. 2.1.

3.8.2.2 Floor Insulation

As part of the Weatherization program, CPS Energy installed floor insulation in 93 homes during FY 2015. The baseline is assumed to be a house with pier and beam construction and no floor insulation against the floor of conditioned area.

Energy savings for this measure are calculated using Texas TRM v. 2.1 savings values.

Table 3.8-4: Weatherization - Floor Insulation Deemed Annual Energy Savings (kWh)

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	0	0
Electric Heat	1.70757	1.65891
Heat Pump	0.58324	0.55718

Note that the for this weather zone, the TRM doesn't indicate any cooling energy savings. For homes listed as having "mixed" heating fuels, Frontier averaged the gas heat and electric heat savings values.

Non-coincident peak demand savings were calculated using residential heating and cooling load profiles developed using US DOE's BEopt and EnergyPlus residential simulation modeling software.

The EUL for floor insulation is 25 years, based on Texas TRM v. 2.1.

3.8.2.3 Solar Screens

As part of the Weatherization program, CPS Energy installed solar screens on 2,698 during FY 2015. The baseline is a single pane, clear glass, unshaded, east-, west-, or south-facing window with a solar heat gain coefficient of 0.75.

Energy savings for this measure are calculated using Texas TRM v. 2.1 savings values:

Table 3.8-5: Weatherization – Solar Screens Deemed Energy Savings (kWh) per Square Foot

Gas Heat (per sq. ft.)	ER Heat (per sq. ft.)	Heat Pump (per sq. ft.)
5.82998	3.78803	4.72758

For homes listed as having "mixed" heating fuels, Frontier averaged the gas heat and electric resistance heat savings values. Note that for this measure, the TRM applies a heating penalty to homes with electric or heat pump heat, to account for the reduction in solar heat gain during the heating season.

For this measure, installed quantity was provided in united inches (window width plus height, in inches). This is the typical pricing unit for contractors. TRM savings values are per square foot of treated window area. To convert united inches to square feet, Frontier assumed an average dimension of 3' x 5'. To reduce the potential error in the savings estimate resulting from this assumption, Frontier recommends that total square feet of solar screens installed per home be captured, in addition to united inches.

Non-coincident peak demand savings were calculated using residential heating and cooling load profiles developed using US DOE's BEopt and EnergyPlus residential simulation modeling

software.

The EUL for solar screens is 10 years, based on Texas TRM v. 2.1.

3.8.2.4 Water Heater Pipe Insulation

As part of the Weatherization program, CPS Energy installed water heater pipe insulation in 297 homes during FY 2015. A total of 2,195 linear feet of pipe insulation was installed, for an average of 7.4 feet per installation. The baseline assumption is an electric water heater with no heat traps and no existing pipe insulation.

Energy savings for this measure are calculated using a Texas TRM v. 2.1 savings algorithm. Inputs to the algorithm include:

- Linear feet of pipe insulation installed
- Surface area of the pipe to be insulated (A pipe diameter of 0.5 inches is assumed.)
- R-value of the added insulation
- Seasonal average ambient temperature (Location is assumed to be in a conditioned space.)
- Water heater tank temperature (120 degrees assumed for this calculation)
- Water heater efficiency

From the above calculation, the annual savings for this measure are estimated as 42 kWh per installation.

Non-coincident peak demand savings were calculated using a DHW load profile developed from the Building America Analysis spreadsheet for existing homes.[29]

The EUL for water heater pipe insulation is 13 years, based on Texas TRM v. 2.1.

3.8.2.5 Water Heater Insulation

As part of the Weatherization program, CPS Energy installed water heater insulation on 325 water heaters during FY 2015. The baseline is assumed to be a typical electric water heater with no insulation, manufactured prior to the current federal efficiency standard.

Energy savings for this measure are calculated using a Texas TRM v. 2.1 savings algorithm. Inputs to the algorithm include the:

- Pre-installation R-value of the tank
- Post-installation R-value (assumes a minimum R-5 added insulation)
- Surface area of the water heater (For a 40 gallon water heater of standard height and diameter this value is provided by the TRM as 21.81 square feet.)
- Seasonal average ambient temperature (Location is assumed to be in a conditioned space.)
- Water heater tank temperature (120 degrees assumed for this calculation)

[29] Building America Analysis Spreadsheet for existing homes, accessed on February 23, 2015 from http://energy.gov/eere/buildings/downloads/building-america-analysis-existing-homes.

- Water heater efficiency

Using the algorithm, the annual savings for this measure are estimated to be 155 kWh per water heater insulated.

Non-coincident peak demand savings were calculated using a DHW load profile developed from the Building America Analysis spreadsheet for existing homes.[30]

The EUL for water heater insulation is 7 years, based on Texas TRM v. 2.1.

3.8.2.6 Low-Flow Showerheads

As part of the Weatherization program, CPS Energy installed 218 low-flow showerheads in homes with electric water heaters during FY 2015. The baseline is assumed to be a 2.5 gallons per minute (GPM) showerhead. The replacement showerhead is assumed to have a flow rate no higher than 2.0 GPM.

Energy savings for this measure are calculated using a Texas TRM v. 2.1 savings algorithm. This algorithm includes a derivation of the reduction in annual hot water used per showerhead, based on several studies. The value for all Texas weather zones is 1,074 gallons of hot water per year per showerhead. Using this value, annual savings are estimated using an algorithm that includes the following inputs:

- Water mains temperature (an average annual value of 74.7 is used for San Antonio)
- Water heater efficiency
- Water heater tank temperature (assumed to be 120 degrees)

Using the algorithm, the annual savings for this measure are estimated to be 121 kWh per showerhead.

Non-coincident peak demand savings were calculated using a DHW load profile developed from the Building America Analysis spreadsheet for existing homes.[31]

The EUL for low-flow showerheads is 10 years, based on Texas TRM v. 2.1.

3.8.2.7 Air Infiltration Reduction

A key element of the Weatherization program is the installation of air infiltration control measures. This measure was implemented on 2,956 homes in FY 2015. The average leakage rate reduction was 1,388 cubic feet per minute (CFM), measured at 50 pascal.

The savings for this measure are calculated using Texas TRM v. 2.1 savings values:

[30] Building America Analysis Spreadsheet for existing homes, accessed on February 23, 2015 from http://energy.gov/eere/buildings/downloads/building-america-analysis-existing-homes.
[31] Building America Analysis Spreadsheet for existing homes, accessed on February 23, 2015 from http://energy.gov/eere/buildings/downloads/building-america-analysis-existing-homes.

Table 3.8-6: Weatherization – Air Infiltration Reduction Deemed Energy Savings per CFM_{50} Reduction

Gas Heat	Resistance Heat	Heat Pump Heat
0.2694	0.7945	0.4438

For homes listed as having "mixed" heating fuels, Frontier averaged the gas heat and resistance heat savings values.

Non-coincident peak demand savings were calculated using residential heating and cooling load profiles developed using US DOE's BEopt and EnergyPlus residential simulation modeling software.

The EUL for this measure is 11 years, based on Texas TRM v. 2.1.

3.8.2.8 Duct System Improvement

Another key element of the Weatherization program is duct system repair. During FY 2015, the program installed duct sealing and/or repair measures on 972 homes. The duct measures included:

- Replacing sections of flex duct
- Adding duct insulation
- Adding tape and mastic
- Sealing returns with foam board

Evaluating the energy savings of these measures using the Texas TRM is not possible, since the TRM savings calculations are based on pre- and post-installation duct leakage measurements using a Duct Blaster™ or similar, and these measurements were not typically performed as part of the program. An alternative method for evaluating savings for this measure was developed by Frontier for the State of Arkansas, and is currently part of the Arkansas TRM.[32] This method is based on a table of distribution system values from Building Performance Institute and utilizes visual observations and a qualitative assessment of leakage categories, using a look-up table to provide distribution system improvements. [33]

In the BPI table there are five categories of duct leakage. For duct systems with R-4 to R-7 insulation that are 50% or more outside the conditioned space, there are distribution efficiencies associated with the following leakage categories:

- Connections sealed with mastic
- No observable leaks
- Some observable leaks
- Significant leaks
- Catastrophic leaks

[32] *Arkansas TRM Version 3.0, Volume 2 Deemed Savings*. http://www.apscservices.info/EEInfo/TRM.pdf. Accessed 2/24/2015.
[33] BPI Distribution Efficiency Lookup Table. http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf. Accessed 3/4/2015.

The percent improvement in distribution efficiency going from one category to the next are 5%, 5%, 4%, and 6%. Hence, Frontier assumed that for any measure or combination of measures that were likely to result in the improvement of observable leakage by one or more categories, a distribution system efficiency improvement of 5% was estimated.

Using this method, Frontier was able to identify 405 homes where the installed measures were likely to have resulted in a distribution system improvement of 5% or more.

From the Arkansas TRM, Version 3.0, Volume 2, the following algorithms were used:

$$kWh_{savings,C} = \frac{\Delta DSE \; x \; EFLH_C \; x \; CAP}{1{,}000 \; x \; SEER}$$

Where:

ΔDSE	=	*Improvement in distribution system efficiency, assumed to be 5%*
EFLHc	=	*Estimated full-load cooling hours for San Antonio*
CAP	=	*Cooling capacity, Btuh*
SEER	=	*SEER (default: 10)*

$$kWh_{savings,H} = \frac{\Delta DSE \; x \; EFLH_H \; x \; CAP}{1{,}000 \; x \; HSPF}$$

Where:

ΔDSE	=	*Improvement in distribution system efficiency, assumed to be 5%*
EFLHh	=	*Estimated full-load heating hours for San Antonio*
CAP	=	*Heating capacity, Btuh*
HSPF	=	*HSPF (default: 7.3)*

For electric resistance heat 3,412 was substituted for the denominator in the above equation.

For homes listed as having “mixed” heating fuels, Frontier assumed that 50% of the home was served with electric resistance heat.

Non-coincident peak demand savings were calculated using residential heating and cooling load profiles developed using US DOE’s BEopt and EnergyPlus residential simulation modeling software.

The EUL for this measure is 18 years, based on Texas TRM v. 2.1.

For the FY 2015 program year, Frontier was able to attribute savings to fewer than half of the

homes treated. To better evaluate the energy savings of the various measures installed, Frontier recommends the following:

- For homes in which significant duct leakage is observed, pre- and post-installation leakage-to-outside testing is recommended. Since this is time consuming, testing should probably not be required for all homes. Guidance should be provided to contractors to help them identify homes where duct leakage reduction measures are likely to produce significant and quantifiable savings. Leakage-to-outside testing should probably be performed at the same time as blower door testing.
- For duct insulation, pre- and post-installation R-values should be recorded, as well as duct location (conditioned, unconditioned or semi-conditioned space.

3.8.3 Results and Recommendations

The following are the gross energy and demand savings for the Weatherization program, by measure:

Table 3.8-7: Weatherization Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Air Infiltration	1,896,726	640	1,452
Ducts	170,234	79	105
Ceiling Insulation	4,818,129	1,185	5,139
Wall Insulation	2,623,604	201	3,999
Floor Insulation	74,369	-	130
Solar Screens	1,219,731	866	1,158
Water Heater Insulation	50,298	6	6
Pipe Insulation	12,552	1	3
Showerheads	26,422	2	7
CFLs	1,332,128	42	631
Total	12,224,193	3,022	12,630

3.9 RESIDENTIAL LIGHTING (LED) PROGRAM

3.9.1 Overview

In FY 2015, CPS Energy implemented a successful program to promote the adoption of LED lighting through a campaign with H.E.B. As part of this program, CPS Energy customers received a total of $6.00 off the purchase of a 9.5-watt LED, with CPS Energy contributing $5.00 per lamp, and H.E.B. contributing $1.00. The light output of 800 lumens is roughly equivalent to a conventional 60-watt incandescent A-lamp. During the program year, 200,000 units were scanned by H.E.B. Using a leakage rate of 10% and an estimated installation rate of 84%, savings estimates are based on a total of 151,200 installed units.

3.9.2 Savings Calculation Method & Results

Energy savings calculations are based on the Texas TRM v.3.0, since residential LEDs are not a measure in the TRM v. 2.1. The TRM savings for this measure are in the following table:

Table 3.9-1: Residential Lighting – ENERGY STAR Omni-Directional LEDs – EISA Baselines

Minimum Lumens	Maximum Lumens	Incandescent Equivalent Pre-EISA 2007	Incandescent Equivalent 1st Tier EISA 2007 (W_{base})	Incandescent Equivalent 2nd Tier EISA 2007	Effective Dates for 2nd Tier EISA 2007 Baselines
750	1,049	60	43	20	1/1/2020

There is a two-step savings calculation for this measure, due to the baseline change that is scheduled to occur in 2020. For the period ending in 2020, the assumed baseline is 43 watts, based on the first-tier ERISA 2007 baseline. For the remaining service life after 2020, the savings calculation assumes a baseline of 20 watts, from the baseline that becomes effective in 2020. The TRM also incorporates an interactive effects factor, to account for the impacts on cooling and heating loads. For installations in which the heating system fuel type is not known, a factor of 1.07 is used to adjust the kWh savings.

Assuming a 25,000 hour service life (from manufacturer specification) and 2.2 hours of daily usage, the annual kWh savings values are:

- Tier 1—first 6 years, to 2020: 27.34 kWh per year
- Tier 2—remaining 19 years of service: 8.57 kWh per year

Using a method to calculate the lifetime avoided cost benefit based on CPS Energy's projected avoided costs, a weighted average annual savings of 14.02 kWh per year is derived.

To calculate the maximum potential kW savings, the difference between the pre-installation wattage (the EISA Tier 1 baseline value of 43 watts) and the post-installation wattage (9.5 watts) was multiplied by the number of installed units (151,200). This produced a maximum potential savings value of 5,065 kW.

Non-coincident peak demand savings were calculated using a residential lighting load profile developed from the Building America Analysis spreadsheet for existing homes.[34]

Table 3.9-2: Residential Lighting (LED) Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Maximum Potential Savings (kW)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Residential Lighting	2,119,824	5,065	66	1,005

[34] Building America Analysis Spreadsheet for existing homes, accessed on February 23, 2015 from http://energy.gov/eere/buildings/downloads/building-america-analysis-existing-homes.

4. COMMERCIAL PROGRAMS

4.1 SUMMARY OF COMMERCIAL IMPACTS

CPS Energy offered the following programs for the Commercial sector in FY 2015:

- Commercial Lighting
- Commercial Heating, Ventilation, and Air Conditioning (HVAC)
- Solar Initiative – Commercial & Schools
- Commercial Custom
- Commercial New Construction

CPS Energy's portfolio of commercial programs addresses most markets and major commercial end uses.

To evaluate energy impacts for most program measures, Frontier utilized the current version of the Texas TRM v. 2.1. For programs or measures where other methods were used, those are referenced in each section.

Except where noted, coincident peak values were calculated using the weighted-average 20-hour probability method, as outlined in the previous section.

The contribution of each commercial program to the portfolio's energy, peak demand and non-coincident peak savings are shown in the following charts.

All figures in the table and charts below and throughout this section represent energy and demand savings from new FY 2015 program participants as measured at the participant or end-user level. These savings are adjusted in the program portfolio rollup table in the executive summary and in benefit-cost calculations to account for net-to-gross ratios and distribution line losses.[35]

[35] Net-to-gross (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. Distribution line losses 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 on the distribution system.

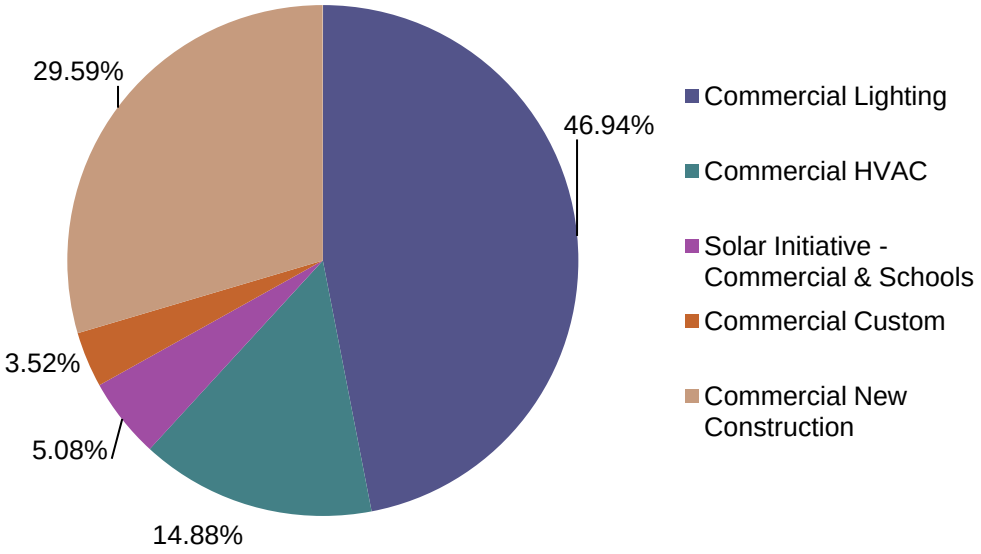


Figure 4.1-1: Summary of Commercial Impacts – kWh by Program

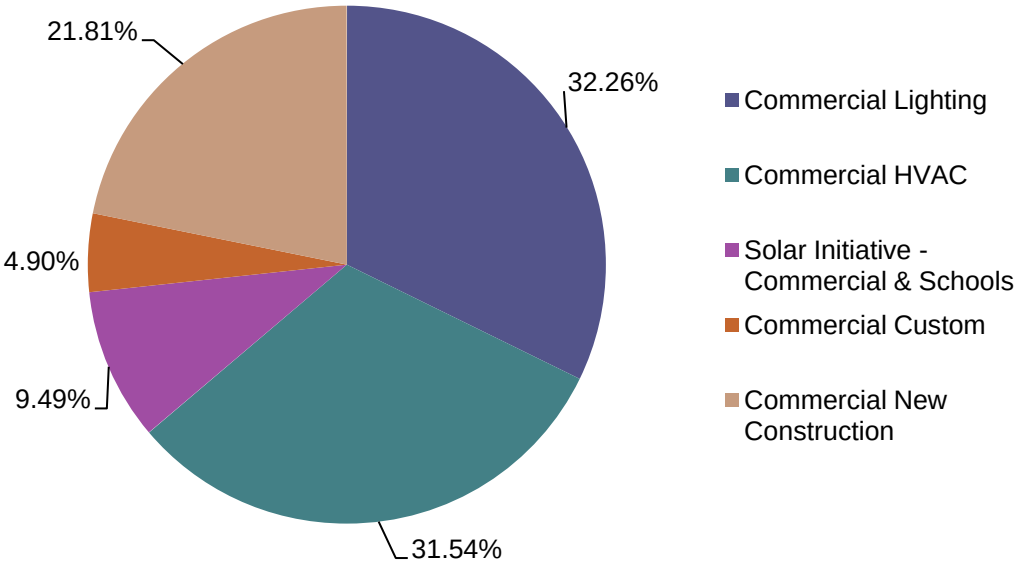


Figure 4.1-2: Summary of Commercial Impacts – Coincident kW by Program

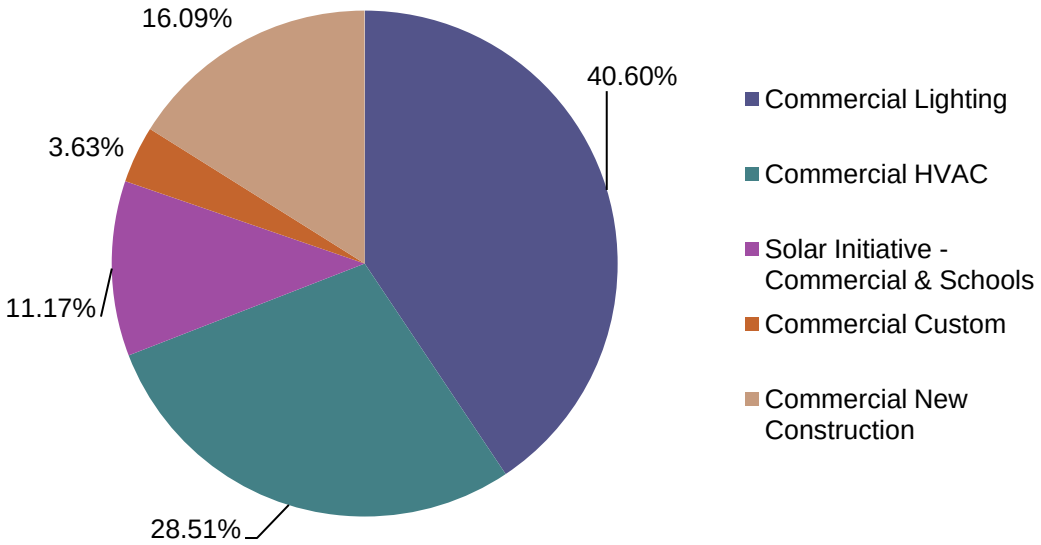


Figure 4.1-3: Summary of Commercial Impacts – Non-Coincident kW by Program

4.2 COMMERCIAL LIGHTING PROGRAM

4.2.1 Overview

In FY 2015, a total of 381 lighting projects received incentive funding in the Commercial Lighting program. This is a 20% decrease from the 478 commercial lighting projects in FY 2014.

In the figures below, Frontier has broken out these projects according to the major commercial building type of each project and the kWh savings contributed by the major commercial building types.

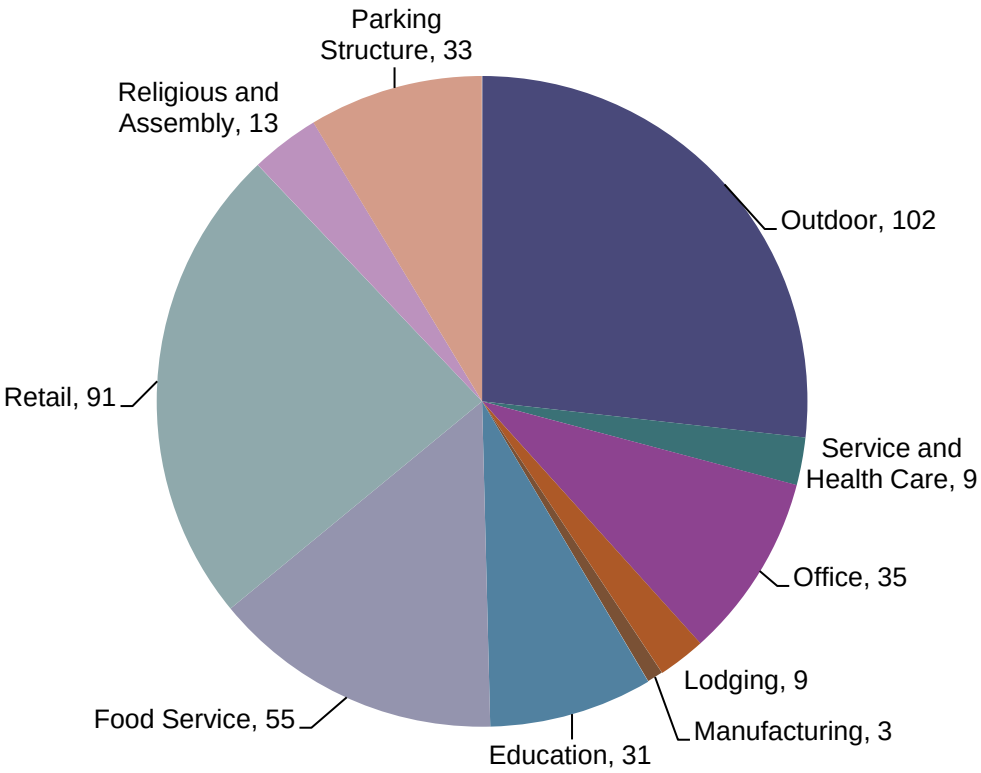


Figure 4.2-1: Commercial Lighting - Number of Projects by Commercial Building Type

According to Figure 4.2-1, most projects were outdoor, retail or food service. However, Figure 4.2-2 shows that although outdoor and retail contributed the most to kWh savings, education provided more kWh savings than food service, despite the greater number of food service projects.

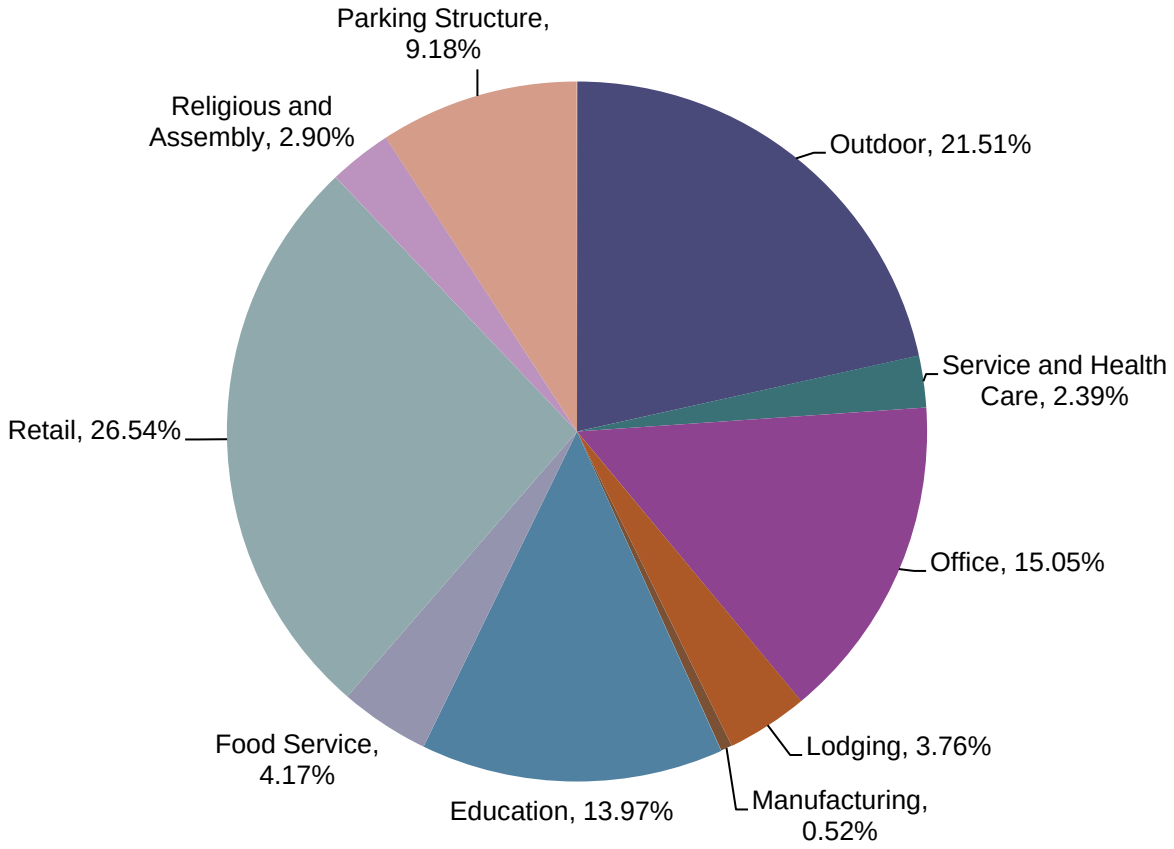


Figure 4.2-2: Commercial Lighting - Percentage of kWh Savings by Commercial Building Type

Frontier also evaluated the LED Street Lights program, and has included those savings in this section. The rebate for this program was paid and accounted for in FY 2013, so Frontier did not include program costs in the analysis this year.

4.2.2 Savings Calculation Method

Frontier Associates randomly selected 58 lighting projects, which provided a sample size with a 90% confidence level and +/- 10% confidence interval of all commercial lighting projects. Frontier analyzed the technology installed, the commercial building types, and the HVAC/refrigeration interactive effects of each project.

In order to estimate interactive effects for high-efficiency lighting installed in cooled spaces, Frontier applied the following deemed factors to the applicable projects.

Table 4.2-1: Commercial Lighting Interactive Effects Factors[36]

Space Cooling Type	Demand Factor	Energy Factor
HVAC	1.10	1.05
Refrigerated	1.25	1.25
No Cooling	1.00	1.00

Frontier used deemed peak coincidence factors in order to calculate coincident peak for the commercial lighting program. The coincidence factors are provided in Table 4.2-2 below:

Table 4.2-2: Commercial Lighting Coincidence Factors[37]

Building Type	Coincidence Factor
Education: K-12, without Summer Session	0.47
Education: College, University, Vocation, Day Care, and K-12 with Summer Session	0.69
Food Sales: Non 24-Hour Supermarket/Retail	0.95
Food Sales: 24-Hour Supermarket/Retail	0.95
Food Service: Fast Food	0.81
Food Service: Sit Down Restaurant	0.81
Health Care: Out-Patient	0.77
Health Care: In-Patient	0.78
Lodging (Hotel/Motel/Dorm): Common Areas	0.82
Lodging (Hotel/Motel/Dorm): Rooms	0.25
Manufacturing	0.73
Multi-Family Housing: Common Areas	0.87
Nursing and Resident Care	0.78
Office	0.77
Outdoor	0.00

[36] Texas Technical Reference Manual Version 2.0. Volume 3: Nonresidential Measures Guide for PY 2015 Implementation. Public Utility Commission of Texas. Last Revision Date: April 18, 2014.
[37] Ibid.

Building Type	Coincidence Factor
Parking Structure	1.00
Public Assembly	0.56
Public Order and Safety	0.75
Religious	0.53
Retail: Excluding Malls and Strip Centers	0.90
Retail: Enclosed Mall	0.93
Retail: Strip Shopping and Non-Enclosed Malls	0.90
Service: Excluding Food	0.90
Warehouse: Non-Refrigerated	0.77
Warehouse: Refrigerated	0.84

Retrofit project energy and demand savings were calculated using the difference in lighting wattages between the baseline fixtures and the newly installed fixtures. The following formulas were used to calculate energy and demand savings.

$$kW\ savings = \frac{\left(FixtureWattage_{base} - FixtureWattage_{post}\right) \times N_{fixtures}}{1{,}000\ watts}$$

$$Peak\ kW\ savings = kW\ Savings\ \times Coincidence\ Factor$$

$$kWh\ savings = kW\ savings\ \times Annual\ Operating\ Hours$$

Where:

$FixtureWattage_{base}$ = *Fixture wattage for pre-retrofit fixture*

$FixtureWattage_{post}$ = *Fixture wattage for post-retrofit fixture*

$N_{fixtures}$ = *Number of fixtures*

$Coincidence\ Factor$ = *Deemed factor that calculates peak demand savings (see Table 4.2-2)*

$Annual\ Operating\ Hours$ = *Annual total burn hours for the fixtures*

4.2.3 Results and Recommendations

After analyzing the sample of projects, Frontier calculated a realization rate of 107% for kW savings and 103% for kWh savings. Using these realization rates, Frontier calculated the total energy and demand savings for the FY 2015 Commercial Lighting program.

Table 4.2-3: Commercial Lighting Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Commercial Lighting	30,802,730	4,118	7,022
LED Street Lights	8,034,306	0	2,011

CPS Energy currently asks participants to provide data on pre and post wattages, fixture types, burn hours, fixture counts, and indoor/outdoor installation in a spreadsheet or PDF. Frontier makes the following recommendations to enhance the data collected from participants in order to improve energy and demand savings calculations in future programs.

- Frontier suggests that CPS Energy enhance their own lighting forms to require participants to provide information about the commercial building type (selected from a list of deemed commercial building types provided in the workbook), the type of cooling (either HVAC, refrigeration [33-41°F] or freezer [-10-10°F]), and control device descriptions.
    - Frontier recommends that participants be required to complete this information in an Excel Workbook in order to ease the data collection process for program implementation and evaluation.
- Alternately, participants could be required to complete a user-friendly lighting savings workbook that would calculate savings. This workbook would:
    - Provide a standardized fixture wattage lookup table for participants to select their pre and post lighting retrofit information.
    - Use deemed operational hours and coincidence factors based on the facility type.
    - Calculate savings that would include interactive HVAC effects in the savings calculation.
    - Collect and utilize information about control devices to calculate control-attributed savings.

- San Antonio voted to adopt IECC 2015 as the residential and commercial energy code on January 29, 2015. The new code does not go into effect until July 1, 2015. Frontier and CPS Energy need to discuss baselines and effective dates for FY 2016.

4.3 COMMERCIAL HVAC PROGRAM

4.3.1 Overview

CPS Energy's Commercial Heating, Ventilation, and Air Conditioning (HVAC) program offers incentives to promote the installation of energy efficient HVAC equipment. The program covers the installation of split/unitary air conditioners and heat pumps (ACs/HPs), packaged terminal air conditioners and heat pumps (PTACs/PTHPs), and air/water cooled water chilling packages (chillers).

The program had 85 projects in FY 2015, including 183 direct expansion (DX) split/unitary ACs/HPs, 30 air cooled chillers (ACCs), and 20 water cooled chillers (WCCs) for a total of 233 installed HVAC systems. This corresponds to a 5% increase in total projects compared to FY 2014 and 33% decrease compared to FY 2013. The number of total HVAC systems installed decreased 3% compared to FY 2014.

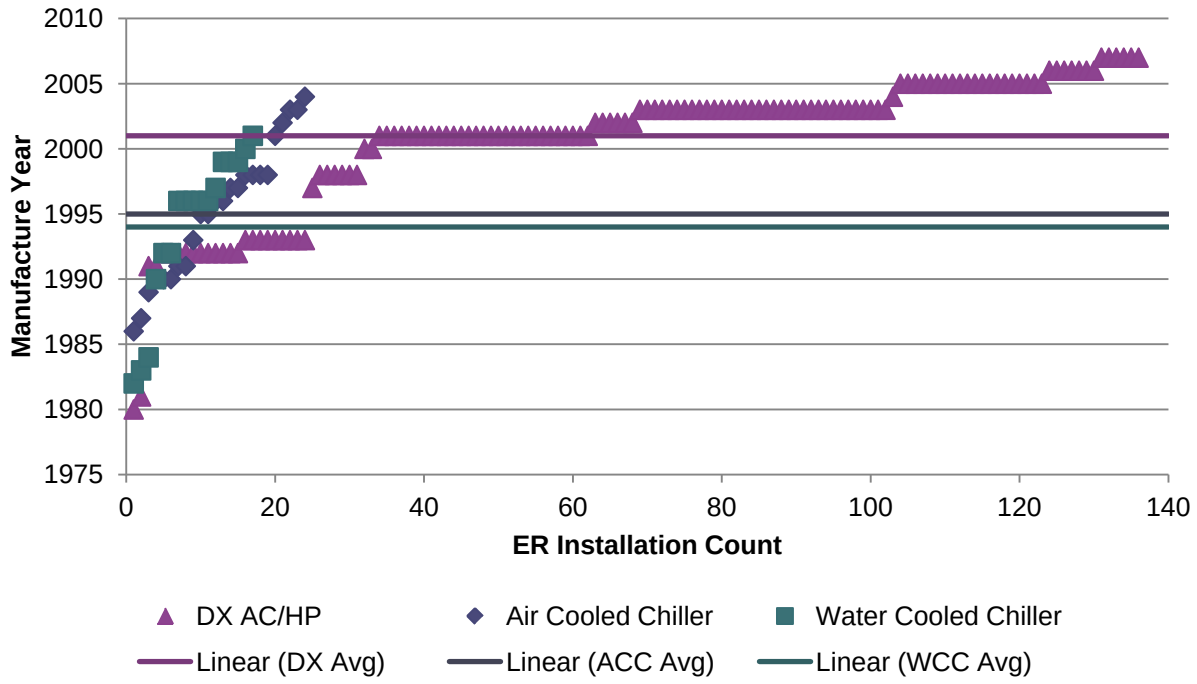


Figure 4.3-1: Commercial HVAC - Average Manufacture Year by Equipment Type for Early Retirement (ER) Projects

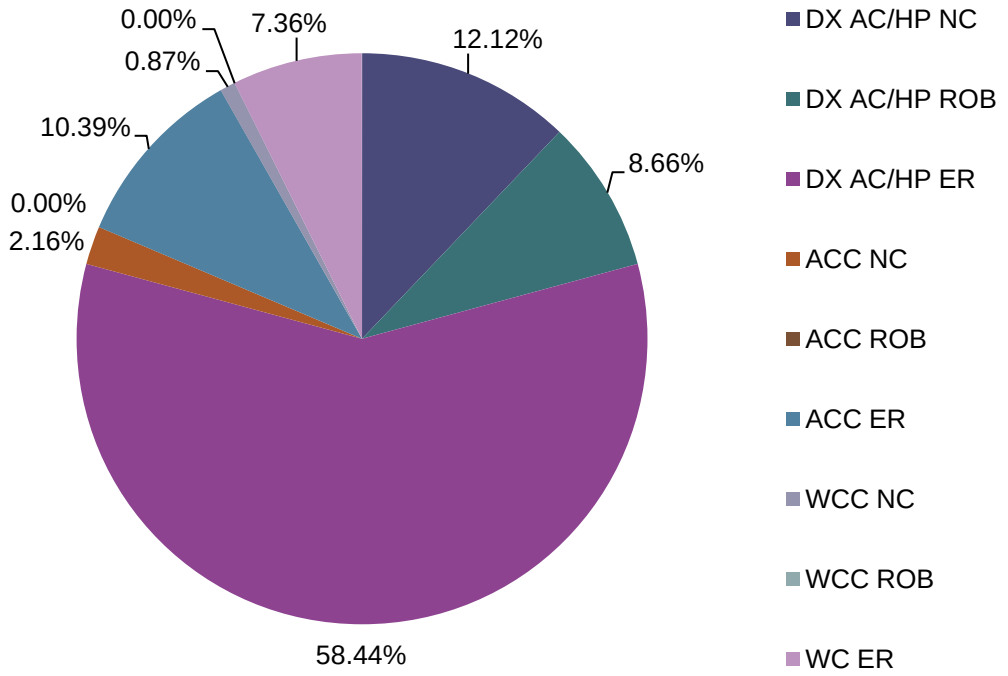


Figure 4.3-2: Commercial HVAC - Percentage of New Construction (NC), Replace-on-Burnout (ROB), and Early Retirement (ER) Projects by Equipment Type

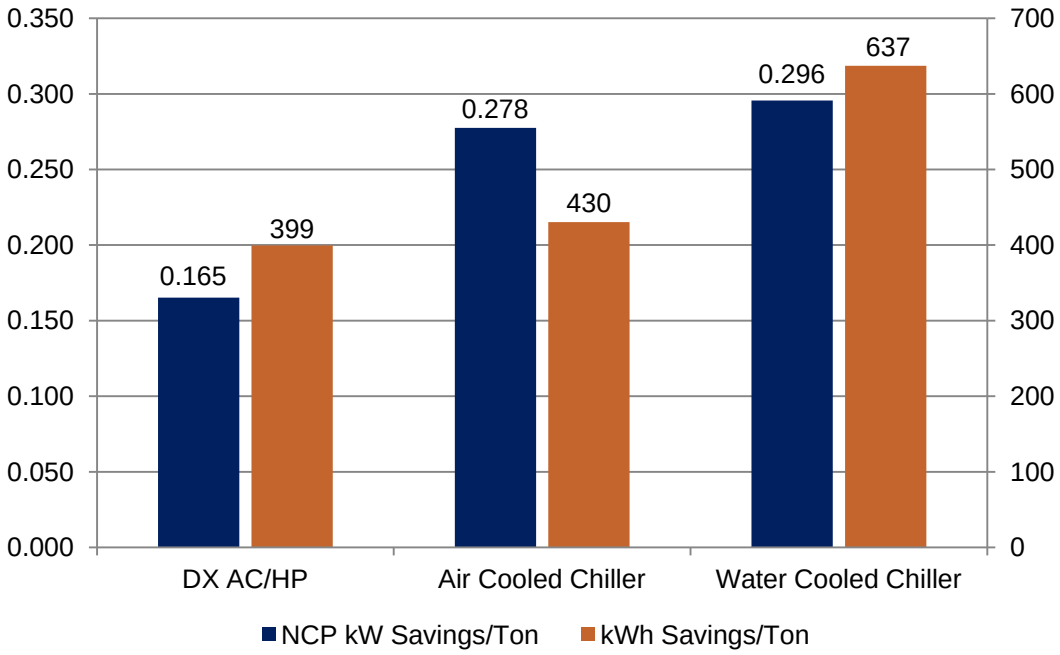


Figure 4.3-3: Commercial HVAC - Average Demand and Energy Savings per Ton by Equipment Type

4.3.2 Savings Calculation Method

Energy and demand savings were estimated using algorithms developed by Frontier for the Texas TRM v. 2.1 as a starting point.[38] However, since the Texas TRM is changing in 2016 to allow part-load efficiencies for the purposes of calculating energy savings, Frontier revised the savings algorithms to reflect that upcoming change.

For this measure, Frontier used weather specific assumptions for TRM climate zone 3.

Baseline equipment efficiencies for new construction (NC) and replace-on-burnout (ROB) projects were assumed to be IECC 2009 for all system types in accordance with the current commercial energy code for the state of Texas.[39] Early retirement (ER) projects were allowed a dual-baseline weighted according to the estimated remaining useful life (RUL) of the existing equipment and estimated useful life (EUL) for the installed equipment.

Table 4.3-1: Commercial HVAC - Dual-Baseline for Early Retirement Projects

Baseline Period	Effective Baseline Code
RUL	Varies based on manufacture year of existing equipment
EUL - RUL	IECC 2009

4.3.2.1 Unitary AC Equipment

Savings algorithms from the Texas TRM v. 2.1 were used to estimate demand savings using full-load system efficiency, and were adjusted to estimate energy savings using part-load system efficiency.

$$kW\ Savings = Capacity \times \frac{1\ kW}{1{,}000\ W} \times \left(\frac{1}{EER_{baseline}} - \frac{1}{EER_{installed}}\right) \times CF$$

$$kWh\ Savings = Capacity \times \frac{1\ kW}{1{,}000\ W} \times \left(\frac{1}{SEER/IEER_{baseline}} - \frac{1}{SEER/IEER_{installed}}\right) \times EFLH$$

[38] Public Utility Commission of Texas (PUCT) Technical Reference Manual (TRM) v. 2.1. Available for download at: http://texasefficiency.com/index.php/regulatory-filings/deemed-savings.
[39] U.S. Department of Energy (DOE): Energy Codes by State. http://www.energycodes.gov/adoption/states.

Where:

Capacity = Rated equipment cooling capacity of installed equipment (Btuh)

CF = Deemed coincidence factor based on building type

EFLH = Deemed equivalent full-load cooling hours

$EER_{baseline}$ *= Deemed full-load efficiency of existing equipment*

$EER_{installed}$ *= Rated full-load efficiency of installed equipment*

$SEER/IEER_{baseline}$ *= Deemed part-load efficiency of existing equipment*

$SEER/IEER_{installed}$ *= Rated full-load efficiency of installed equipment*

For future evaluations, these savings algorithms will be adjusted to include heating savings for heat pumps. Heating savings will be determined based on the heating efficiency upgrade of the installed equipment.

4.3.2.2 Chillers

Savings algorithms from the Texas TRM v. 2.1 were adjusted to estimate demand and energy savings using part-load system efficiency. Part-load efficiencies were used to estimate demand savings for chillers because chillers are rarely operated at full-load and are often installed with a redundant chiller to share cooling load during peak times.

Savings for any chiller projects reported as ROB were calculated using an ER baseline to account for the fact that chillers can typically be repaired rather than replaced.

$$kW\ Savings = Capacity \times (IPLV_{baseline} - IPLV_{installed}) \times CF$$

$$kWh\ Savings = Capacity \times (IPLV_{baseline} - IPLV_{installed}) \times EFLH$$

Where:

Capacity = Rated equipment cooling capacity of installed equipment (tons)

CF = Deemed coincidence factor based on building type

EFLH = Deemed equivalent full-load cooling hours

$IPLV_{baseline}$ *= Deemed part-load efficiency of existing equipment (kW/ton)*

$IPLV_{installed}$ *= Rated part-load efficiency of installed equipment (kW/ton)*

Any integrated part-load value (IPLV) rated in EER has been converted to kW/ton using the following conversion:

$$\frac{kW}{ton} = \frac{12}{EER}$$

4.3.3 Equipment Verification

To verify the accuracy of the efficiency data listed in the program database, Frontier reviewed reported equipment information including project type, system type, count, capacity, and full/part-load efficiency against project invoices, manufacturer specification sheets, and equipment information maintained by the Air Conditioning, Heating, and Refrigeration Institute (AHRI).[40] For each split/unitary AC and HP installation, the reported capacity and full/part-load efficiencies were adjusted based on available AHRI data. For each chiller installation, the reported capacity and full/part-load efficiencies were adjusted based on manufacturer specification sheets, referencing ratings at AHRI conditions whenever available. Reported system types, counts, capacities, and full/part-load efficiencies were adjusted as necessary based on this review.

4.3.4 Results and Recommendations

Total energy and demand savings for the installation of split/unitary air conditioners and heat pumps or air/water cooled water chilling packages are included in the following table:

Table 4.3-2: Commercial HVAC - Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Commercial HVAC	9,766,708	4,025	4,931

The following are Frontier recommendations that CPS Energy may consider for implementation of the Commercial HVAC Program:

- Frontier will work with CPS Energy to update the FY 2016 program worksheet to collect the following:
    - Project type (NC, ROB, ER)
    - Building type
    - AHRI certification number
    - Full and part-load efficiencies for all systems

[40] AHRI Certification Directory: https://www.ahridirectory.org/ahridirectory/pages/home.aspx.

    - Existing chiller count, capacity, and compressor type
    - Chiller operation details

- For split system ACs and HPs, require that all components of the system (condenser, coils, and furnace) are replaced to be eligible for an incentive, ensuring that savings are awarded against an appropriate measure life.
- Compare existing Step 1 and Step 2 efficiency tiers to current Consortium for Energy Efficiency (CEE) Tier 1 and Tier 2 efficiency tiers.
- Refer to the Commercial Custom Program regarding a recommendation to develop a commercial HVAC rebate offering for retrofitting rooftop HVAC units (RTUs) with advanced controls.
- Update baseline efficiencies for internal savings calculator to match IECC 2009 values, the current commercial energy code for the state of Texas.
    - San Antonio voted to adopt IECC 2015 as the residential and commercial energy code on January 29, 2015. The new code does not go into effect until July 1, 2015. Frontier and CPS Energy need to discuss baselines and effective dates for FY 2016.
    - Update: Frontier is currently working with CPS Energy to finalize an updated Commercial HVAC savings calculator that incorporates both IECC 2009 and IECC 2015 baselines.
- Review current incentive structure.
    - Review Step 1 and Step 2 minimum efficiencies to ensure compliance with IECC 2009 and IECC 2015 baselines.
    - Review current incentive rates to ensure cost-effectiveness relative to increases in baseline efficiency.
    - Update: Frontier is currently working with CPS Energy to review cost-effectiveness of existing incentive rates relative to increased baseline efficiencies and to recommend updated incentive rates as required.

4.4 SOLAR INITIATIVE – COMMERCIAL & SCHOOLS PROGRAM

4.4.1 Overview

CPS Energy offers rebates for commercial and school solar photovoltaic (PV) and solar thermal (hot water) systems; however, during the FY 2015 program year there were no solar thermal systems installed. Commercial solar PV rebates were offered at $1.60 per AC watt for the first 25 kWAC in capacity and $1.30 per AC watt for all remaining capacity greater than 25 kWAC, with a maximum rebate of $80,000 or 50% of the total installation price. Systems installed by non-local installers were rebated at $1.30 per AC watt, with a maximum rebate of $80,000 or 50% of the total installation price.

School solar PV rebates were offered at $2.00 per AC watt for the first 25 kWAC in capacity and $1.30 per AC watt for all remaining capacity greater than 25 kWAC, with a maximum rebate of $80,000. All systems were required to be installed by a CPS Energy certified contractor. Rebates were 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 in a net metering arrangement. Systems must be permitted, pass all required inspections, and comply with CPS Energy's requirements for interconnection.

In FY 2015, 53 commercial and school solar PV systems totaling 2,364 kWdc were installed, and $2.824 million in rebates distributed. The average solar PV system size was 44.6 kWdc. The figure below summarizes the commercial and school solar PV program history in terms of capacity installed, average system prices, and rebate levels annually.

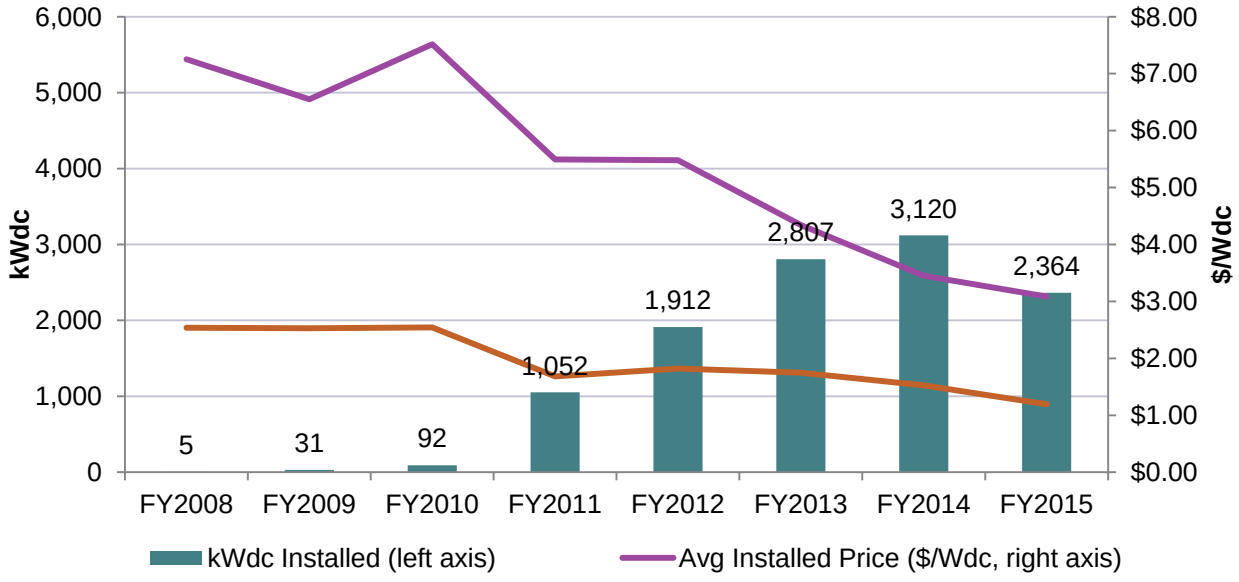


Figure 4.4-1: Solar Initiative - Commercial and Schools Program History: Annual Capacity Installed, Average System Price, and Average Rebate Levels

4.4.2 Savings Calculation Method

The savings calculation methods used for the Commercial and Schools Solar Initiative are identical to those used for the Residential Solar Initiative, with adjustments to account for tilt and orientation combinations more common in commercial installations. These methods are detailed in Section 3.5.2.

4.4.3 Results and Recommendations

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

Table 4.4-1: Solar Initiative - Commercial & Schools Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Commercial / School Solar PV	3,330,487	1,211	1,932

Our recommendations for the Commercial and Schools Solar Initiative program are equivalent to those offered for the Residential Solar Initiative program, and are outlined in Section 3.5.3.

4.5 COMMERCIAL CUSTOM PROGRAM

4.5.1 Overview

In FY 2015, CPS Energy offered incentives for commercial custom measures at $0.08/kWh and $200/kW. There were a total of nine custom projects totaling $315,052 in incentives, as compared to five in FY 2014 totaling $655,629 in incentives.

All nine commercial custom projects were reviewed by the previous EM&V consultant upon application submittal, and the resulting documentation was reviewed for this report. This program's internal review process, revised in FY 2013, was continued during the course of FY 2015. Customers were required to submit explanations for their projected savings, along with equipment information. Each project was reviewed individually, and an appropriate measurement and verification (M&V) plan was developed and provided to the customer. M&V was performed both before and after installation of new equipment, providing a high level of confidence in the calculation of actual energy savings achieved on each project.

4.5.2 Savings Calculation Method

Savings calculations followed standard industry procedures for each given application. A combination of measured data and manufacturer specifications was generally used, along with engineering estimations and assumptions where appropriate.

4.5.3 Results and Recommendations

The gross energy and demand savings calculated for the Custom Program are listed in Table 4.5-1 and depicted in Figure 4.5-1 and Figure 4.5-2.

Table 4.5-1: Custom Program Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Commercial Custom	**2,306,893**	**625**	**628**

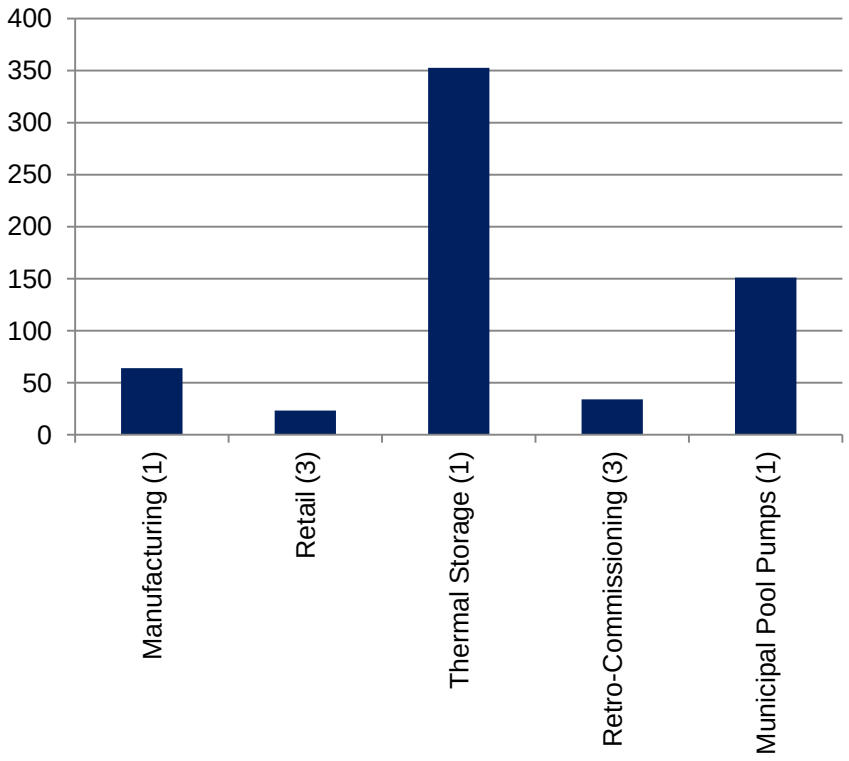


Figure 4.5-1: Commercial Custom – Coincident Peak Demand Reduction (kW) by Project Type

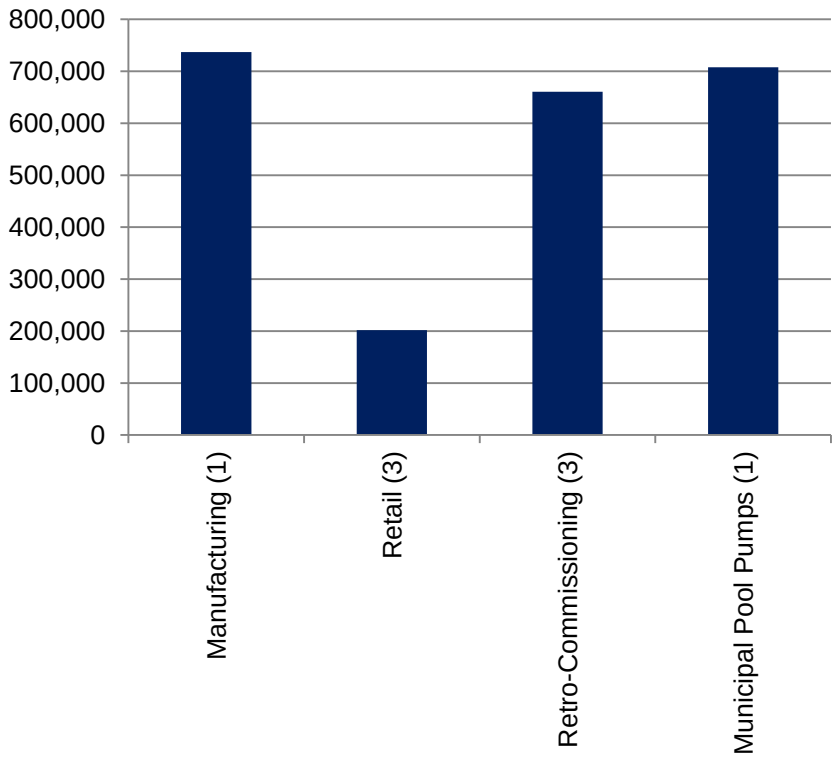


Figure 4.5-2: Commercial Custom – Energy Reduction (kWh) by Project Type

The following are program findings and recommendations CPS Energy may consider for this program in the future:

- Continue requiring customers to submit information and calculations before projects begin work.
- Continue performing cost-effective M&V on each project.
- Consider a new "Retro-Commissioning" (RCx) program that would:
    - Rebate the entire cost of a retro-commissioning study, with a cap calculated based on facility parameters;
    - Pre-qualify several service providers;
    - Claim the savings estimated and reported from the RCx study for repairs and no/low cost measures implemented, subject to inspection and EM&V review; no rebates will be awarded for these measures as the Owner will (by prior commitment) implement them based on savings and no/low cost;
    - Identify savings achievable by capital measures arising from the RCx process; Owner would be encouraged to apply for rebates under existing programs.

- Referring to one of the custom projects done in FY 2015, develop a prescriptive commercial HVAC incentive for retrofitting rooftop HVAC units (RTUs) with advanced controls, such as variable-speed drives on the supply fan, economizer control, demand-controlled ventilation, onboard fault detection diagnostics, and remote monitoring. Savings could likely be based on deemed values (e.g. $/ton per building type). Advanced RTU controls retrofits have been the subject of recent successful Department of Energy (DOE) field trials, and equipment packages are offered by several vendors.
- San Antonio voted to adopt IECC 2015 as the residential and commercial energy code on January 29, 2015. The new code does not go into effect until July 1, 2015. Frontier and CPS Energy need to discuss baselines and effective dates for FY 2016.

4.6 COMMERCIAL NEW CONSTRUCTION PROGRAM

4.6.1 Overview

In FY 2015, CPS Energy paid incentives totaling $1,799,501 for ten commercial new construction projects at the following rates:

- $0.08/kWh and $125/kW for savings 15-25% above code (Tier 1)
- $0.12/kWh and $150/kW for savings 25-35% above code (Tier 2)
- $0.20/kWh and $200/kW for savings more than 35% above code (Tier 3)

In comparison, for FY 2014, four commercial new construction projects were awarded rebates totaling $679,396.

All ten commercial new construction projects (100%) were reviewed by the previous EM&V consultant upon application submittal, and the resulting documentation was reviewed for this report. During the course of FY 2015, the internal review process for this program, revised in FY 2013, was continued. Customers were required to submit whole building energy models in approved software and complete sets of design documents. Each project was reviewed by the EM&V consultant, with energy models first compared to design documents to confirm accurate modeling, and then compared to ASHRAE baselines to confirm calculations of savings relative to code.

4.6.2 Savings Calculation Method

Savings calculations were based on confirmed energy models. The models provide savings between the new building design and a corresponding reference design meeting minimum code requirements.

4.6.3 Results and Recommendations

The gross energy and demand savings calculated for the Commercial New Construction program are listed in Table 4.6-1 and depicted in Figure 4.6-1 and Figure 4.6-2.

Table 4.6-1: Commercial New Construction Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)
Commercial New Construction	19,417,757	2,784	2,784

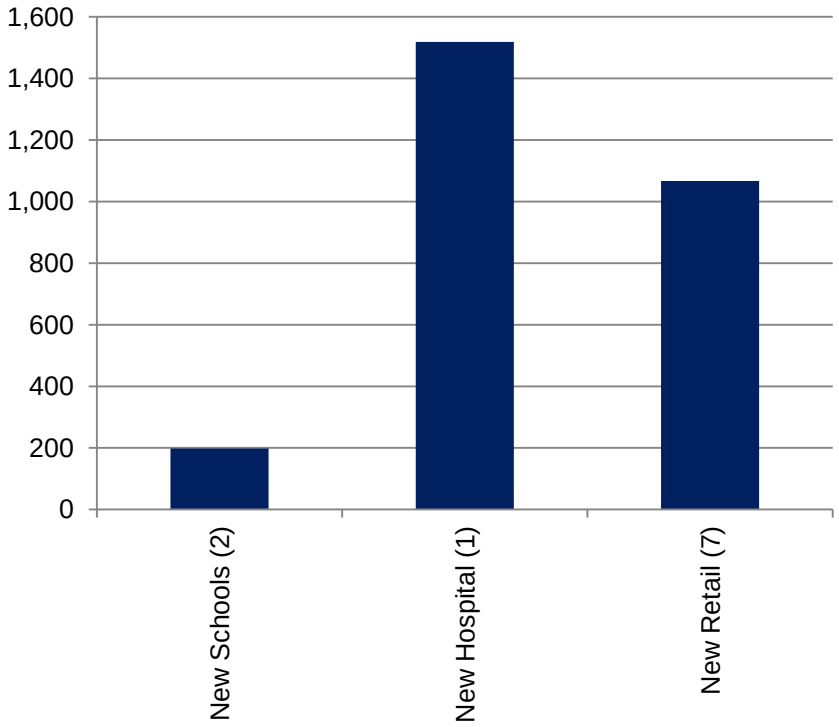


Figure 4.6-1: Commercial New Construction - Coincident Peak Demand Reduction (kW) by Building Type

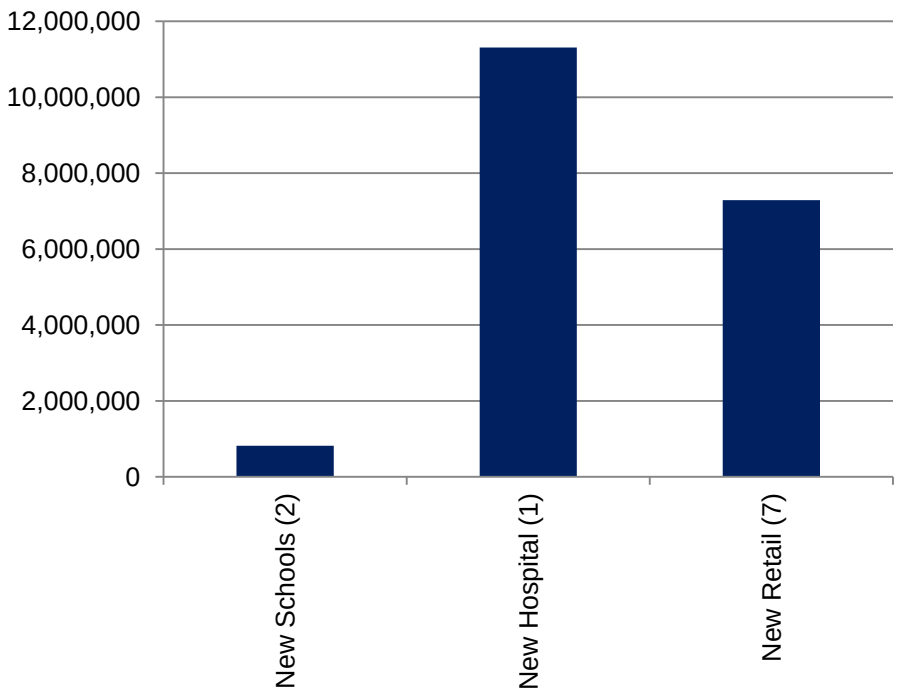


Figure 4.6-2: Commercial New Construction – Energy Reduction (kWh) by Building Type

The following are findings and recommendations that CPS Energy may consider for future implementation of this program:

- Because of the relatively small number of projects, continue requiring submittal and EM&V review of simulation models and design documents for each project. Consider methods to streamline this review.
- Continue requiring customers to submit whole building energy models and complete sets of design documents for each project; confirm (or add) the following submittals required for EM&V review (each project) prior to rebate disbursement:
    - Approved contractor product submittals for HVAC and lighting equipment, or product sheets from operations and maintenance (O&M) manual;
    - Simulation summary reports;
    - Hourly energy output files;
    - Demand and energy savings calculation file (spreadsheet);
    - Commissioning Report and HVAC TAB (test, adjust & balance) Report; review of these reports will confirm initial building control settings are in accordance with design.

- San Antonio voted to adopt IECC 2015 as the residential and commercial energy code on January 29, 2015. The new code does not go into effect until July 1, 2015. Frontier and CPS Energy need to discuss baselines and effective dates for FY 2016.

5. DEMAND RESPONSE PROGRAMS

5.1 SUMMARY OF DEMAND RESPONSE IMPACTS

CPS Energy offered the following demand response programs in FY 2015:[41]

- Smart Thermostat
- Home Manager
- Commercial & Industrial (C&I) Demand Response
  - C&I Demand Response Options 1-3
  - Automated Demand Response (ADR)
  - Emergency Demand Response (EDR)
- Nest Rush Hour Rewards Pilot
- ThinkEco Room Air Conditioner Pilot

While the Smart Thermostat, Home Manager, and C&I Demand Response programs (with the exception of ADR, a new program in 2014) have been in existence for a number of years, the Nest and ThinkEco programs are pilot programs, designed to test new technologies for achieving a reduction in energy demand during periods of high wholesale market prices or high demand on the ERCOT or CPS Energy systems.

The contribution of each demand response program to energy, peak demand and non-coincident peak savings are shown below. All figures in the table and charts below and throughout this section represent energy and demand savings from all program participants at the end of FY 2015 as measured at the participant or end-user level. These savings are adjusted in the program portfolio rollup table in the executive summary to account for net-to-gross ratios and distribution line losses.[42]

This approach differs from that taken in reporting energy and demand savings from traditional energy efficiency programs. For demand response programs, we report estimated savings from all active participants, including those who signed up in previous years, because this set most accurately represents the demand response program's actual impacts in FY 2015 as well as program capability going forward.

For benefit-cost calculations, our approach focuses on the incremental impacts of only new participants added in FY 2015, consistent with the approach used in all energy efficiency program benefit-cost calculations.

[41] CPS Energy also implemented the Friedrich Kühl AC Rebate Program in FY 2015, a pilot effort with a local manufacturer to build DR-ready window units and sell them in the local market with a package of incentives and rebates from CPS Energy. Due to low uptake, this program was not evaluated.

[42] FN: Net-to-gross (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. Distribution line losses 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 on the distribution system..

Table 5.1-1: Summary of Demand Response Impacts – All Participants

Program	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	Demand Reduction during 4CPs
Smart Thermostat	**879,839**	**37,659**	**37,659**	**27,140**
Home Manager	**307,702**	**32,185**	**32,185**	**15,235**
Commercial DR (Options 1, 2, and 3)	1,652,845	77,537	77,537	54,876
Automated DR	19,124	1,765	1,765	1,235
Emergency DR	4,230	4,230	4,230	(n/a)
Nest Pilot	14,713	1,334	1,334	197
ThinkEco Pilot	2,293	121	121	62
Total	2,880,746	154,831	154,831	98,745

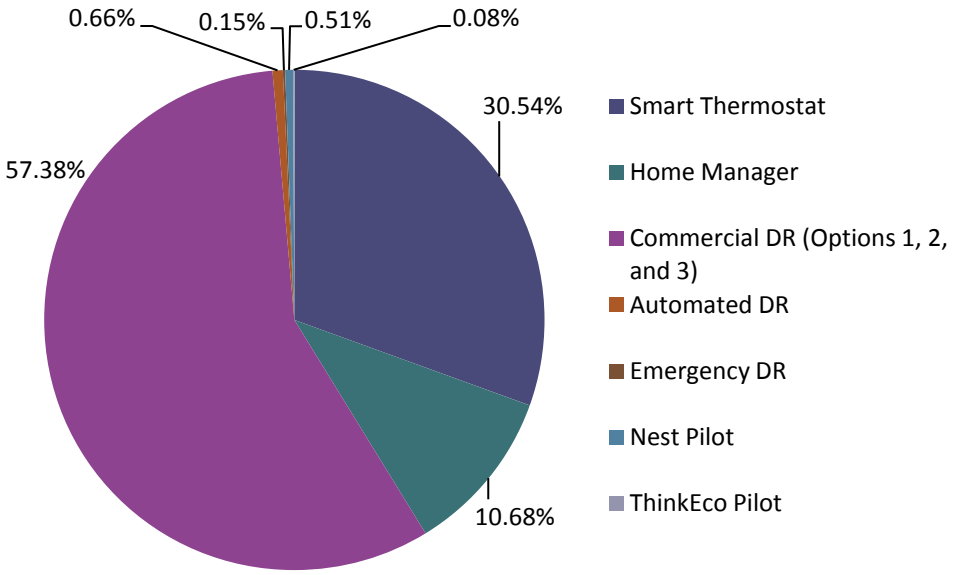


Figure 5.1-1: Summary of Demand Response Impacts – Energy (kWh) by Program

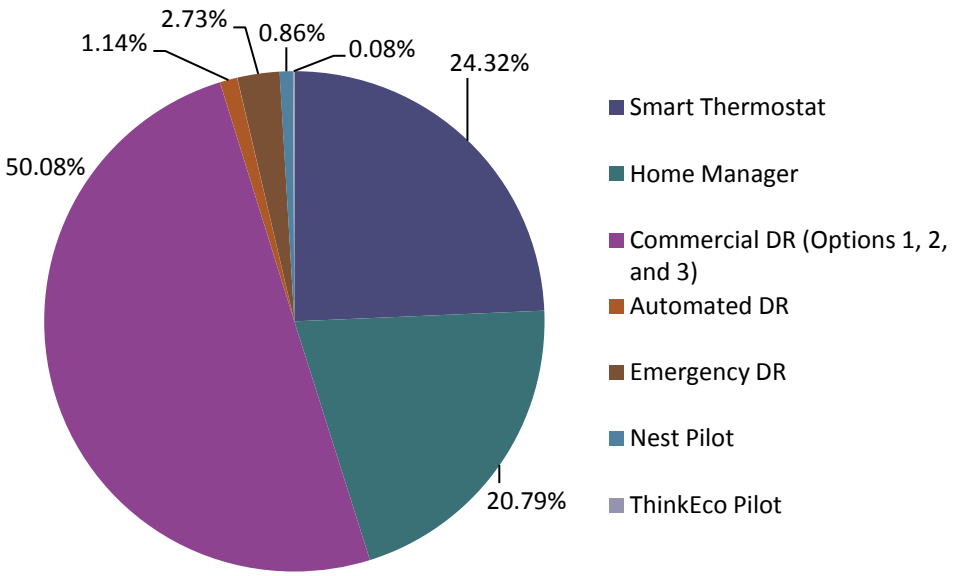


Figure 5.1-2: Summary of Demand Response Impacts – Peak Demand and Non-Coincident Peak Demand (kW) by Program

5.2 SMART THERMOSTAT PROGRAM

5.2.1 Overview

The Smart Thermostat direct load control program has been available to residential sector participants in single family homes since 2003. It was expanded to include multi-family and small commercial customers in 2010. CPS Energy installs a programmable, controllable thermostat (PCT) at participants' home (or place of business) at no cost to the customer. In return, CPS Energy is permitted remote access to their central air conditioning system.

Through the program, CPS Energy can cycle on and off the air conditioner compressor for short periods of time on event days. Multi-family and small business customers participate at a 33% cycling rate, such that HVAC compressors are cycled off for ten minutes of each half hour. Residential customers can either participate at the 33% cycling rate or opt for a higher 50% cycling rate (units cycle off for 15 minutes during each half hour). Residents receive an additional $30 incentive annually in the form of a bill credit for opting into the 50% cycling rate (Residents are required to stay on the program the entire summer to qualify for the credit). Cycling events occur during the summer months of May through September, between the hours of 3 p.m. and 7 p.m. on weekdays. Each air conditioning unit is given a randomized start time that ensures all units will not be cycling off and back on at exactly the same time.

Table 5.2-1: Smart Thermostat – Program Participation by Group

	Single-Family Dwellings, 33% Cycling	Multi-Family Dwellings, 33% Cycling	Commercial – 33% Cycling	Single-Family Dwellings, 50% Cycling
End of FY 2015 (01/31/2015) Count	40,380	34,724	2,310	11,290

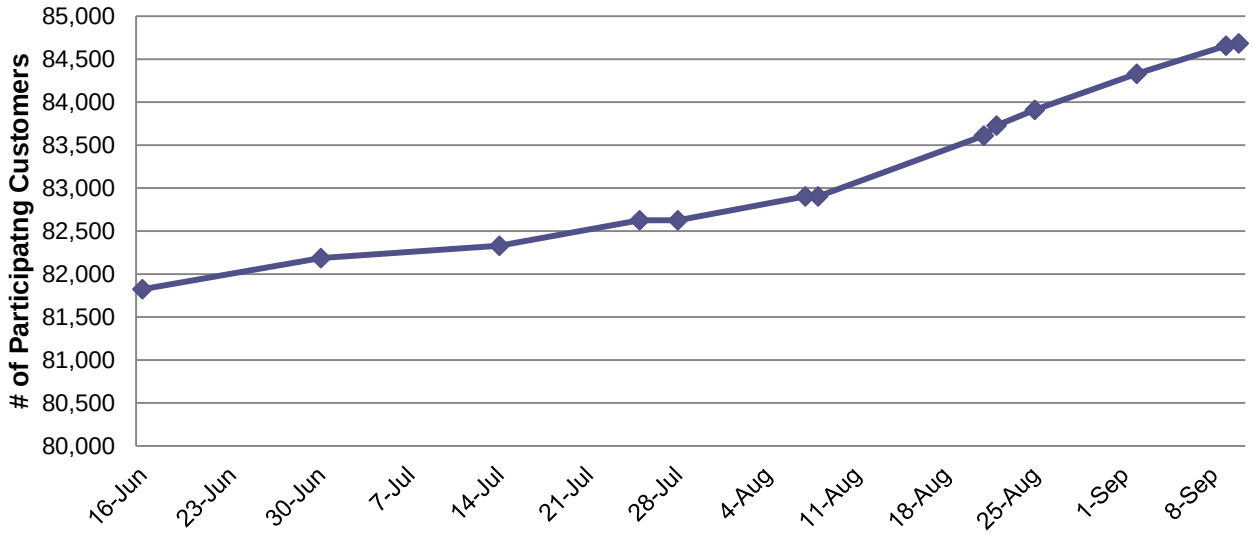


Figure 5.2-1: Smart Thermostat - Participation Trend (Summer 2014) – Total Customer Count

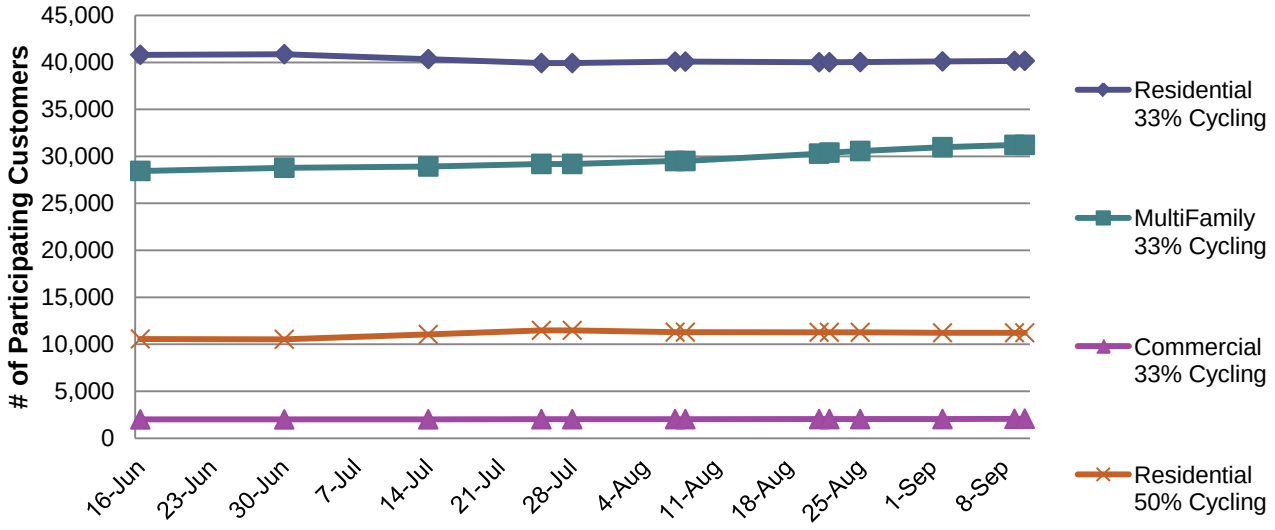


Figure 5.2-2: Smart Thermostat Participation Trend (Summer 2014) – By Customer Category

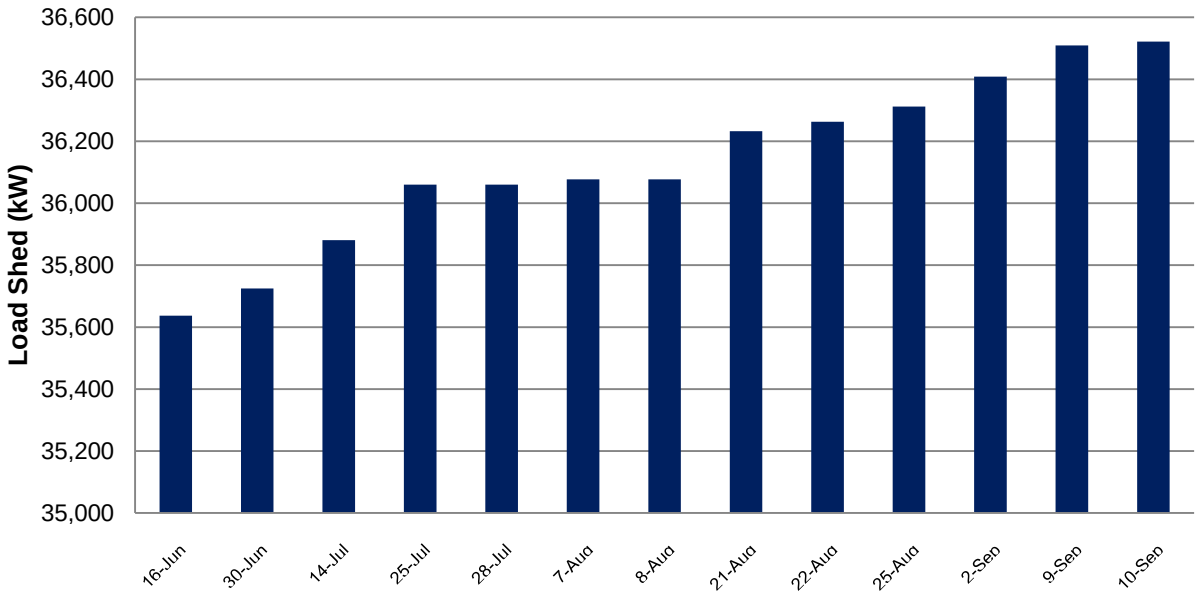


Figure 5.2-3: Smart Thermostat – Program-Level Impacts by Event, Summer 2014

5.2.2 Savings Calculation Method

A previous study conducted by Nexant examined how the per-device (i.e., per-thermostat) impacts achieved by this program during events in 2013 were related to the cycling strategy (i.e., 33% cycling versus 50% cycling) the outdoor temperature, and the afternoon hours coinciding with the event.[43] Frontier reviewed Nexant's analysis and concluded that the methods employed by Nexant and the findings reported were reasonable. The formulas derived by Nexant were applied to the demand response events called by CPS for this program during the summer of 2014 to obtain an estimate of the demand reduction attributable to the program this year. The impacts of specific events ranged from 35,637 kW (6/16/2014 Event)[44] to 36,522 kW (9/10/2014).[45]

[43] Nexant, *Impact Evaluation of CPS Energy's 2013 Smart Thermostat Program*, February 11, 2014. Values for kW are based on 100-degree day.

[44] Total Impacts of 6/16/2014 event = kW savings per device for 33% single family group * # of 33% single family devices on 6/16/2014 + kW savings per device for 33% multi family group * # of 33% multi family devices on 6/16/2014 + kW savings per device for 33% commercial group * # of 33% commercial devices on 6/16/2014 + kW savings per device for 50% single family group * # of 50% single family on 6/16/2014 = 40802*0.49+10568*0.72+28446*0.25+2008*0.46=35637

[45] Total Impacts of 9/10/2014 event = kW savings per device for 33% single family group * # of 33% single family devices on 9/10/2014 + kW savings per device for 33% multi family group * # of 33% multi family devices on 9/10/2014 + kW savings per device for 33% commercial group * # of 33% commercial devices on 9/10/2014 + kW savings per device for 50% single family group * # of 50% single family on 9/10/2014 = 40163*0.49+11221*0.72+31217*0.25+2084*0.46=36522

5.2.3 Results and Recommendations

By the end of FY 2015, the Smart Thermostat program was capable of achieving roughly 37,659[46] kW of both peak and non-coincident demand reduction. This represents the estimated savings per participating customer times the total number of participating customers at the end of FY 2015. Three of the events called by CPS Energy during the summer of 2014 coincided with the four coincident peak intervals (4CPs) used by ERCOT to allocate transmission costs to load-serving entities. The program therefore delivered average demand reduction during FY 2015 4CP intervals of 27,140 kW, approximately 75% of the total.

Table 5.2-2: Smart Thermostat Gross Energy[47] and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	Demand Reduction during 4CPs
Single-Family Dwellings, 33% Cycling	NA	19,786	19,786	14,830
Single-Family Dwellings, 50% Cycling	NA	8,129	8,129	5,944
Multi-Family Dwellings	NA	8,681	8,681	5,661
Commercial	NA	1,063	1,063	705
Total	879,839	37,659	37,659	27,140

5.3 HOME MANAGER PROGRAM

5.3.1 Overview

Launched in 2012, the Home Manager Program is a comprehensive electric load monitoring and direct load control program for residential customers. This system was installed at 22,460 residences by the end of FY 2015.

The Home Manager system controls three types of devices: HVAC units, electric water heaters, and pool pumps. When CPS Energy calls an event, all Home Manager thermostats are adjusted upward by three degrees from their pre-event setpoints. Water heaters and pool pumps are powered off for the duration of the event. Customers have the ability to reset their thermostat

[46] Total Impacts (Take 01/31/2015 Population) = kW savings per device for 33% single family group * year-end # of 33% single family devices + kW savings per device for 33% multi family group * year-end # of 33% multi family devices + kW savings per device for 33% commercial group * year end # of 33% commercial devices + kW savings per device for 50% single family group * year end # of 50% single family = 40380*0.49+34724*0.25+2310*0.46+11290*0.72=37659

[47] 879,839 = $\sum_{events=1}^{13}$(scaled total energy savings during event time − scaled kW savings per device for 33% single family group ∗ # of devices for 33% single family group∗snapback duration− scaled kW savings per device for 50% single family group∗# of devices for 50% single family group ∗ snapback duration − scaled kW savings per device for 33% commercial group ∗ # of devices for 33% commercial group ∗ snapback duration − scaled kW savings per device for 33% multi family group ∗ # of devices for 33% multi family group ∗ snapback duration)

setpoints or drop completely out of the event at any time. In 2015, CPS Energy called 10 events, ranging from 1 to 2.25 hours in duration.

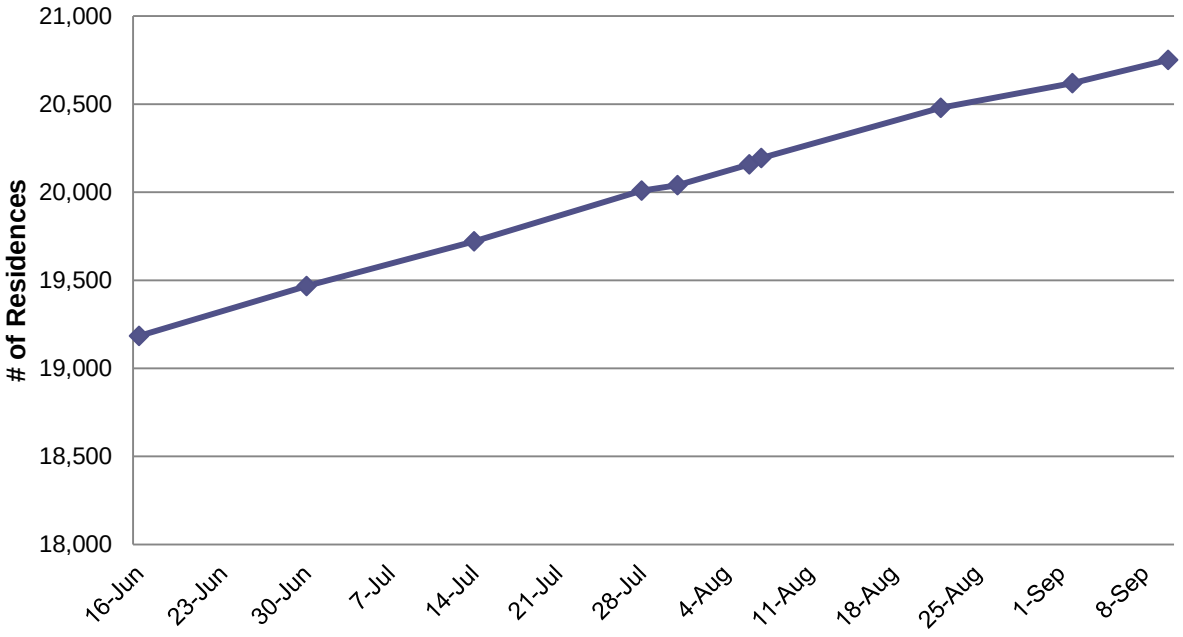


Figure 5.3-1: Home Manager - Program Participation, Summer 2014[48]

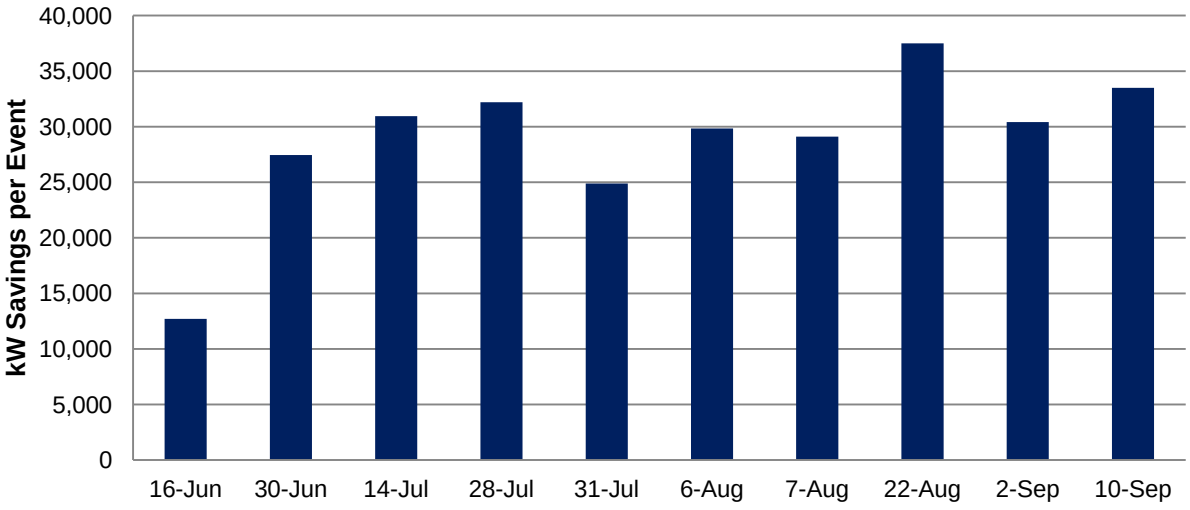


Figure 5.3-2: Home Manager – Load Shed by Event (kW)

[48] Nexant, *Impact Evaluation of CPS Energy's 2014 Home Manager Program*, November 10, 2014

5.3.2 Event kW and kWh Savings

Following the summer of 2014, Nexant estimated the program impacts.[49] Frontier Associates reviewed Nexant's study and found the results to be credible. Consequently, their per-participant peak demand and energy savings impacts are used herein; participation estimates reflect the number of participants in this program at the end of FY 2015.

5.3.3 Results and Recommendations

The per-participant demand reduction achieved through this program during events called by CPS Energy ranged from 0.662 kW to 1.831 kW, and averaged 1.433 kW.[50] Multiplying these savings values by the number of participants at year-end yields an demand reduction capability of 32,185 kW.[51]

The energy savings achieved through events called by CPS Energy averaged 1.37 kWh per event:[52] annual energy savings capability is estimated at 307,702 kWh, reflecting the per-participant energy savings estimated by Nexant, the number and duration of events called, and the number of participants at the end of the fiscal year. Two of the events called by CPS Energy for the Home Manager Program coincided with ERCOT's 4CP intervals in 2014, resulting in average achieved demand reduction during 4CP intervals of roughly 15,235 kW.[53]

Table 5.3-1: Home Manager Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	Demand Reduction during 4CPs
Total	**307,702 [1]**	**32,185**	**32,185**	**15,235**
[1] 307,702 kWh = year-end customer counts * net energy savings per customer * number of events called = 22460 * 1.37 * 10				

5.4 COMMERCIAL DEMAND RESPONSE PROGRAMS

5.4.1 Overview

CPS Energy's Commercial Demand Response (DR) programs are voluntary load curtailment programs for its commercial customers. The programs are designed to reduce CPS Energy's peak load growth by incentivizing customers to shed electric loads on peak summer days. The

[49] Nexant, *Impact Evaluation of CPS Energy's 2014 Home Manager Program*, November 10, 2014.
[50] Ibid., p. 2.
[51] Average demand reduction = year-end customer counts * average impact per residence = 22460*1.433 = 32,185kW
[52] Note that this does not include the energy savings that might be realized by participants using the programming features of the Consert system to achieve additional energy savings.
[53] Average 4CP load reduction = customer counts matching with June 4CP * load reduction per residence on that event + customer counts matching with September 4CP load * load reduction per residence on that event = (19467*1.410+20751*1.614)/4=15235.15kW

Commercial Demand Response programs run from June 1 through September 30. Participating customers commit to be available between 1 p.m. and 7 p.m.; typically, events occur on weekdays between 3 p.m. and 6:30 p.m.

The Commercial Demand Response Programs consist of:

- Large Commercial Demand Response (Options 1, 2, and 3)
- Emergency Demand Response (EDR)
- Automated Demand Response (ADR)

Table 5.4-1: Commercial Demand Response Notification Times

Program	Notification Time
Large Commercial DR (Options 1 and 2)	Two hours
Large Commercial DR (Option 3)	30 minutes
Emergency DR	One hour
Automated DR	Immediate

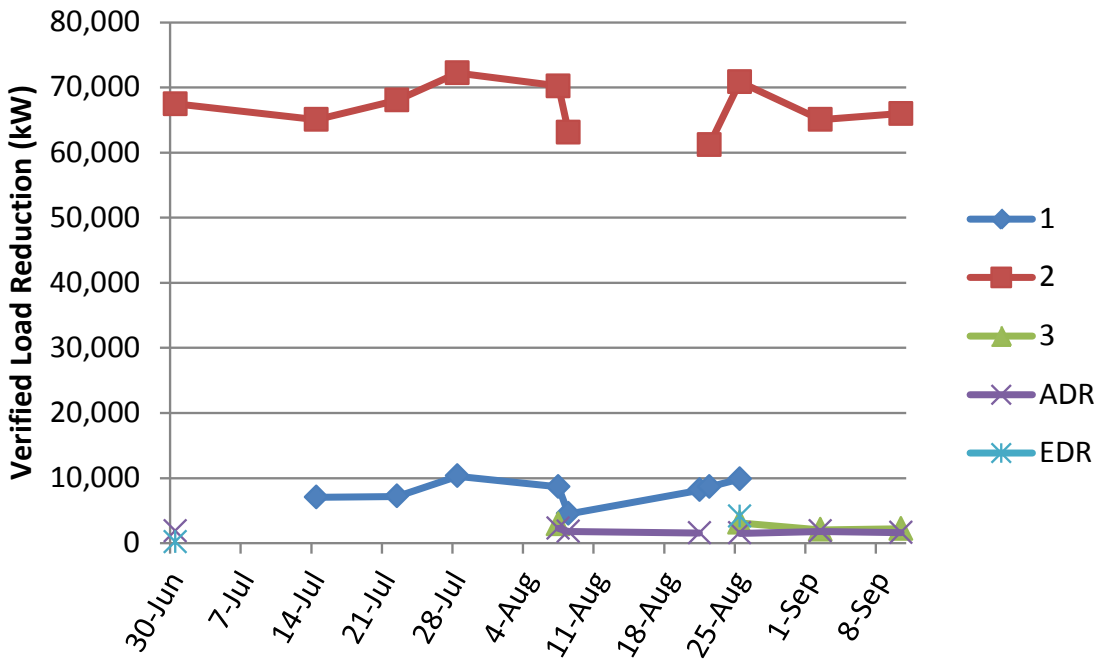


Figure 5.4-1: Claimed Load Reduction by Program Option by Event

Table 5.4-2: Commercial Demand Response - Participation by Program Option

Program Offering	Participants (Customers)	Participants (Sites)	Amount Contracted (kW)
Large Commercial DR Option 1	14	63	7,265
Large Commercial DR Option 2	68	197	58,423
Large Commercial DR Option 3	1	1	1,000
Automated DR	7	10	1,710
Emergency DR	5	7	2,960
Total	95	278	71,358

5.4.2 Event kW and kWh Savings

During Calendar Year 2014, CPS Energy called on participating Commercial Demand Response customers to provide DR on 11 occasions. CPS Energy estimates delivered load shed according to a High 3 of 10 baseline estimation method (with a day-of adjustment based on the hour prior to notification). Participant load shed delivery is estimated by event for each

Commercial DR program event, and annual performance is estimated as the average delivery across all events.

5.4.3 Results and Recommendations

Commercial Demand Response customers provided approximately 83.5 MW of load reduction during the summer of 2014, distributed across the program options as shown in Table 5.4-2. Three of the 11 events coincided with the four coincident peak (4CP) intervals used by ERCOT to allocate transmission costs to load-serving entities: averaged across the four CP intervals (including zero delivery for the July 4CP interval), the program reduced CPS Energy's 4CP contribution by about 56.1 MW. Frontier Associates recommends that snap-back or rebound effects should be explored in future evaluations of this program.

Table 5.4-3: Commercial Demand Response Gross Energy and Demand Savings

Measure	Energy Savings (kWh) [1][2]	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	Demand Reduction during 4CPs
Large Commercial DR Option 1	137,956	8,037	8,037	2,463
Large Commercial DR Option 2	1,491,767	66,934	66,934	51,084
Large Commercial DR Option 3	23,122	2,566	2,566	1,330
Automated DR	19,124	1,765	1,765	1,235
Emergency DR	4,230	4,230	4,230	n/a
Total	1,676,199	83,532	83,532	56,112 [3]

[1] Frontier did not scale the demand reduction and energy savings values to year-end customer number for this program because the participants in the Commercial Demand Response program are very heterogeneous.
[2] Snap-back effects were not considered as part of this analysis.
[3] Here Frontier applies the event average delivered load reduction rather than a reduction estimate for the 4CP intervals alone. Load reductions during the 4CP-coincident events were as follows: June 4CP, 69.3 MW; July 4CP, 0 MW; August 4CP, 85.3 MW; September 4CP, 69.8 MW.

5.5 NEST RUSH HOUR REWARDS PILOT PROGRAM

5.5.1 Overview

CPS Energy partnered with Nest Labs to implement a pilot program (Nest Pilot) in the summer of 2014 for customers with Nest thermostats to take advantage of Nest's Rush Hour Rewards

program. Rush Hour Rewards uses a combination of pre-cooling in anticipation of a 'rush hour' – a demand response event initiated by CPS Energy – and air conditioner cycling during the events, to achieve load reduction. Because of Nest's 'learning' capabilities, reductions may vary based on whether the home is occupied at the time of the event, or other variables. More information on Nest's Rush Hour Rewards program is available from the Nest Labs website.[54]

CPS Energy provided a one-time bill credit for customers enrolling in the program, and is offering annual account credits for every additional year customers participate in the program. By the end of FY 2015, 1,434 CPS Energy customers had signed up for the Nest Rush Hour Rewards program.

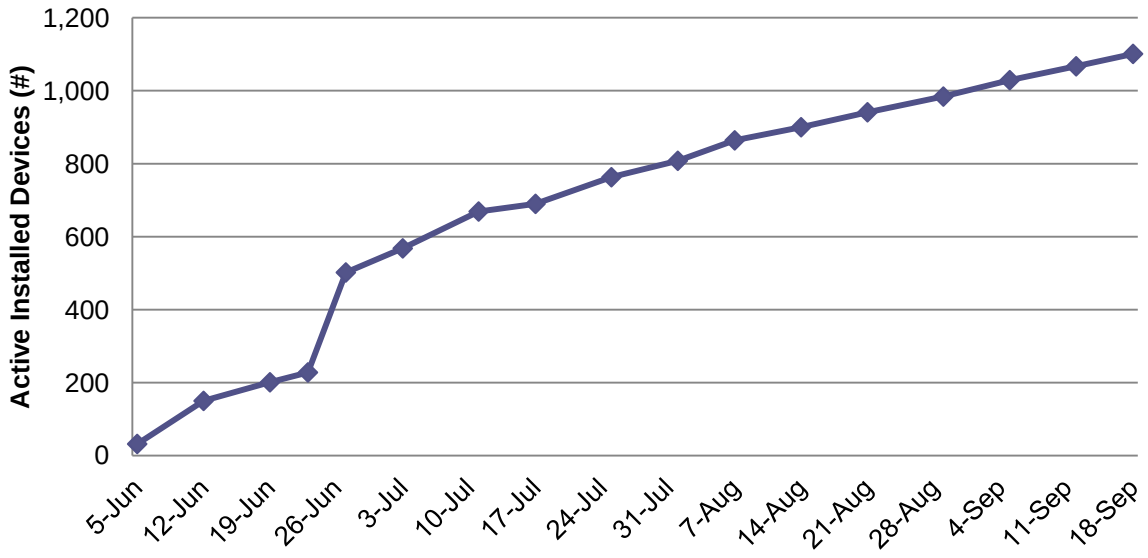


Figure 5.5-1: Nest Pilot - Program Participation, Summer 2014[55]

5.5.2 Event kW and kWh Savings

Following the pilot period during the summer of 2014, Nexant estimated the impacts of the program.[56] Frontier Associates reviewed Nexant's study and found the results to be credible. Consequently, they are relied upon herein.

All Nest Pilot Program customers were categorized into 2 groups. A total of 9 events were called. For the first 8 events, 4 were called for Group A; the other 4 were called for Group B. For the last event (9/10/2014 15:00-18:00), all customers were called.

[54] Nest Support. *What is Rush Hour Rewards?* Online. Available: https://nest.com/support/article/What-is-Rush-Hour-Rewards. Accessed March 18, 2015.
[55] Nexant, *CPS Energy Nest Pilot Evaluation FY 2015 - Final*, November 21, 2014.
[56] Nexant, *CPS Energy Nest Pilot Evaluation FY 2015 - Final*, November 21, 2014.

5.5.3 Results and Recommendations

The Nest Pilot Program was capable of achieving 1,334 kW[57] of demand reduction by the end of 2014. One of the events called by CPS Energy coincided with the four coincident peak intervals (4CPs) used by ERCOT to allocate transmission costs to load-serving entities. The demand reduction achieved by this program during the September CP interval was roughly 790 kW,[58] so the average demand reduction during all four intervals is estimated to be a quarter of that total, or 197 kW.

Table 5.5-1: Nest Pilot Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	Demand Reduction during 4CPs
Total	**14,713 [1]**	**1,334**	**1,334**	**197**
[1] 14,713kWh = energy savings per household * year end # of residences * # of total events called = 1.14kWh * 1434 * 9				

In its assessment of the Nest Pilot, Nexant estimated that the "…average net energy savings on event days was…1.14 kWh per household…" by comparing load reduction during the event to additional energy use for pre-cooling and post-event snapback. Accordingly, Frontier estimated energy savings from the Nest Pilot by multiplying the 1.14 kWh/household/event number by the number of participating households (1,434 at the end of FY 2015) and the number of events (9) to estimate just under 15,000 kWh of energy savings.

[57] 1334kW = year end # of residences * load reduction per household = 1434 * 0.93kW
[58] On 9/10/2014, "active installed" devices (instead of all devices) were between 1029 (9/5/2014 active device) and 1067 (9/12/2014 active device). The average estimated load reduction over the three event hours was 0.74kW per home and 0.71kW per device. Per home reduction is probably between 1029*0.74=761.46kW and 1067*0.74=789.58kW.

5.6 THINKECO ROOM AIR CONDITIONER PILOT PROGRAM

5.6.1 Overview

Through the ThinkEco Room Air Conditioner Pilot Program,[59] (ThinkEco Pilot) CPS Energy customers with one or more room air conditioners (RACs) are offered a free SmartAC kit from ThinkEco (valued at $139) and a participation incentive in the form of a $30 end-of-season bill credit. In return, participants allow CPS Energy to adjust the RAC set points during peak summer day events. The SmartAC kit allows consumers to remotely control the thermostat on their RAC. This remote displays a “DR” indicator during a demand response event, during which time the customer’s thermostat set point is raised. Customers are able to opt out of an event by adjusting their set points via the remote, web, or smartphone application. A “refresh” signal is sent halfway through the event, requiring customers to opt out a second time if they wish to again over-ride the curtailment request.

Curtailment implementation combined cycling with a setpoint adjustment: at the start of an event and subsequent event refresh. First, units are cycled off for 10 minutes at the start and refresh of each event: regardless of the RAC’s set point or the indoor room temperature relative to that setpoint, RACs were turned completely off for the first 10 minutes. Subsequently, the SmartAC moderated RAC usage by revising the thermostat set point on controlled units. The exact timing at which the individual units are brought into a given event was randomized across devices in an effort to smooth the load shed from the initial equipment cycle off. Beginning with the July 28th event, CPS Energy increased the duration of initial and refresh unit cycling from 15 minutes to 30 minutes.

[59] CPS Energy also implemented the Friedrich Kühl AC Rebate Program in FY 2015, a pilot effort with a local manufacturer to build DR-ready window units and sell them in the local market with a package of incentives and rebates from CPS Energy. Due to low uptake, this program was not evaluated.

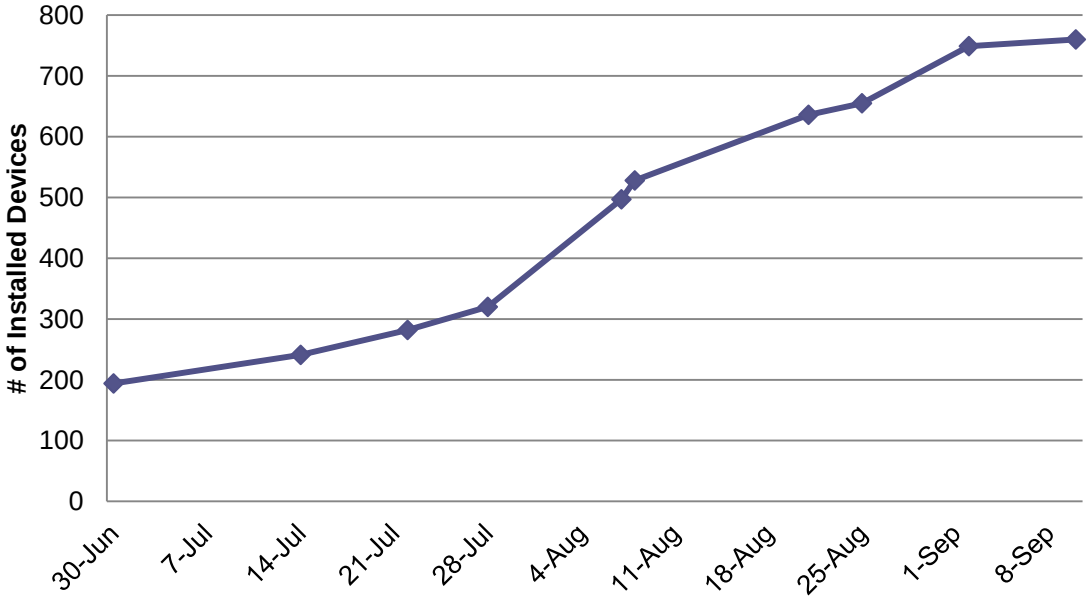


Figure 5.6-1: ThinkEco Pilot - Program Participation by Devices Installed, Summer 2014

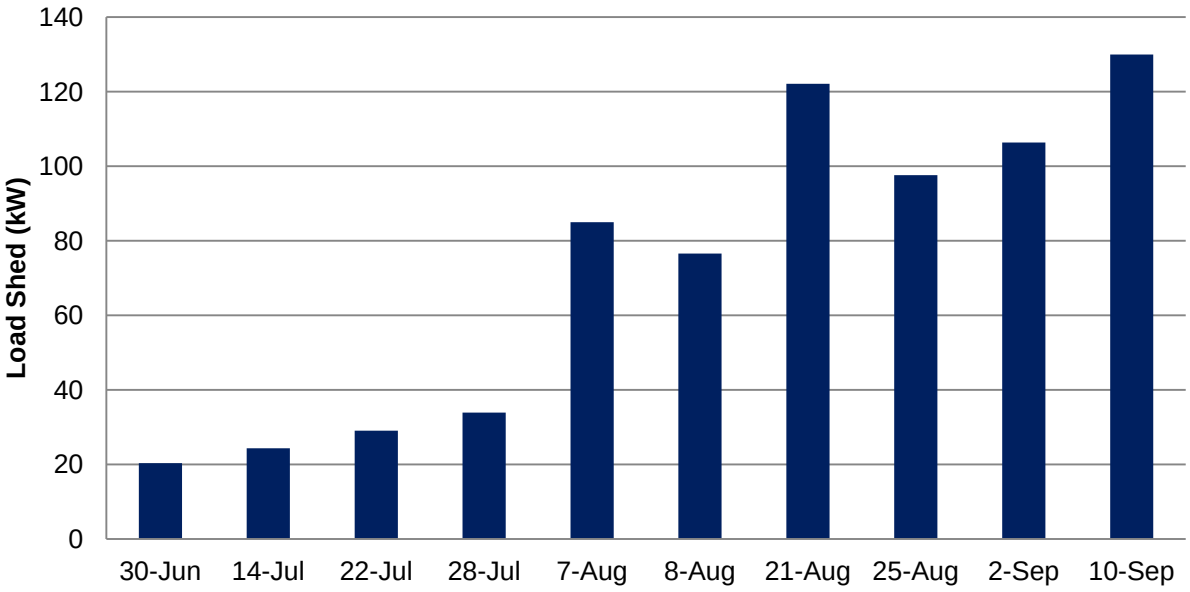


Figure 5.6-2: ThinkEco Pilot - kW Savings By Event

5.6.2 Event kW and kWh Savings

Following the pilot period during the summer of 2014, Nexant estimated the impacts of the program.[60] Frontier Associates reviewed Nexant's study and found the results to be credible. Consequently, they are reported here.

5.6.3 Results and Recommendations

The ThinkEco Pilot was capable of achieving 121 kW[61] of demand reduction by the end of FY 2014. Three of the events called by CPS Energy coincided with the four coincident peak intervals (4CPs) used by ERCOT to allocate transmission costs to load-serving entities, resulting in a reduction in CPS Energy's demand during an average of the 4CP intervals of roughly 62 kW.[62]

Table 5.6-1: ThinkEco Pilot Gross Energy and Demand Savings

Measure	Energy Savings (kWh)	Peak Demand Savings (kW)	Non-Coinc. Demand Savings (kW)	Demand Reduction during 4CPs
Total	2,293 [1]	121	121	62
[1] 2,293kWh = year end # of installed devices * net energy savings per device * # of events * Average Percent of Installed Devices Online= 872 * 0.346kWh * 10 * 0.76				

In its analysis, Nexant estimated energy savings net of post-event snapback to be 0.346 kWh per unit (online device) for 2-hour events. All but the last two events called in 2014 were 2 hours in duration; the final two events lasted 1.5 hours. Frontier estimated energy savings by applying the Nexant estimates to all ten events and the 872 units for which CPS Energy indicates the ThinkEco SmartAC Kit has been installed, modified by the 76 percent of installed devices that were online, on average, for the events called through the 2014 pilot.

[60] Nexant, *CPS Energy ThinkEco Pilot Evaluation FY 2015 - Final*, November 21, 2014.
[61] 121kW = year end # of installed devices * average impact per household = 872 * 0.139kW
[62] Average demand reduction during 4CP events is less than 75% of capable demand reduction because it is calculated using actual participation levels during FY 2014 4CP events. Participation levels increased rapidly throughout 2014, and was lower during 4CP intervals than at year end. 61.981kW =(# of installed devices on June 4CP* average impact per installed device on June 4CP + # of installed devices on August 4CP * average impact per installed device on August 4CP + # of installed devices on September 4CP * average impact per installed device on September 4CP) / 4 = (194*0.105+655*0.149+760*0.171)/4

6. TOTAL IMPACTS AND COST-EFFECTIVENESS

6.1 NET PROGRAM IMPACTS & COST-EFFECTIVENESS

Program impacts previously presented in this report are gross program impacts, without any adjustments for distribution losses or Net-to-Gross (NTG) adjustments. The net program savings values were derived by converting the program-level gross savings at the meter to savings at the source using a CPS Energy-provided line loss factor equal to 5.5%. The gross 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 with the exception of the residential weatherization program. Based on Frontier experience and industry standards used in Texas, a 100% NTG factor was used.

Overall, CPS Energy's energy efficiency and demand response portfolio produced positive net benefits, resulting in a portfolio-wide benefit-cost ratio of 1.51.

Frontier also calculated the three following economic metrics, in-line with previous evaluations:

1. Cost of Saved Energy (includes DR) ($/kWh) = $0.06
2. Reduction in Revenue Requirements (includes DR) = $48,581,436
3. Benefit Cost Ratio = 1.51

The net program impacts and results of the Benefit-Cost tests are provided in the following table:

Table 6.1-1: FY 2015 Net Energy and Demand Savings

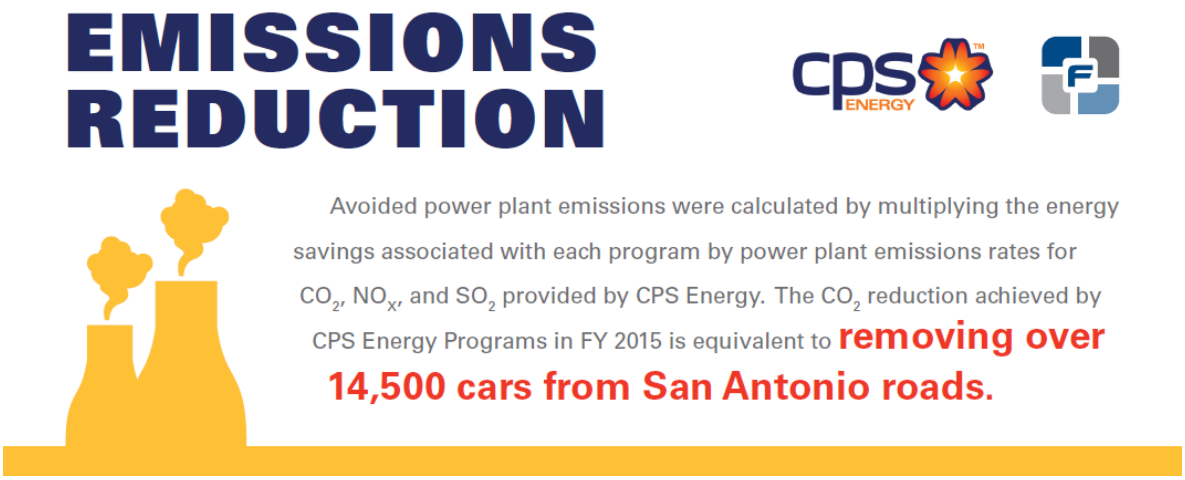
Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net Peak Demand Savings (kW)	Net Non-Coinc. Demand Savings (kW)	Net Present Value of Avoided Cost Benefits	Rebate $	Admin and Marketing $	Total Program Spending	Benefit-Cost Ratio
Energy Efficiency Programs									
Home Efficiency	93%	1,920,450	549	736	$1,638,836	$844,194	$98,383	$942,578	1.74
Air Flow	90%	858,815	392	525	$838,032	$750,280	$66,875	$817,155	1.03
Residential HVAC	95%	14,275,837	4,368	5,836	$12,129,476	$3,403,050	$240,343	$3,643,393	3.33
Solar Initiative	100%	7,018,005	2,476	4,144	$7,846,168	$6,482,046	$502,714	$6,984,760	1.12
New Homes	100%	11,738,507	2,490	2,490	$11,375,624	$1,777,100	$118,576	$1,895,676	6.00
Refrigerator Recycling	63%	497,482	66	70	$156,323	$53,740	$67,946	$121,686	1.52
Weatherization	100%	12,935,654	3,198	13,365	$9,116,398	$13,382,366	$1,693,265	$15,075,631	0.60
Residential Lighting	85%	1,906,720	59	4,556	$1,188,350	$1,000,000	$76,072	$1,076,072	1.10
Residential Subtotal		**51,151,470**	**13,599**	**31,722**	**$44,289,207**	**$27,692,776**	**$2,864,174**	**$30,556,950**	**1.45**
Commercial Lighting	85%	36,208,070	3,704	8,444	$13,910,932	$4,427,913	$448,155	$4,876,068	2.85
Commercial HVAC	96%	9,921,735	4,089	5,009	$10,251,139	$2,660,635	$250,158	$2,910,793	3.52
Solar Initiative – Commercial & Schools	100%	3,524,325	1,281	2,044	$3,995,203	$2,811,929	$253,561	$3,065,490	1.30
Commercial Custom	96%	2,343,510	635	638	$1,289,400	$315,052	$35,898	$350,950	3.67
Commercial New Construction	100%	20,547,891	2,946	2,946	$13,183,463	$1,799,501	$158,362	$1,957,863	6.73
Commercial Subtotal		**72,545,532**	**12,655**	**19,082**	**$42,630,137**	**$12,015,030**	**$1,146,134**	**$13,161,164**	**3.23**
Energy Efficiency Subtotal		**123,697,002**	**26,254**	**50,804**	**$86,919,344**	**$39,707,806**	**$4,010,308**	**$43,718,114**	**1.99**

Program	Net-to-Gross Ratio	Net Energy Savings (kWh)	Net Peak Demand Savings (kW)	Net Non-Coinc. Demand Savings (kW)	Net Present Value of Avoided Cost Benefits	Rebate $	Admin and Marketing $	Total Program Spending	Benefit-Cost Ratio
Demand Response Programs									
Smart Thermostat	100%	931,047	39,851	39,851	$3,390,054	$6,176,118	$487,662	$6,663,780	0.50
Home Manager	100%	325,611	34,058	34,058	$13,832,373	$7,615,747	$1,941,292	$9,557,039	1.04
Commercial Demand Response	100%	1,749,042	82,050	82,050	$8,769,723	$5,463,450	$498,042	$5,961,492	1.47
Auto Demand Response	100%	20,237	1,868	1,868	$1,823,829	$913,358	$83,261	$996,618	0.36
Emergency Demand Response	100%	4,476	4,476	4,476	$336,691	$109,148	$9,950	$119,098	2.83
Nest Program	100%	15,569	1,412	1,412	$1,111,391	$202,249	$89,057	$291,306	1.48
Think Eco Room AC	100%	2,426	128	128	$126,247	$337,538	$82,825	$420,363	0.10
Demand Response Subtotal		**3,048,408**	**163,842**	**163,842**	**$29,390,308**	**$20,817,607**	**$3,192,089**	**$24,009,696**	**0.89**
Grand Total					**$116,309,652**	**$60,525,413**	**$7,202,396**	**$116,309,652**	**1.51**

6.2 EMISSIONS REDUCTION

Table 6.2-1: Emissions Reduction Impacts by Program (lbs/MWh)

Program	CO_2	NO_x	SO_2
Home Efficiency	2,330,735	922	2,074
Air Flow Performance	1,042,293	412	928
HVAC	17,325,727	6,852	15,418
Solar Initiative - Residential	8,517,332	3,369	7,579
New Homes Construction	14,246,321	5,634	12,678
Refrigerator Recycling	603,764	239	537
Weatherization	15,699,227	6,209	13,971
Residential Lighting (LEDs)	2,314,072	915	2,059
Residential Sector Total	**62,079,470**	**24,553**	**55,244**
Commercial Lighting	33,625,303	13,299	29,923
HVAC	12,041,415	4,762	10,715
Solar Initiative - Commercial & Schools	4,277,262	1,692	3,806
Custom	2,844,179	1,125	2,531
New Construction	24,937,742	9,863	22,192
Commercial Sector Total	**77,725,900**	**30,741**	**69,167**
Smart Thermostat	155,601	62	138
Home Manager	153,161	61	136
Commercial Demand Response (All)	2,147,768	849	1,911
Nest Program	18,895	7	17
Think Eco Room AC	2,945	1	3
Demand Response Subtotal	**2,478,369**	**980**	**2,205**
TOTAL	**142,283,740**	**56,274**	**126,616**



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