LADWP
Retrospective Impact Evaluation
Fiscal Years 15/16 – 19/20

Submitted to:

Los Angeles Department of Water & Power

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Submitted by:

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ENERGY RESEARCH AND EVALUATION

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Executive Summary

Los Angeles Department of Water and Power (LADWP) is the nation's largest municipal utility, with 8,019 megawatts (MW) of electric capacity and serving an average of 435 million gallons of water per day to the more than 4 million residents of Los Angeles, its businesses, and visitors. For more than 100 years, LADWP has provided the city with reliable water and power service in a cost-effective and environmentally responsible manner. With a workforce of more than 11,000 employees, LADWP is guided by the five-member Board of Water and Power Commissioners, appointed by the Mayor and confirmed by the City Council.

LADWP engaged ADM Associates, Inc. (the Evaluator) to conduct a retrospective impact evaluation of its portfolio of energy efficiency programs, beginning from Fiscal Year 2015/2016 to Fiscal Year 2019/2020 (FY 15/16 to FY 19/20, or the Retrospective Period). This chapter summarizes the impacts from five program years and $678,735,980 in spending, achieving over 2 GWH in energy savings - the total energy use of 187,000 homes.

ES.1. Regulatory Context

Senate Bill 1037 (SB 1037, signed September 29, 2005) - California's publicly owned utilities (POUs) prioritized cost-effective, reliable, and feasible energy efficiency resources over generation or other options.

Assembly Bill 2021 (AB 2021, signed September 29, 2006) - expanded annual reporting requirements. The expansion required reporting on investment funding, cost-effectiveness methodologies, and evaluation, measurement, and verification of public utility programs.

Senate Bill 350 (SB350, signed October 6, 2015) - increased California's renewable electricity procurement goal from 33% by 2020 to 50% by 2030. SB 350 also required California to double statewide energy efficiency savings in electricity and natural gas end-uses by 2030.

Senate Bill 100 (SB100, signed September 10, 2018) – Set a 2045 goal of fulfilling all retail electricity sold in California and state agency electricity needs with renewable and zero-carbon resources, updated the Renewables Portfolio Standard to ensure that by 2030 at least 60% of California's electricity is renewable, and required the California Energy Commission (CEC, or the Commission), CPUC and Air Resources Board to use programs under existing laws to achieve 100% clean electricity.

ES.2. Portfolio Performance Summary

Table ES-1 shows Ex-Ante and Ex-Post MWh savings and the realization rate for each program during the Retrospective Period. The overall MWh realization rate not including

Codes, Standards, and Ordinances was 86%. Table ES-2 shows Ex-Ante and Ex-Post MW savings and the realization rate for each program during the Retrospective Period. The overall MW realization rate not including Codes, Standards, and Ordinances was 79%.

Table ES-1 Retrospective Period MWh Portfolio Performance Summary

Sector	Program	Ex-Ante MWh	Ex-Post MWh	Realization Rate
Non-Residential	Commercial Direct Install	347,371	313,600	90%
	Commercial Lighting Incentive Program	262,369	256,613	98%
	Custom Performance Program	187,101	178,753	96%
	Food Service Program Comprehensive	1,375	1,365	99%
	Food Service Program Point-of-Sale	60	45	76%
	LADWP Facilities	4,600	2,302	50%
	LAUSD Direct Install	13,745	13,895	101%
	Saving By Design	23,956	22,516	94%
	Upstream HVAC	39,052	24,057	62%
Residential	Customer Rebate Program	54,331	37,504	69%
	Efficient Product Marketplace	3,657	4,682	128%
	Energy Savings Assistance Program	14,727	6,141	42%
	Home Energy Improvement Program	24,540	23,273	95%
	Refrigerator Exchange	27,277	27,133	99%
	Refrigerator Turn-in and Recycle Program	34,572	9,352	27%
	Residential Lighting Efficiency Program	146,461	88,905	61%
Cross-Sector	AC Optimization Program	41,388	39,097	94%
	Codes, Standards, and Ordinances	430	400	93%
	Multifamily Whole Building Program	855,777	884,651	103%
Total		2,082,787	1,934,286	93%
Total Excluding Codes, Standards, and Ordinances		1,227,010	1,049,635	86%

Table ES-2 Retrospective Period MW Portfolio Performance Summary

Sector	Program	Ex-Ante MW	Ex-Post MW	Realization Rate
Non-Residential	Commercial Direct Install	41.01	42.11	103%
	Commercial Lighting Incentive Program	43.47	37.27	86%
	Custom Performance Program	41.77	31.12	75%
	Food Service Program Comprehensive	9.77	0.18	2%
	Food Service Program Point-of-Sale	0.01	0.00	53%
	LADWP Facilities	0.50	0.32	64%
	LAUSD Direct Install	2.93	2.27	77%
	Saving By Design	6.48	4.05	62%
	Upstream HVAC	17.08	6.79	40%
Residential	Customer Rebate Program	26.23	13.06	50%
	Efficient Product Marketplace	1.91	4.40	231%
	Energy Savings Assistance Program	0.99	0.85	86%
	Home Energy Improvement Program	15.52	4.09	26%
	Refrigerator Exchange	5.00	5.85	117%
	Refrigerator Turn-in and Recycle Program	4.39	2.28	52%
	Residential Lighting Efficiency Program	15.42	10.84	70%
Cross-Sector	AC Optimization Program	22.91	36.76	160%
	Codes, Standards, and Ordinances	0.06	0.05	96%
	Multifamily Whole Building Program	53.38	132.19	248%
Total		308.82	334.49	108%
Total Excluding Codes, Standards, and Ordinances		255.44	202.30	79%

Figure ES-1 shows Ex-Ante and Ex-Post energy savings and the realization rate for each program during the Retrospective Period, while Figure ES-2 shows Ex-Ante and Ex-Post peak demand impacts and the realization rate for each program during the Retrospective Period. Both figures do not include energy and demand impacts from Codes, Standards, and Ordinances.

Figure ES-1 Retrospective Period Energy Impacts Not Including Codes, Standards, and Ordinances

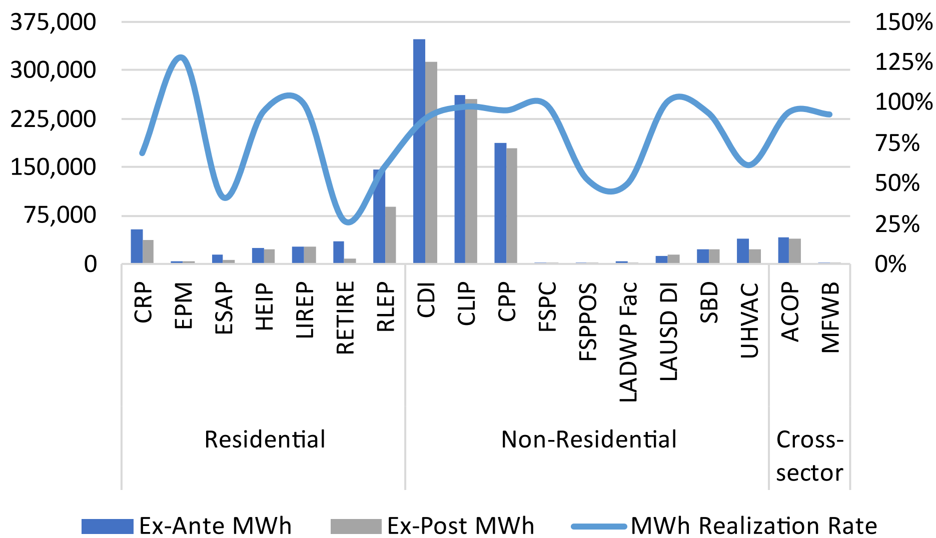


Figure ES-2 Retrospective Period Peak Demand Impacts Not Including Codes, Standards, and Ordinances

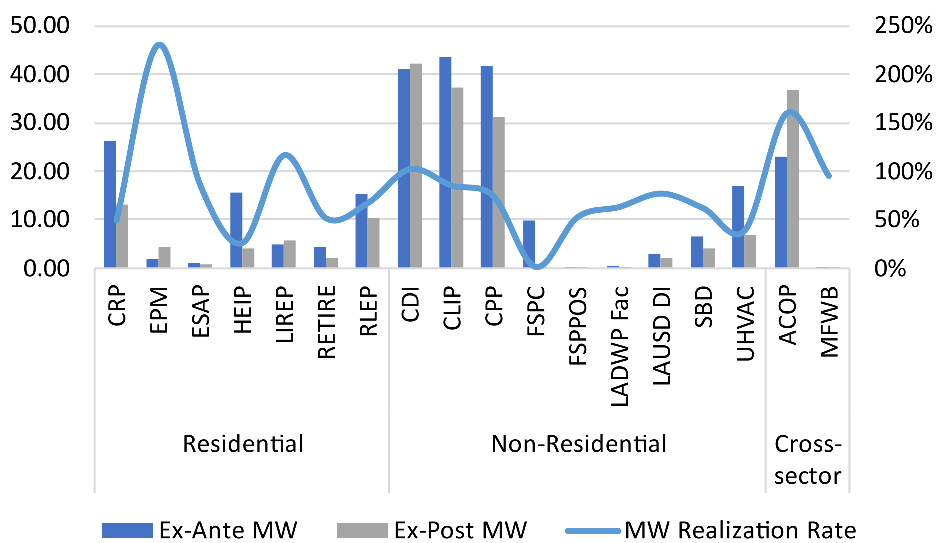


Figure ES-3 through Figure ES-6 show energy and demand impacts from Los Angeles Local Ordinances and Title 20/24.

Figure ES-3 Retrospective Period Energy Impacts of Los Angeles Local Ordinances

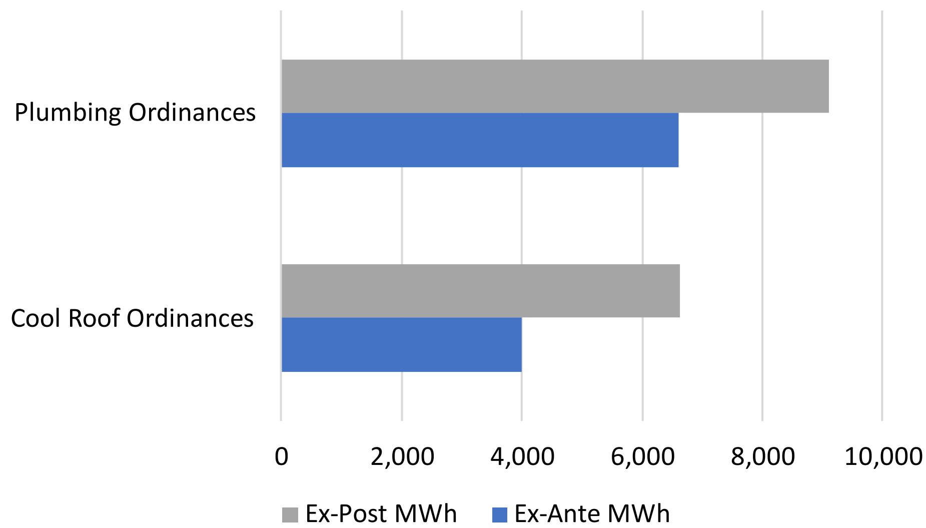


Figure ES-4 Retrospective Period Peak Demand Impacts of Los Angeles Local Ordinances

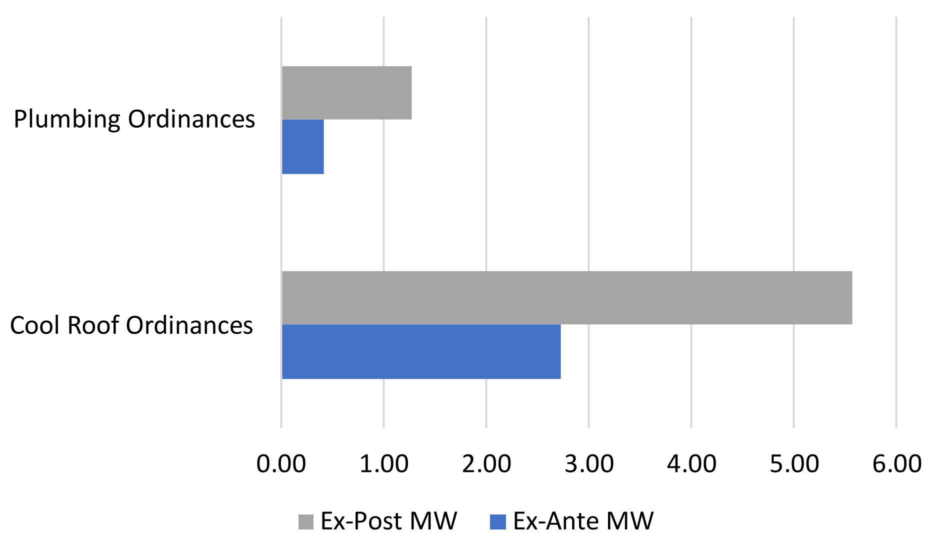


Figure ES-5 Retrospective Period Energy Impact of Title 20/24 within Los Angeles

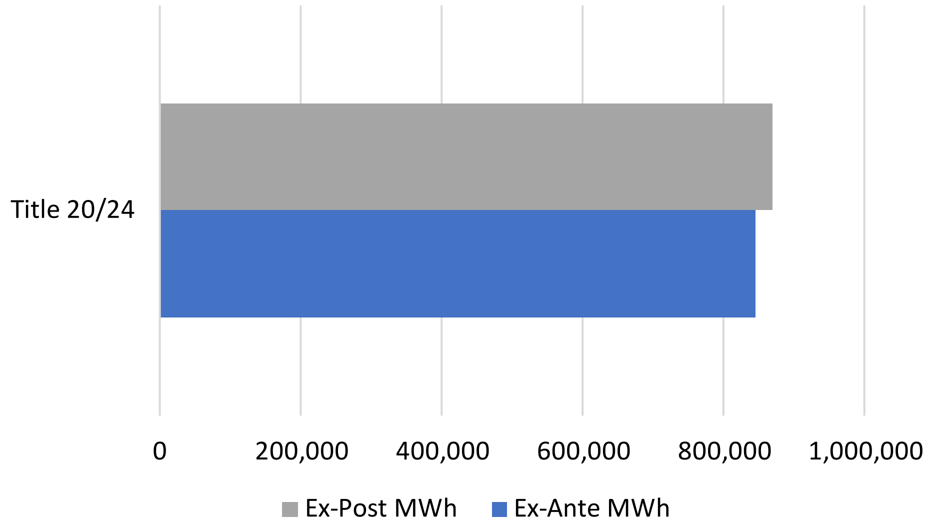
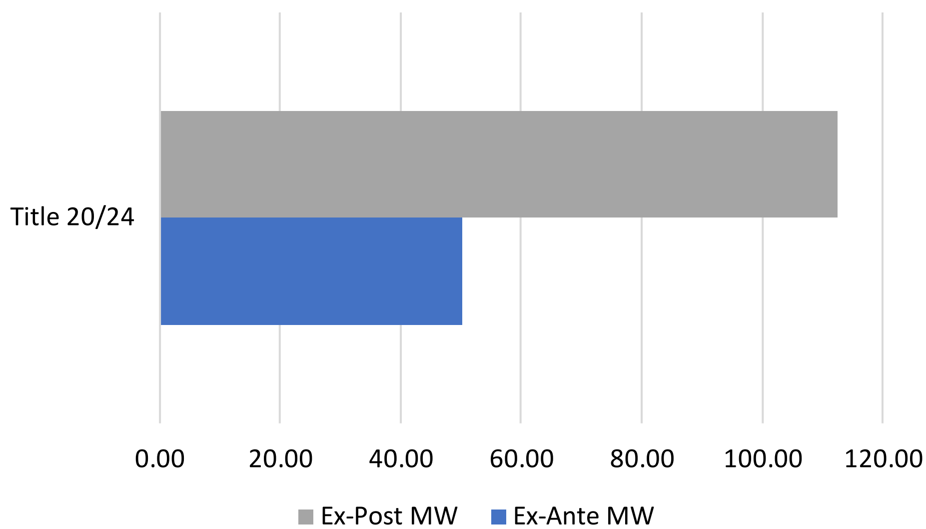


Figure ES-6 Retrospective Period Peak Demand Impact of Title 20/24 within Los Angeles

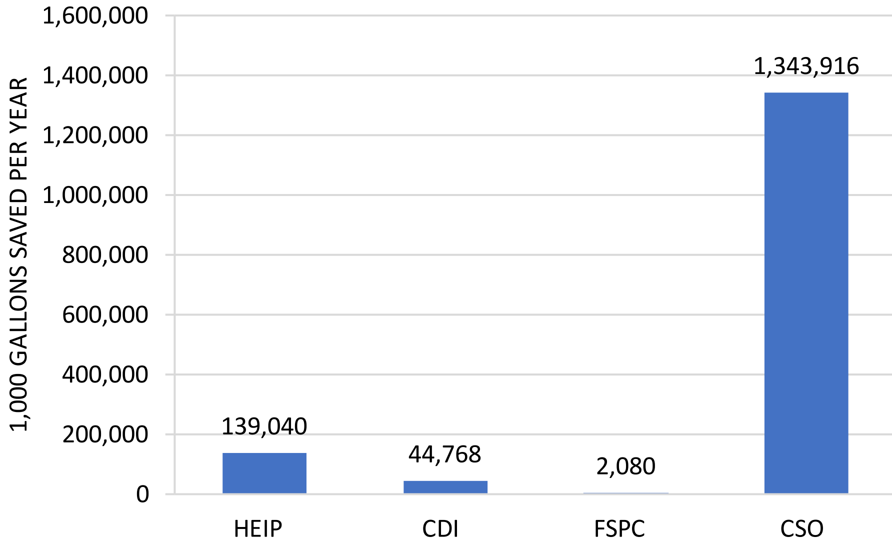


ES.3. Water Savings

The LADWP energy efficiency portfolio offered numerous water conservation measures that saved energy by reducing hot water loads and the energy used in the treatment and distribution of water (known as the “embedded energy” of water).

LADWP programs contributed to water savings via the Los Angeles Plumbing Ordinance, as well as through the direct installation of low-flow fixtures in residential and small commercial facilities. See Figure ES-7 for a summary of water savings.

Figure ES-7 Retrospective Period Water Savings



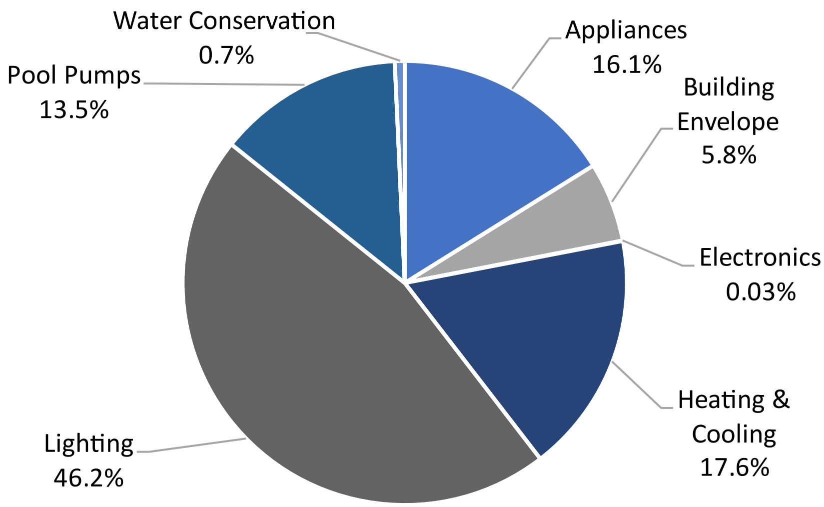
ES.4. Residential Impacts by Technology Type

Retrospective Period residential sector savings totaled 230,435,662 kWh (excluding savings from Codes, Standards, & Ordinances and AC Optimization Commercial).

Drivers of savings included:

- Lighting: 45.5% of sector-level kWh savings. From FY 16/17 to FY 19/20, LADWP distributed 4,333,552 LED kits to residents throughout Los Angeles, providing free-of-charge energy savings to all customers.
- Appliances: 16.3% of sector-level impacts, of which 10.8% was efficient appliance replacement and 5.5% was the disposal of inefficient secondary appliances.

Figure ES-8 Residential Savings by Technology

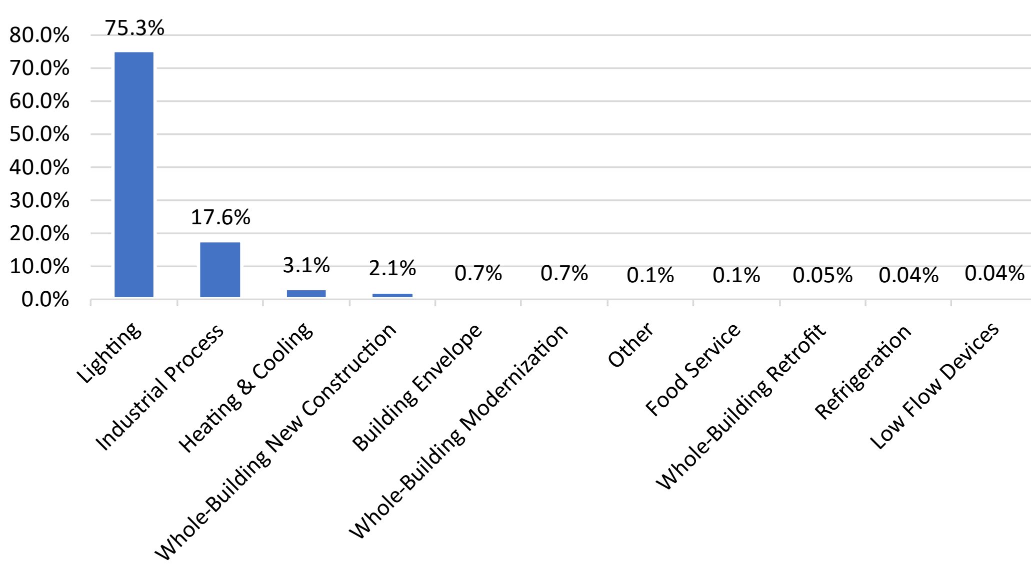


ES.5. Non-Residential Impacts by Technology Type

Retrospective Period Non-residential sector savings totaled 816,166,589 kWh (excluding savings resulting from Codes, Standards, and Ordinances). Similar to the residential sector, lighting accounted for a large share of total sector savings (75.3%).

38.7% of non-residential savings were from programs that served Los Angeles' small businesses (Commercial Direct Install and AC Optimization - Commercial).

Figure ES-9 Non-Residential Savings by Technology



ES.6. Impact of COVID-19

This evaluation included a review of the impacts of the COVID-19 pandemic and Safer-at-Home (SAH) orders. For programs analyzed via billing impacts, statistical models incorporated SAH status as an interaction term. For other programs, savings were re-estimated under COVID-19 and non-COVID-19 conditions based on a review of operating hours with representatives from program participants.

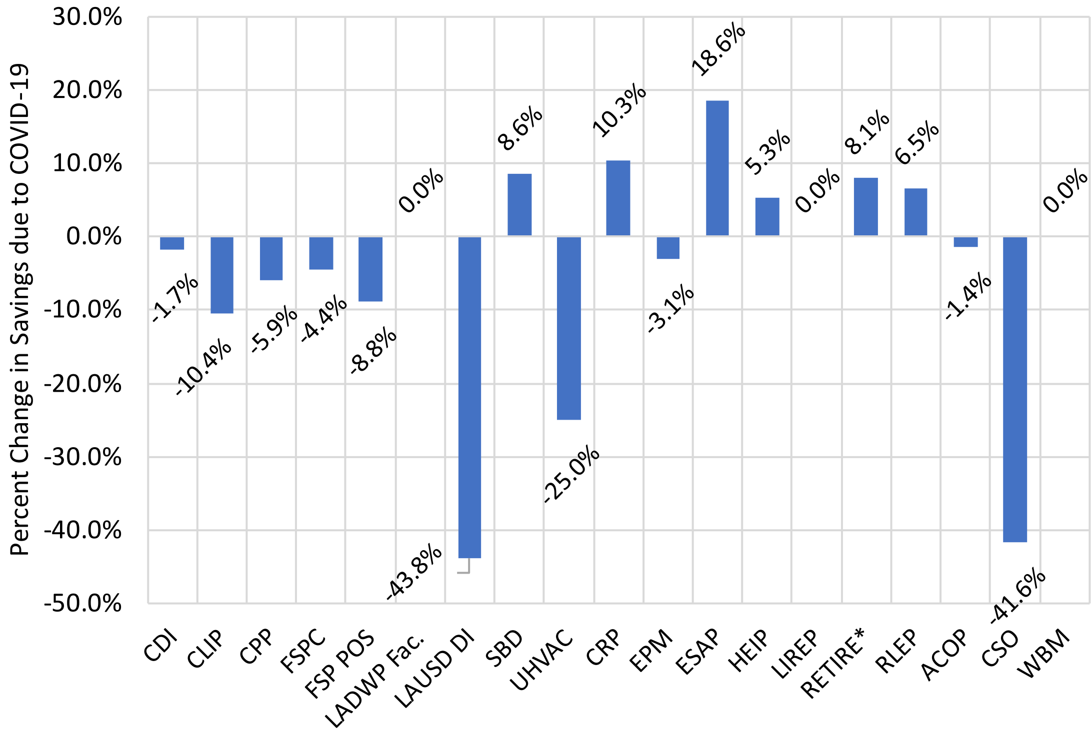
It should be noted that this analysis looked at the impact on savings, not usage. If a facility reduced its hours of operation by 50% due to an SAH order, the resulting impact on savings potential from its lighting declined by 50%, even though their usage declined as a result of the shutdown.

ES.6.1. Changes in Methodology Due to COVID-19 Pandemic

LADWP and the Evaluator prioritized customer safety in conducting this evaluation. Steps taken to ensure the safety of LADWP, their customers, and their contractors included:

- Conducting update meetings remotely;
- Replacing planned end-use metering with analysis of billing data;
- Conducting virtual verifications instead of on-site verifications. Virtual verifications were conducted primarily via the STREEM platform, enabling customers to participate in the verification process via a mobile app; and
- Collecting data in participant surveys addressing whether the participant's home or business had been affected by the COVID-19 pandemic.

Figure ES-10 Impact of Covid-19 on Program Savings



*RETIRE impacts only include Room AC measure savings

ES.6.2. Impact of COVID-19 Key Takeaways

The impact of COVID-19 on savings by program varied widely. Notable findings include:

- LAUSD demonstrated a 43.8% reduction in savings, due to the shutdown of most educational facilities.
- Residential lighting showed higher savings, as SIP orders resulted in higher home occupancy. This meant higher energy use, but when estimating the impacts of an LED, the savings increased from what they would have been if customers still had incandescent or halogen lamps in place.
- Many large programs showed little to low impact. Custom Performance and Commercial Direct Install both had savings impacted by less than 6% and 2% respectively.
- The Codes, Standards, & Ordinances were not included in this re-estimation of savings.

ES.7. Cost Effectiveness Results

The cost-effectiveness of LADWP's programs was calculated based on reported total spending and verified energy savings for each energy efficiency program. All spending estimates and incentive costs were provided by LADWP. The methods used to calculate cost-effectiveness are informed by the California Standard Practice Manual.

Table ES-3 lists benefits and costs along with cost-effectiveness results for each fiscal year during the Retrospective Period. Cost-effectiveness results are shown for the Total Resources Cost (TRC) Test, Program Administrator Cost (PAC) Test, the Rate-payer Impact Measure (RIM) Test, Participant Cost Test (PCT), and Modified Total Resources Cost (MTRC) Test.

Table ES-3 Retrospective Period Portfolio Level Cost Effectiveness Results

Fiscal Year	PAC		TRC		PCT		RIM		MTRC	
	Benefits/ Costs*	Ratio	Benefits/ Costs*	Ratio	Benefits/ Costs*	Ratio	Benefits/ Costs*	Ratio	Benefits/ Costs*	Ratio
15/16	$265,179	4.02	$265,179	17.02	$640,716	NA.	$265,179	0.38	$265,179	17.02
	$66,005		$15,582		$0		$691,997		$15,582	
16/17	$278,109	2.33	$278,109	10.75	$771,682	>1.00	$278,109	0.32	$278,109	10.75
	$119,575		$25,860		$18		$875,594		$25,860	
17/18	$240,204	1.89	$240,204	2.19	$625,473	36.48	$240,204	0.33	$240,204	2.19
	$127,014		$109,630		$17,145		$723,356		$109,630	
18/19	$293,796	1.74	$293,796	3.59	$874,098	26.49	$293,796	0.32	$293,796	3.59
	$169,161		$81,743		$33,000		$922,841		$81,743	
19/20	$248,192	1.26	$248,192	2.87	$901,756	67.23	$922,841	0.25	$248,192	2.87
	$196,981		$86,435		$13,413		$248,192		$86,435	
Grand Total	$1,325,480	1.95	$1,325,480	4.15	$3,813,725	59.99	$974,785	0.32	$1,325,480	4.15
	$678,736		$319,250		$63,575		$1,325,480		$319,250	

*Dollar amounts in thousands of dollars

1 Introduction

This report is a summary of the evaluation, measurement, and verification (EM&V) effort of the portfolio of programs for the Los Angeles Department of Water and Power (LADWP) during Fiscal Year 15/16 through Fiscal Year 19/20 (Retrospective Period). The evaluation was administered by ADM Associates, Inc (herein referred to as the "Evaluator").

1.1 Regulatory Context

Two legislative bills, Senate Bill 1037 (SB 1037) and Assembly Bill 2021 (AB 2021), were signed into law a year apart. SB 1037 requires that California's publicly owned utilities (POUs) – similar to the state's investor-owned utilities (IOUs)—place cost-effective, reliable, and feasible energy efficiency and demand reduction resources at the top of the utility resource loading order, giving priority to the efficiency resource in utility operating plans. Additionally, SB 1037 requires an annual report describing utility programs, expenditures, expected energy savings, and actual energy savings.

AB 2021, signed by the governor a year later, reiterated the loading order and annual report stated in SB 1037, as well as expanded on the annual report requirements. The expanded report required the inclusion of investment funding, cost-effectiveness methodologies, and an independent evaluation that measures and verifies the energy efficiency savings and reductions in energy demand achieved by the energy efficiency and demand reduction programs. AB 2021 additionally required a report every 3 years that highlights cost-effective electric potential savings from energy efficiency and established annual targets for electricity energy efficiency and demand reduction over 10 years.

The California Energy Commission (CEC, or the Commission) was given the mandate to oversee POU SB 1037 and AB 1021 energy efficiency program and EM&V efforts, with the following requirements for CEC:

- Monitor POUs' annual efficiency progress;
- Review POU independent evaluation studies, reporting results, and, if necessary, recommend improvements; and
- Ensure that savings verification increases the reliability of savings and contributes to better program design.

The CEC was also mandated to provide the POUs with EM&V Guidelines under which plans should be submitted. This guidance is summarized in a checklist listed in Section 1.1.3.

This plan is submitted in compliance with the CEC EM&V guidelines. In this plan, the Evaluator describes the technical and economical reasoning including the advantages and disadvantages of our recommended methods for each applicable energy efficiency program and energy efficiency measure in this document. EM&V methods meet or exceed the rigor requirement as prescribed by the EM&V Protocols listed above.

1.1.1 EM&V and Related Protocols

The Evaluator used the following guidelines for the impact evaluation of LADWP programs:

- CEC POU EM&V Guidelines
- California Energy Efficiency Evaluation Protocols
- California Evaluation Framework

The following references supplemented the evaluation method as applicable:

- U.S. Department of Energy (DOE) Uniform Methods Project (both draft and final chapters)
- International Performance Measurement and Verification Protocol (IPMVP) to determine the best options for evaluating energy efficiency measures (EEMs).

1.1.2 CEC Reporting Schedule

LADWP is required to submit an annual report on its energy efficiency programs. Specifically, Article 1, Section 1311 of Title 20 of the California Code of Regulations requires that:

Beginning in 2008, and every year thereafter, each local publicly owned utility shall report no later than March 15 to the Commission its annual investments in energy efficiency and demand reduction programs for its previous fiscal year. The report shall include at least:

(a) for electric energy efficiency programs:

(1) a description of each program by category (residential, nonresidential, new construction, cross-customer, and other);

(2) expenditures by program category, identified as administrative costs, delivery costs, incentive and installation costs, and evaluation, measurement, and verification costs;

(3) expected and actual annual energy and peak demand savings by the program category; and

(4) an explanation of how these energy efficiency programs were determined to be cost-effective.

(b) for demand reduction programs:

(1) a description of each program;

(2) expenditures associated with each program;

(3) expected demand reduction, and any actual reduction from the programs, and

(4) an explanation of how these demand reduction programs were determined to be cost-effective.

1.1.3 CEC Checklist

The following checklist is a guideline for submitting POU EM&V reports. It is based on the California Energy Commission EM&V Guidelines for Energy Efficiency Programs, "CEC Framework of Criteria" guidelines (Part D).

Contextual Reporting

- The EM&V report clearly states savings values consistent with the associated annual report.
- The evaluation covers a significant portion of LADWP's portfolio and clearly describes the programs and savings reported.
- The evaluation assesses risk or uncertainty in selecting components of the portfolio to evaluate.

Overview and Documentation of Specific Evaluation Effort

- The report clearly identifies what is being evaluated for each program.
- The evaluation includes an assessment of savings and the end of useful life.
- The evaluation provides documentation of all engineering and billing analysis algorithms, assumptions, survey instruments, and methods.
- The methodology is described in sufficient detail in the report such that another evaluator could replicate the study and achieve similar results.
- All data collection methods are included in the appendix.

Gross Savings

- The report reviews the program's choice of baseline.
- The report clearly characterizes the population of participants.
- The report clearly discusses its sampling approach and sample design.
- The report states the sampling precision targets and achieved precision.
- The report clearly presents the Ex-Post savings.
- The report clearly indicates where Ex-Ante savings are being passed through.
- The report explains the differences between Ex-Ante and Ex-Post savings.

EM&V Summary and Conclusions

- The report provides clear recommendations for improving program processes to achieve measurable and cost-effective energy savings.
- The evaluation assesses the reliability of the verified savings and areas of uncertainty.

1.2 LADWP Energy Efficiency Programs

The following sections describe the energy efficiency programs offered by LADWP during the Retrospective Period.

1.2.1 Commercial/Industrial/Institutional Customer Programs

The following are the non-residential programs offered by LADWP.

1.2.1.1 Commercial Direct Install (CDI)

The CDI Program targets small to large business customers in the LADWP service territory, offering upgrades to targeted systems, including lights, water, and natural gas. LADWP is partnering with Southern California Gas Company on CDI, with LADWP as the lead utility. This program is designed to integrate electric, water, and natural gas efficiency measures. LADWP is leveraging its Power Construction Maintenance Group (PCM), contract personnel, an IT system, and strategically located community-based organizations (CBOs) to market and implement the CDI Program. The design is intended to maximize the electric, water, and natural cost savings in a cost-effective manner. CDI is a direct install program managed by the LADWP Mass Market Programs Group and implemented with the assistance of an external vendor (Lime Energy).

1.2.1.2 Commercial Lighting Incentive Program (CLIP)

CLIP uses a calculated savings approach, allowing customers to replace their lighting with a wider variety of more efficient systems. This not only gives customers greater flexibility in lighting design, but also offers the potential for greater energy savings. CLIP also offers customers an innovative approach to finding qualified light-emitting diode (LED) products that qualify for incentives. Customers may now search the Department of Energy's Lighting Facts database for products that match their lighting needs and meet CLIP requirements.

1.2.1.3 Custom Performance Program (CPP)

LADWP's Custom Performance Program offers cash incentives for energy-saving measures not covered by existing prescriptive programs, such as equipment controls, industrial processes, and other innovative energy saving strategies that exceed Title 24 or Industry Standards and that are not included in other LADWP non-residential Energy Efficiency Programs. Incentives for each project are paid per kilowatt-hour based on energy savings calculated or accepted by LADWP. In addition, two previously selfstanding LADWP efficiency programs, Retro-commissioning and the Energy Efficiency Technical Assistance Program, were rolled into the CPP in 2017.

1.2.1.4 Food Service Program (FSP)

FSP is a program designed to assist grocery stores (small to large), liquor stores, convenience stores, restaurants, and other commercial customers with refrigeration and food service equipment. This program offers rebates for ice machines, glass, and solid door freezers/refrigerators, commercial ovens, etc. The Food Service Program is designed to be utilized by major vendors and manufacturers to promote the highest efficiency refrigeration and food service equipment for retrofit projects.

1.2.1.5 LADWP Facilities and Upgrade Program

The LADWP Facilities Upgrade Program was established in 2009 in response to the City of Los Angeles Green LA directive. The program reduces energy and water consumption in LADWP facilities through energy efficiency and water conservation measures. The program is designed to provide technical design, project management experience, and expertise in retrofitting LADWP facilities, with high-efficiency HVAC equipment, lighting fixtures, plumbing fixtures, irrigation equipment, and California Friendly landscaping utilizing LADWP engineering staff.

1.2.1.6 LAUSD Direct Install (LAUSD DI) Program

The LAUSD DI Program was launched in October 2012 in response to the opportunities for energy and water efficiency within the District, the District's budget challenges, and the numerous opportunities to be able to capture water, natural gas, and electricity savings and budget to improve the financial standing of LAUSD and enhance the learning environment for the students of LAUSD. The program entered a dormant period in FY 15/16 and was relaunched in May of 2016 with a focus on lighting. The program includes (1) direct install for LAUSD facilities, (2) Proposition 39 project management support, and (3) pilot efficiency projects.

1.2.1.7 Savings by Design (SBD)

SBD was California's non-residential new construction energy efficiency program, administered statewide and adopted by investor-owned (IOU) and publicly owned utilities (POU). This statewide approach offered the non-residential building industry a uniform, multi-faceted program designed to consistently serve the needs of the building community throughout California. SBD encouraged energy-efficient building design and construction practices by promoting the efficient use of energy by offering up-front design assistance supported by financial incentives based on project performance. Projects participating in SBD received services including design assistance, owner incentives, design team incentives, and energy design resources.

1.2.1.8 Upstream HVAC (UHVAC)

Through an agreement with participating distributors and manufacturers, UHVAC provides incentives to participants to stock and upsell high-efficiency HVAC equipment. Contractors and HVAC customers can then immediately access premium replacement technology that might not have been readily available to them without the program. The upstream approach allows LADWP to capture energy savings at the point of sale which would not have been applied for in LADWP's downstream programs.

1.2.2 Residential Customer Programs

The following are the residential programs offered by LADWP.

1.2.2.1 Consumer Rebate Program (CRP)

CRP is designed to offer and promote specific energy efficiency solutions within the residential market sector. By encouraging the adoption of economically viable energy efficiency measures, the residential portfolio strives to overcome market barriers and to deliver programs and services aligned to support LADWP's energy efficiency objectives.

1.2.2.2 Efficient Product Marketplace (EPM)

The EPM program is designed to simplify shopping for energy-efficient electronic products and streamline obtaining a rebate. The key feature of EPM is its website which provides an easy-to-use platform for customers to find energy-efficient products, review details, and locate stores and online retailers. The website provides users with lists of eligible products, rebate information, energy savings estimates, ENERGY STAR scores, product details, features, popularity/review ratings, an Eco review, and locations where the product can be purchased within LADWP's service area.

1.2.2.3 Energy Savings Assistance Program (ESAP)

ESAP targeted income-qualifying residents living in multi-family housing, providing no-cost energy and water-saving measures for residents with an income under 200% of the Federal Poverty Guidelines. ESAP offers efficiency upgrades for individual residential units. The efficiency measures include weather stripping, caulking, low-flow showerheads, water heater blankets, and door and building envelope repairs that reduce air infiltration. LADWP has partnered with SoCalGas to jointly implement certain programs to provide more comprehensive services to customers and save on overall program costs.

1.2.2.4 Home Energy Improvement Plan (HEIP)

HEIP is a comprehensive whole-house retrofit program that offers residential customers a full suite of products and services to improve the energy and water efficiency in the home by upgrading/retrofitting the home's core systems. The program is targeted to primarily serve LADWP's low-, moderate-, and fixed-income single- and multi-family residential customers. No income restrictions are in place, but the program is primarily marketed to the targeted customer segments.

1.2.2.5 Low Income Refrigerator Exchange Program (REP)

The REP program is designed to target LADWP residential customers that qualify on either LADWP's Low-Income or Senior Citizen/Disability Lifeline Rates. REP is an existing program that provides free new and efficient refrigerators, as well as pick-up and recycling of existing refrigerators. This program leverages a third-party party contractor, ARCA, to administer the delivery of the program, while LADWP oversees and manages ARCA and the program. In addition to providing a new, energy-efficient refrigerator, the REP Program also retrieves and disposes of the existing refrigerator in an environmentally responsible manner, ensuring that these older refrigerators are taken off the grid forever.

1.2.2.6 Refrigerator Turn-In & Recycle (RETIRE) Program

The RETIRE program is designed to target LADWP residential customers that have either made a retail purchase of a new refrigerator and/or those that have two, three, or more refrigerators in the household. This program offers a monetary incentive ($50) to residential customers to turn in old refrigerators and freezers. Eligible units must be fully operational and satisfy certain age and size requirements. This program leverages a third-party contractor, ARCA, to administer the delivery of the program, while LADWP oversees and manages the program and rebate processing to the end-use customers. The RETIRE Program picks up and safely and environmentally recycles old, energy-wasting refrigerators at no cost to the customer and rewards customers with a $50 rebate.

1.2.2.7 Residential Lighting Efficiency Program

The RLEP program is designed to distribute free LED bulbs in a cost-effective way and to deliver energy efficiency directly to all LADWP residential customers, both in single-family and multifamily homes. LADWP has distributed free LED bulbs to all its customers (nearly 125,000 homes in its service territory) in each of three major campaigns. LED bulb kits are also distributed for free through the REP and the RETIRE Program, and other community outreach events.

1.2.3 Cross-sector Programs

The following are the cross-sector programs offered by LADWP.

1.2.3.1 Air Condition Optimization Program (ACOP)

The AC tune-up program includes maintenance efficiency checks for residential and commercial air conditioning systems at no cost to the ratepayer, as well as incentives of up to $150 towards the purchase and installation of programmable thermostats. A wi-fi enabled smart programmable thermostat, including installation, is offered free of charge to program participants who do not already have a smart programmable thermostat.

1.2.3.2 Codes, Standards & Ordinances (CSO)

The CSO Program addresses the needs of the ratepayers of the City of Los Angeles for water and energy conservation and sustainability through direct involvement with code-setting bodies for buildings, fixtures, and appliance codes and standards in the strengthening of water and energy efficiency requirements. This program investigates emerging technologies and new methods of construction that promote conservation and sustainability and advocates for, and in some cases, develops local ordinances to address water and energy savings mandates specific to the requirements of the City of Los Angeles.

1.2.3.3 Multifamily Whole Building Program (MFWB)

The MFWB is a collaborative program with the Southern California Gas Company that offers energy consultation, audit, and incentives for energy-efficient electric, water, and natural gas upgrades to owners of existing multi-family properties. The MFWB incentives apply to measures in individual residential units as well as common areas throughout the property, including no- and low-cost measures, modifications to system controls and building automation, operational changes, and potential capital upgrades.

1.3 Evaluation Methodology

Evaluation methods applied in the five-year retrospective evaluation applied industry best practices, including:

- International Measurement & Verification Protocols (IPMVP);
- Uniform Methods Project (UMP);
- California Evaluation Framework; and
- California Standard Practice Manual: Economic Analysis of Demand-Side Projects and Programs.

Impact analysis methods included:

- Billing Data Analysis
  - Measuring impacts of projects on customer bills
  - Pre- and post-analysis, and analysis of post bills with usage adjusted to align with minimum code
- Project M&V
  - Audits of commercial & industrial projects
  - Apply International Performance Measurement and Verification Protocols
- Survey-Based Verification
  - Survey efforts with residential and nonresidential customers to address measure installation and persistence
- Virtual Verification

- Virtual facility walkthroughs - customers show their project to evaluation staff through a user-friendly mobile app

1.3.1 Data Collection

Data collected included program data that tracked projects completed by participants, documentation supporting the completion of projects, primary data collected during field visits, data showing billing or energy usage, and participant survey response data.

1.3.1.1 Program and Project Data Collection

The Evaluator completed the following types of data collection for the impact evaluation of non-residential programs:

Table 1-1 Non-Residential Program Data Collection

Data	Source
Program tracking data	Data requested from LADWP including all data tracking program participation
Desk review	Reviews of project documentation (Proposed Activity Report, Post Installation Report, energy models) of a sample of customers who have participated in the program
On site verification	Virtual or in-person site visits of a sample of customers to collect data used for savings calculations, verify installation, and determine operating parameters

The Evaluator completed the following types of data collection for the impact evaluation of residential programs:

Table 1-2 Residential Program Data Collection

Data	Source
Program tracking data	Data requests to LADWP for all measure level program tracking data
Recipient and control group billing data	Data requests to LADWP for all relevant billing data in the study period
Participation in other LADWP programs	Data requests to LADWP for all residential program participation in the study period
Recipient and control group customer data	Data requests to LADWP for other customer information (e.g., demographics, contact permissions)

1.3.1.2 Participant Surveys

The Evaluator administered surveys to customers who participated in the following programs during the Retrospective Period:

- Consumer Rebate Program (CRP);

- Efficient Products Marketplace (EPM);
- Home Energy Improvement Program (HEIP);
- Refrigerator Exchange Program (REP);
- Refrigerator Turn-in and Recycle Program (RETIRE); and
- Residential Lighting Efficiency Program (RLEP).

The surveys were designed to verify the measures that customers implemented through the programs recorded in program data and collect other information for use in assessing the energy impacts of the measures.

Survey samples were designed to achieve 90% confidence and ±10% precision for the program during the Retrospective Period. For the verification surveys, the Evaluator used one of the following approaches, depending on the program:

- Simple Random Sampling. Simple random sampling involved administering the survey to a random sample of all contacts for a program.
- Stratified Random Sampling. For some programs, participants were grouped based on the types of measures they received through the program and then sampled customers at random within the groups.

To develop the sample frame of program projects, the Evaluator used data on program participation and matched this data to current customer records provided by LADWP. Samples were developed from participants in each year of the Retrospective Period.

The Evaluator excluded customers who opted out of email communications from the samples. For cases where a customer participated in more than one program, the customer was sampled at random to receive a survey invitation for a single program (i.e., participants were not asked to complete multiple surveys).

Because RLEP distributed LED light bulbs to all customers, the Evaluator used the customer database to develop a sample frame of customers to which the survey was administered.

The Evaluator administered the survey online and contacted program participants by email to complete the survey. Participants received an initial email contact and up to two reminders to complete the survey. Participants in the CRP, EPM, HEIP, REP, and RETIRE programs were entered into a drawing for one of four $50 gift cards.

Table 1-3 summarizes the planned and achieved sample sizes.

Table 1-3 Summary of Participant Survey Data Collection

Program	Planned Sample Size	Number of Customers Contacted	Achieved Sample Size	Sample Type
CRP	150	3,767	179	Stratified Random Sample
EPM	150	3,758	431	Stratified Random Sample
HEIP	110	2,509	320	Stratified Random Sample
REP	75	9,558	841	Simple Random Sample
RETIRE	75	8,047	691	Simple Random Sample
RLEP	200	14,716	376	Simple Random Sample
Total	760	42,355	2,838	

1.4 Overview of Report

The report is organized as follows:

- The CDI Program evaluation is presented in Chapter 2 with technical details presented in Appendix A Section A.1
- The CLIP evaluation is presented in Chapter 3 with technical details presented in Appendix A Section A.2
- The CPP evaluation is presented in Chapter 4 with technical details presented in Appendix A Section A.3
- The FSP Comprehensive evaluation is presented in Chapter 5 with technical details presented in Appendix A Section A.4
- The FSP POS evaluation is presented in Chapter 6 with technical details presented in Appendix A Section A.5
- The LADWP Facilities Program evaluation is presented in Chapter 7 with technical details presented in Appendix A Section A.6
- The LAUSD DI Program evaluation is presented in Chapter 8 with technical details presented in Appendix A Section A.7
- The SBD Program evaluation is presented in Chapter 9 with technical details presented in Appendix A Section A.8
- The UHVAC Program evaluation is presented in Chapter 10 with technical details presented in Appendix A Section A.9
- The CRP evaluation is presented in Chapter 11 with technical details presented in Appendix A Section A.10
- The EPM Program evaluation is presented in Chapter 12 with technical details presented in Appendix A Section A.11

- The ESAP evaluation is presented in Chapter 13 with technical details presented in Appendix A Section A.12
- The HEIP evaluation is presented in Chapter 14 with technical details presented in Appendix A Section A.13
- The REP evaluation is presented in Chapter 15 with technical details presented in Appendix A Section A.14
- The RETIRE Program evaluation is presented in Chapter 16 with technical details presented in Appendix A Section A.15
- The RLEP evaluation is presented in Chapter 17 with technical details presented in Appendix A Section A.16
- The ACOP evaluation is presented in Chapter 18 with technical details presented in Appendix A Section A.17
- The CSO Program evaluation is presented in Chapter 19
- The MFWB Program evaluation is presented in Section 4.5.3.
- The Cost Effectiveness evaluation is presented in Chapter 20 with measure level results presented in Appendix B
- The Home and demographic characteristics from survey responses are summarized in Appendix C
- The Site level non-residential sector reports are presented in Appendix D

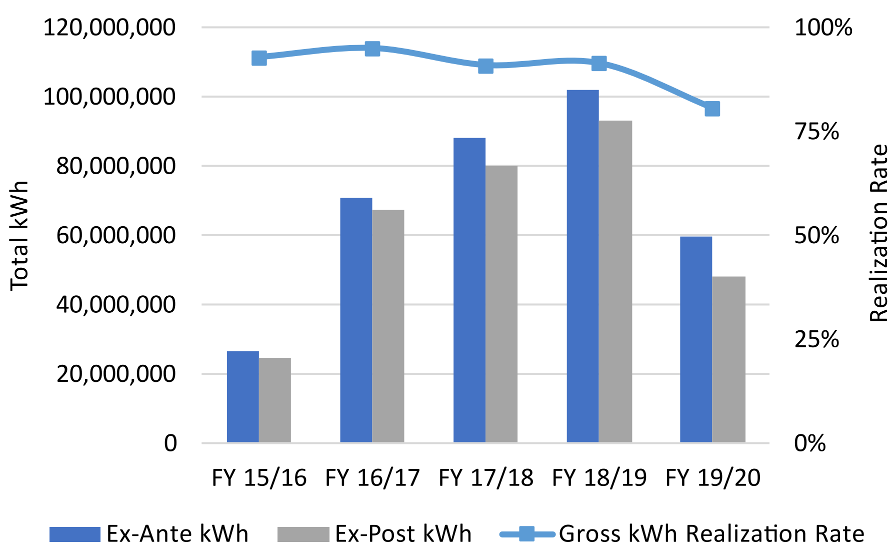
2 Commercial Direct Install Program

This chapter summarizes the impact evaluation of the Commercial Direct Install Program (CDI) that LADWP offered customers from fiscal years (FY) 15/16 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to CDI Program.

2.1 Program Performance Summary

CDI is a program in partnership with SoCal Gas that provides direct installation of lighting, hot water, and gas efficiency measures to small and medium commercial customers (with monthly demand no greater than 250 kW). The program is supported and marketed by the LADWP Power Construction Maintenance Group and community-based organizations (CBOs). Figure 2-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 2-1 Commercial Direct Install Program Performance Summary



2.1.1 Key Evaluation Takeaways

- The program had a 90% kWh realization rate.
- Realized savings were the lowest in the last fiscal year of evaluation (FY 19/20). There was a larger discrepancy between Energy Savings Platform, Inc. (ESP) filed values and those supported in program tracking data. Whereas FY 15/16 through FY 18/19 differed on average only by 1% between program tracking and ESP filings, FY 19/20 had a discrepancy of 12%.

- Once this discrepancy was resolved, projects that had tracking data and documentation support in FY 19/20 were largely similar in performance and realized savings as all prior fiscal years.

2.2 Program Description

The CDI Program targets small to large business customers in the LADWP service territory, offering upgrades to targeted systems, including lighting, hot water, and natural gas equipment. LADWP has partnered with Southern California Gas Company on CDI, with LADWP as the lead utility. CDI is a direct install program managed by the LADWP Mass Market Programs Group and implemented with the assistance of an external vendor (Lime Energy). This program is designed to integrate electric, water, and natural gas efficiency measures. LADWP is leveraging its Power Construction Maintenance Group (PCM), contract personnel, an IT system, and strategically located community-based organizations (CBOs) to market and implement the CDI Program. The design is intended to maximize electric, water, and natural gas savings, in a cost-effective manner.

Energy Service Representatives (ESRs) perform program outreach and door-to-door customer engagement to sign businesses up for an audit. The program provides businesses with energy and water use audits performed by subcontractors, and no-cost direct install measures. The CDI program is available to qualifying businesses whose average monthly electrical demand is 250 kilowatts (kW) or less.

Table 2-1 summarizes the program's ESP Ex-Ante energy and demand savings and contribution to the Retrospective Period savings by fiscal year.

Table 2-1 CDI Retrospective Ex-Ante Savings Summary

Fiscal Year	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
15/16	26,663,441	7.7%	883.35	2.2%
16/17	70,840,095	20.4%	2,532.00	6.2%
17/18	87,972,111	25.3%	16,239.00	39.6%
18/19	102,130,238	29.4%	12,859.72	31.4%
19/20	59,764,622	17.2%	8,500.29	20.7%
Total	347,370,507	100.0%	41,014.36	100.0%

Table 2-2 provides a complete list of CDI measures offered during the Retrospective Period.

Table 2-2 CDI Measure Offerings

Measure Category	Measures
Lighting	Lighting Retrofits

Measure Category	Measures
	Lighting Controls
Hot Water	Faucet Aerators Pre Rinse Spray Nozzles Low Flow Showerheads High-Efficiency Toilets Tank/Pipe Insulation

The following table summarizes the measures installed and tracking data Ex-Ante kWh savings by measure and fiscal year.

Table 2-3 CDI Tracking Data Ex-Ante Savings by Measure

Fiscal Year	Measure	Program Data Ex-Ante kWh Savings
15/16	Lighting	25,791,560
	Plumbing	108,990
	Total	25,900,550
16/17	Lighting	74,344,684
	Plumbing	168,892
	Total	74,513,576
17/18	Lighting	88,227,127
	Plumbing	21,605
	Total	88,248,732
18/19	Lighting	102,168,424
	Plumbing	21,588
	Total	102,190,012
19/20	Lighting	52,824,535
	Plumbing	5,749
	Total	52,830,284
Grand Total		343,683,154

2.3 Methodology

This section presents a brief summary of the tracking data review and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program. As part of the impact evaluation, the Evaluator performed the following data collection activities outlined in Table 2-4:

Table 2-4 CDI Data Sources for Impact Evaluation

Data	Source
Program Tracking Data	Data requested from LADWP including all data tracking program participation
Desk Review	Reviews of project documentation (Proposed Activity Report, Post Installation Report) of a sample of customers who have participated in the program
On Site Verification	Virtual or on-site visits of a sample of customers to collect data for savings calculation, to verify installation, and determine operating parameters

LADWP provided the Evaluator with the available program tracking data for rebated measures. The evaluation methodology consisted of the following key components.

- Tracking data review;
- M&V sample design;
- Review of algorithms and references; and
- M&V approach.

A detailed evaluation methodology is available in Appendix A, section A.1.1.

2.4 Impact Evaluation

This section provides a brief summary describing how Ex-Post kWh savings and peak kW reduction were calculated using the appropriate DEER workpapers and other proven industry techniques. Important input parameters were based on information collected during virtual or on-site verification, or available project documentation. The impact evaluation consisted of the following key components:

- Detailed program data review;
- Data collection and desk review activities; and
- Project-level impact evaluation.

A detailed impact evaluation is available in Appendix A, section A.1.2.

2.5 Ex-Post Gross Results and Findings

This section presents Ex-Post gross realized savings for CDI. Table 2-5 compares Ex-Post energy impacts to Ex-Ante claimed savings from the tracking data, while Table 2-6 compares Ex-Post energy impacts to Ex-Ante claimed savings from ESP.

Table 2-5 CDI Retrospective Evaluation Results by Strata

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	9,765,683	6,452,326	66%	2,322.78	1,983.58	85%
2	44,344,785	37,633,683	85%	9,793.44	8,418.02	86%
3	73,708,921	91,778,605	125%	14,440.44	14,765.40	102%
4	102,011,756	86,223,375	85%	18,880.74	13,753.62	73%
5	93,012,096	70,543,467	76%	15,734.53	10,995.72	70%
6	20,839,913	20,969,038	101%	27,46.46	2,870.64	105%
Total	343,683,154	313,600,495	91%	63,918.38	52,786.98	83%

For the Retrospective Period, the program-level Ex-Post energy savings realization rate was 91% when comparing to tracking data Ex-Ante savings. The realization rate is a result of the application of annual hours of use and EIF values used in Ex-Post site-level analyses.

Table 2-6 CDI Retrospective Evaluation Results by Fiscal Year

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
15/16	26,663,441	24,750,781	93%	883.35	3,553.82	402%
16/17	70,840,095	67,299,455	95%	2,532.00	8,726.86	345%
17/18	87,972,111	79,992,833	91%	16,239.00	11,761.27	72%
18/19	102,130,238	93,345,479	91%	12,859.72	11,208.33	87%
19/20	59,764,622	48,211,947	81%	8,500.29	6,857.16	81%
Total	347,370,507	313,600,495	90%	41,014.36	42,107.44	103%

When comparing Ex-Post to ESP Portfolio Ex-Ante kWh, the Evaluator calculated an overall gross realization rate of 90%; similarly, a rate of 103% was calculated when comparing Ex-Post to ESP Ex-Ante peak kW impacts. The Evaluator was unable to recreate the reported ESP Portfolio Ex-Ante kWh and kW impact values with the provided program tracking data. The Evaluator was limited by this absence of detail in the data and was only able to extrapolate project-level savings to the unique number of projects presented in the delivered program tracking data. This is a factor that may have affected gross realization rates when comparing Ex-Post to ESP Ex-Ante savings.

CDI saw increases in program savings from FY 15/16 through FY 18/19. However, there was a decrease in savings from FY 18/19 to FY 19/20, most likely due to the onset of the COVID-19 pandemic, and due to program activity ending early in June 2020.

2.5.1 COVID-19 Impacts on Energy Use

The program level tracking data Ex-Post COVID-19 energy savings for FY 19/20 are 1.7% less than the Ex-Post energy savings. The Evaluator completed seven virtual site visits, and four of those sites relayed COVID-19 impacts. The 1.7% change is a result of stratum 2,3, and 4, and specifically four virtual verification sites within those strata. The Evaluator confirmed the sites experienced a shutdown or reduced hours of operation during the pandemic. One site that was open seven days per week began closing on Sundays during the COVID-19 era. Another site closed for two weeks, and the remaining two sites closed for a month.

Table 2-7 CDI COVID-19 Era Impact on Ex-Post Gross Energy Savings

Stratum	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
1	1,362,537	1,362,537	-	0.0%
2	8,351,802	7,965,650	-386,152	-4.6%
3	17,360,474	17,059,138	-301,336	-1.7%
4	13,292,723	13,159,647	-133,076	-1.0%
5	7,625,322	7,625,322	-	0.0%
6	219,089	219,089	-	0.0%
Total	48,211,947	47,391,383	-820,564	-1.7%

2.6 Program Recommendations

The Evaluator offers the following recommendations for the CDI program:

- Verification efforts are difficult to accomplish for projects completed several years ago. Annual evaluations have the advantage of providing customer feedback and measure level findings in a timely manner.
- Evaluation results indicate some impacts from differing hours of operation and interactive effects. Utilizing DEER hours and interactive effects would improve program realizing rates.

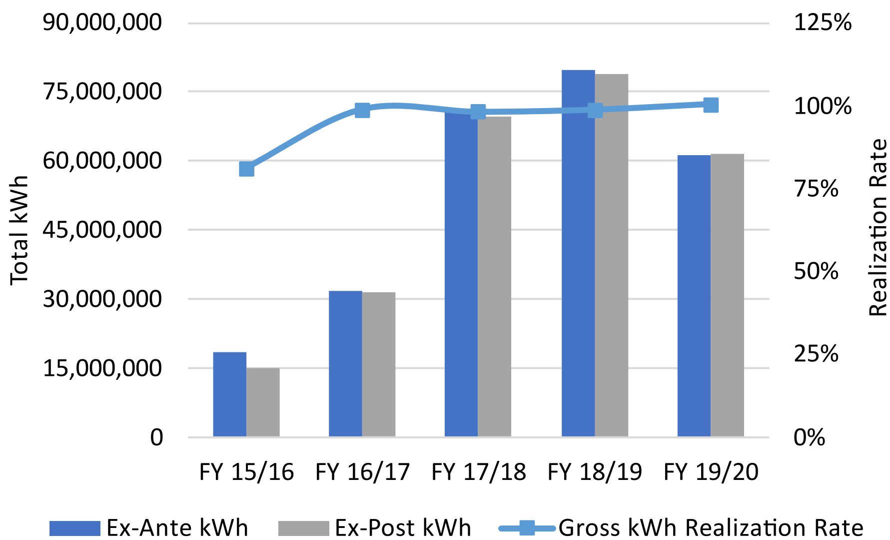
3 Commercial Lighting Incentive Program

This chapter presents an evaluation of the Commercial Lighting Incentive Program (CLIP) that LADWP offered customers during the fiscal year (FY) 15/16 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to CLIP.

3.1 Program Performance Summary

CLIP provides incentives for standard fixture replacements and installation of lighting controls. Participation is mostly contractor-driven, though customers may submit applications on their own behalf in lieu of using a contractor to do so. Figure 3-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 3-1 Commercial Lighting Incentive Program Performance Summary



3.1.1 Key Evaluation Takeaways

- The program had 98% kWh realization. The projects were, in general, well-documented and used reliable data in estimating hours of use and connected load reduction associated with lighting retrofits.
- When adjustments were made to projects, the most common cause was revision of project baselines. This included cases where projects had sufficient burnt-out preexisting fixtures to warrant a replace-on-burnout rather than an early-replacement baseline.

3.2 Program Description

The CLIP program is designed to offer incentives to non-residential customers for replacing standard lighting fixtures with high efficiency fixtures, lamps, and/or controls. Any high efficiency lighting product that meets program requirements is eligible for incentives through CLIP. Participation in CLIP is mostly contractor driven, although there are multiple paths to program participation. Table 3-1 summarizes the program's Energy Savings Platform, Inc. (ESP) Ex-Ante energy savings and peak demand reduction and contribution to the Retrospective savings by fiscal year.

Table 3-1 CLIP Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Projects	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
15/16	188	18,498,102	7.1%	4,058.00	9.3%
16/17	453	31,735,271	12.1%	4,915.00	11.3%
17/18	2,021	71,029,568	27.1%	11,926.00	27.4%
18/19	1,266	79,863,767	30.4%	13,630.20	31.7%
19/20	307	61,242,231	23.3%	8,939.26	20.6%
Total	4,235	262,368,939	100.0%	43,468.46	100.0%

3.3 Methodology

This section presents a brief summary of the tracking data review and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program. As part of the impact evaluation, the Evaluator performed the following data collection activities outlined in Table 3-2:

Table 3-2 CDI Data Sources for Impact Evaluation

Data	Source
Program Tracking Data	Data requested from LADWP including all data tracking program participation
Desk Review	Reviews of project documentation (Proposed Activity Report, Post Installation Report) of a sample of customers who have participated in the program
On Site Verification	Virtual or on-site visits of a sample of customers to collect data for savings calculation, to verify installation, and determine operating parameters

LADWP provided the Evaluator with the available program tracking data for rebated measures. The evaluation methodology consisted of the following key components,

- Tracking data review;
- M&V sample design;
- Review of algorithms and references; and
- M&V approach.

A detailed evaluation methodology is available in Appendix A, section A.2.1.

3.4 Impact Evaluation

This section provides a brief summary describing how Ex-Post energy savings and demand reduction values were calculated using applicable DEER workpapers and other proven industry techniques, with key parameters based on information gathered during site visits or applicable project documentation. A full evaluation analysis was conducted on the 39 randomly sampled projects from the Retrospective Period, for which results were aggregated to determine a strata level realization rate for extrapolation to the population. Project-level and measure-level results can be found in the project site-level reports.

The impact evaluation consisted of the following key components:

- Detailed program data review;
- Data collection and desk review activities; and
- Project-level impact evaluation.

A detailed impact evaluation is available in Appendix A, section A.2.2.

3.5 Ex-Post Gross Results and Findings

This section presents Ex-Post gross realized savings for CLIP. Table 3-3 compares Ex-Post energy impacts to Ex-Ante claimed savings from the tracking data, while Table 3-4 compares Ex-Post energy impacts to Ex-Ante claimed savings from ESP.

Table 3-3 CLIP Retrospective Evaluation Results by Strata

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	14,800,233	14,473,629	98%	2,934.14	3,276.41	112%
2	31,468,295	29,600,057	94%	5,645.84	5,069.18	90%
3	43,349,496	42,235,904	97%	7,392.99	6,658.94	90%
4	56,935,101	52,876,873	93%	9,090.02	9,285.19	102%
5	62,345,098	66,185,566	106%	9,822.09	10,048.62	102%
6	28,172,443	29,069,989	103%	4,753.54	5,227.02	110%
7	21,989,887	22,170,836	101%	3,890.69	2,205.64	59%
Total	259,060,553	256,612,856	99%	43,529.31	41,871.00	96%

Table 3-4 CLIP Retrospective Evaluation Results by Fiscal Year

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
15/16	18,498,102	15,013,181	81%	4,058.00	2,155.65	53%
16/17	31,735,271	31,393,114	99%	4,915.00	4,070.05	83%
17/18	71,029,568	69,727,731	98%	11,926.00	10,253.44	86%
18/19	79,863,767	78,918,704	99%	13,630.20	11,806.56	87%
19/20	61,242,231	61,560,126	101%	8,939.26	8,985.67	101%
Total	262,368,939	256,612,856	98%	43,468.46	37,271.37	86%

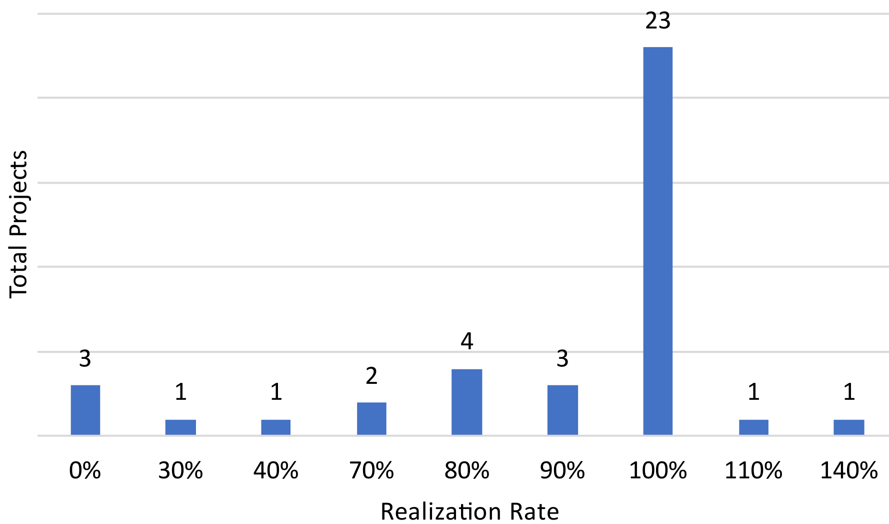
The kWh realization rate is 99% when organizing by stratum and comparing Ex-Post to Program Data Ex-Ante. When organizing the program analysis by fiscal year and comparing Ex-Post to ESP Ex-Ante, the kWh realization rate is 98%.

CLIP reflected increases in program savings from FY 15/16 through FY 18/19 as shown above. However, there was a decrease in savings from FY 18/19 to FY 19/20, most likely due to COVID-19 pandemic safety measures enacted near the end of first quarter of 2020. As the pandemic ends and with a return to normalcy, it should be expected that CLIP participation/savings will increase from FY 19/20 values.

3.5.1 Gross Realization Rate Distribution by Sampled Project

Results of the Ex-Post savings of the program sample were grouped by stratum to determine a realization rate for energy savings, demand reduction, and lifetime savings. The values determined from the Ex-Post analysis of the program sample were extrapolated to the other projects within the program by stratum. The distribution of realization rates of all projects within the M&V sample are illustrated below in Figure 3-2.

Figure 3-2 Gross Realization Rate Distribution for Sampled Projects



3.5.2 COVID-19 Impacts on Energy Use

The impact of COVID-19 was assessed based on findings of the virtual verification process. Generally, facilities that were impacted by COVID-19 had been affected by either a temporary halting of operations or by a reduction in operating hours.

Table 3-5 CLIP COVID-19 Era Impact on Ex-Post Gross Energy Savings

Stratum	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
1	375,093	274,948	-100,145	-26.7%
2	1,975,913	1,584,613	-391,300	-19.8%
3	6,621,793	6,391,849	-229,944	-3.5%
4	10,836,948	8,680,443	-2,156,505	-19.9%
5	18,871,425	18,452,321	-419,104	-2.2%
6	9,199,761	7,642,429	-1,557,332	-16.9%
7	13,679,193	12,144,612	-1,534,581	-11.2%
Total	61,560,126	55,171,215	-6,388,911	-10.4%

3.6 Program Recommendations

The Evaluator offers the following recommendations for the CLIP program:

- The peak kW savings reported in the tracking data is the difference in connected load for the baseline and efficient project measures. The Evaluator recommends adjusting the methodology for determining peak kW savings, as doing so would improve project realization rates.

- There is no reference for the baseline wattages utilized in the Ex-Ante calculations. The Evaluator recommends using the baseline wattages outlined in DEER workpapers or adding the reference to future iterations.
- The Evaluator recommends utilizing hours of use and interactive effects from applicable DEER workpapers, as doing so would improve project realization rates.

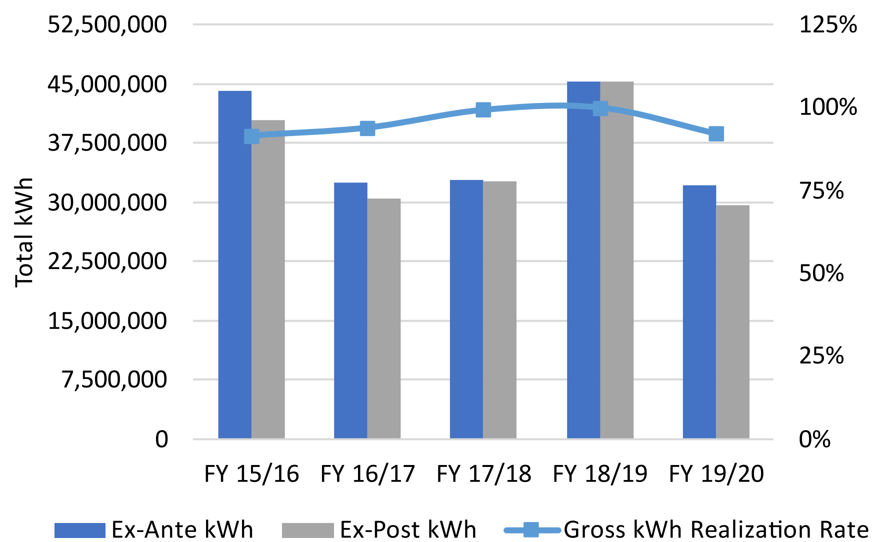
4 Custom Performance Program

This chapter presents an evaluation of the Custom Performance Program (CPP) that LADWP offered customers during fiscal years (FY) 15/16 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to CPP.

4.1 Program Performance Summary

The CPP program provides customized incentives for a range of equipment retrofits for the commercial and industrial sectors, including equipment controls, process improvements, heating and cooling retrofits, retro-commissioning, and any other improvement that cannot be readily captured by other LADWP programs. Figure 4-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 4-1 Custom Performance Program Performance Summary



4.1.1 Key Evaluation Takeaways

- The program had a 96% kWh realization rate. Though successful, the Evaluators found many inconsistencies in the savings estimation methodologies applied across similar projects, as well as differences in analytical tools used when projects could have a consistent spreadsheet template.
- Energy Efficiency Technical Assistance Projects (EETAPs) had a lower realization rate (59%). Savings were presented based on EETAP recommendations, and verified impacts were based on measures that could be identified as installed.
- EETAP measures with the lowest realization rates included window film, controls, HVAC setpoint changes, water / air / pressure resets, and motor replacement.

4.2 Program Description

The non-residential CPP provides incentives for energy savings measures which include equipment controls, industrial processes, retro-commissioning, chiller efficiency, and innovative energy saving strategies meeting or exceeding Title 24 or Industry Standards that are not included in other LADWP non-residential energy efficiency programs. Table 4-1 summarizes the program's Energy Savings Platform, Inc. (ESP) Ex-Ante energy savings and peak demand reduction and contribution to the Retrospective savings by fiscal year.

Table 4-1 CPP Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Projects	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
15/16	99	44,217,570	23.6%	6,993.00	16.7%
16/17	118	32,482,948	17.4%	5,007.00	12.0%
17/18	126	32,900,154	17.6%	4,847.00	11.6%
18/19	127	45,329,924	24.2%	18,733.46	44.8%
19/20	163	32,170,009	17.2%	6,192.38	14.8%
Total	633	187,100,605	100.0%	41,772.84	100.0%

For analysis purposes, the Evaluator used program tracking data to compare ex-post results at the project level. A comparison between ESP and program tracking data is shown in Table 4-2.

Table 4-2 CPP Ex-Ante Savings Summary

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Ante kWh Savings	ESP Data Ex-Ante Peak kW Savings	Program Ex-Ante Data kW Savings
15/16	44,217,570	43,505,279	6,993.00	6,949.00
16/17	32,482,948	32,267,890	5,007.00	5,007.15
17/18	32,900,154	35,302,989	4,847.00	5,285.36
18/19	45,329,924	45,641,957	18,733.46	9,235.29
19/20	32,170,009	32,089,779	6,192.38	5,583.48
Total	187,100,605	188,807,893	41,772.84	32,060.28

4.3 Methodology

This section presents a brief summary of the methodology used to evaluate the CPP.

Ex-Post annual energy savings, lifetime energy savings, and peak demand reduction have been determined using the methodologies described. A site-specific approach was used to determine Ex-Post site level impacts with extrapolation to the population based on the design of the CPP. The methods employed include:

- Review of program tracking data for completeness and sampling;
- Project documentation review;
- Site-specific Measurement and Verification Plans (M&V Plans);
- Primary data collection from site contacts;
- Engineering analysis for each sampled project; and
- Extrapolation of sample level results to determine program level impact estimates.

A detailed evaluation methodology is available in Appendix A, section A.3.1.

4.4 Impact Evaluation

This section provides a brief summary describing how Ex-Post kWh savings and peak kW reduction were calculated through evaluation of M&V efforts. Ex-Post kWh savings and peak kW reduction were estimated using proven industry techniques. Important input parameters were based on information collected during on-site or virtual verifications or obtained with available project documentation. The impact evaluation consisted of the following key components:

- Detailed program data review:
- Data collection and desk review activities; and
- Project-level impact evaluation.

A detailed impact evaluation is available in Appendix A, section A.3.2.

4.5 Ex-Post Gross Results and Findings

The aggregated verified gross energy impacts from the sample (by project) were extrapolated to the population by stratum. The evaluation was achieved for 35 projects. Not all sampled projects were able to be evaluated but the projects verified resulted in a statistical precision of ±8.00% at the 90% confidence interval for annual energy savings. The precision for peak demand reduction was ±27.6Program-level results are shown in Table 4-3. The Evaluator calculated a kWh realization rate of 95% and a kW realization rate of 76% when comparing Ex-Post to Program Data Ex-Ante values.

Table 4-3 CPP Retrospective Evaluation Results by Strata

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	12,615,179	21,908,630	87%	2,833.00	2,632.56	93%

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
2	24,944,338	22,499,320	90%	4,509.95	4,072.32	90%
3	42,761,494	35,894,374	84%	6,725.00	6,538.10	97%
4	52,809,417	51,517,088	98%	8,498.85	4,476.43	53%
5	35,687,870	36,010,228	101%	6,597.67	4,675.76	71%
6	19,989,595	21,571,531	110%	2,895.80	1,889.89	65%
Total	188,807,893	178,753,172	95%	32,060.28	24,285.06	76%

Program Ex-Post results by fiscal year compared to ESP Ex-Ante results are shown in Table 4-4. The Evaluator calculated a kWh realization rate of 95% and a kW realization rate of 75% when comparing Ex-Post to ESP Ex-Ante values.

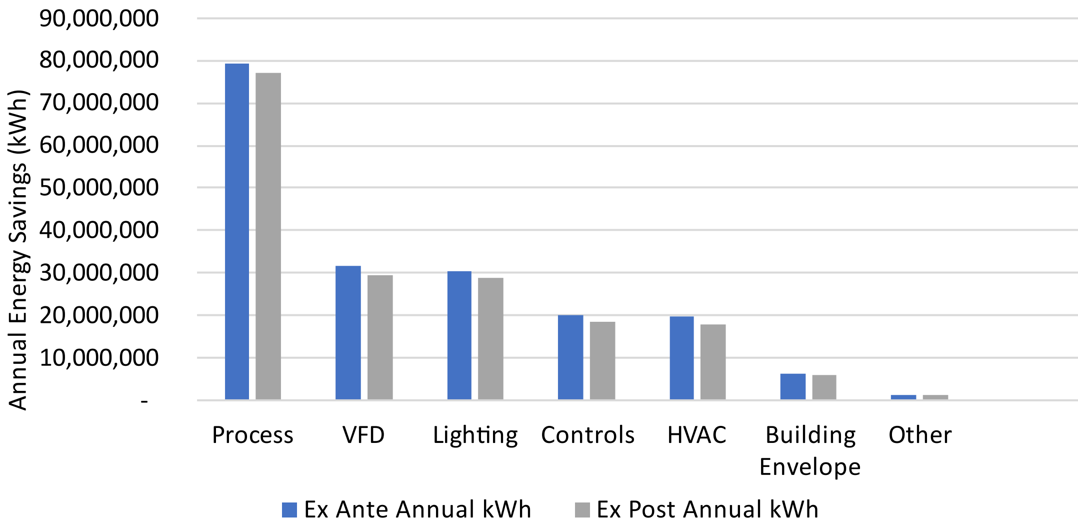
Table 4-4 CPP Retrospective Evaluation Results by Fiscal Year

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
15/16	44,217,570	40,509,811	92%	6,993.00	5,388.09	77%
16/17	32,482,948	30,521,259	94%	5,007.00	3,791.52	76%
17/18	32,900,154	32,684,971	99%	4,847.00	5,235.16	108%
18/19	45,329,924	45,366,511	99%	18,733.46	10,059.41	54%
19/20	32,170,009	29,670,620	92%	6,192.38	6,647.15	107%
Total	187,100,605	178,753,172	95%	41,772.84	31,121.32	75%

4.5.1 Gross Realization Rate by Measure

Realization factors determined during evaluation do not point to any measure-specific systematic issues in the development of Ex-Ante savings estimates. The Evaluator's measure category of "Process" includes the bulk of energy savings for the program. This category included data center measures, motors, and industrial processes. The category represents the additional measures of compressed air, injecting molding machines, and Custom Express Projects. The impact of realization rate factors by measure category is shown in Figure 4-2.

Figure 4-2 CPP Energy Savings by Measure Category



Evaluation sample savings impacts by measure category are shown in Table 4-5.

Table 4-5 CPP Retrospective Evaluation Sample Savings by Measure Category

Measure Category	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
Bldg. Envelope	2,271,810	2,391,605	105%	1,365.00	528.57	39%
Controls	7,309,296	7,355,272	101%	815.00	815.76	100%
HVAC	2,522,112	2,440,171	97%	487.63	425.96	87%
Lighting	5,009,553	4,821,812	96%	1,134.75	113.15	10%
Process	19,374,477	20,849,833	108%	3,638.86	2,534.25	70%
VFD	9,815,996	9,476,556	97%	2,369.54	1,815.19	77%
Total	46,303,245	47,335,249	102%	9,810.78	6,232.88	64%

4.5.2 COVID-19 Impacts on Energy Use

The Evaluator analyzed the impact of COVID-19 on annual energy savings for each sampled project. The analysis included information from the site contact regarding changes in operation due to the pandemic. The most likely causes of consumption change were due to occupancy changes and mechanical system setpoints. These results indicate the variance in annual energy savings expected if the impacts of COVID-19 were to persist into a typical fiscal year.

The analysis indicated an overall slight reduction in annual energy savings compared to the typical year evaluation results. Individual measures saw reductions in energy usage due to the following reasons:

- HVAC controls were adjusted for a setback during the increased unoccupied times.
- Lighting occupancy sensor controls were assumed to have an increased unoccupied time based on occupancy rates and operating hours reduction.
- Lighting operating hours were reduced to coincide with reduced operating hours (non-controls).

Individual projects saw increased energy consumption due to the following reasons:

- Ventilation rates were increased impacting run times for VFDs on HVAC fans and raising the mixed-air return temperature during cooling hours.

The impacts on energy savings varied based on the determination of baseline conditions, however, a general reduction in energy consumption in the assumed baseline condition resulted in a reduction in energy savings. The Evaluator's findings of HVAC set point changes in sampled projects were the driving factor to an overall reduction in sampled CPP measures. COVID-19 savings implications from FY 19/20 by measure type are shown in Table 4-6.

Table 4-6 CPP COVID-19 Era Impact on Ex-Post Gross Energy Savings

Measure Category	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
Building Envelope	313,763	264,026	-49,737	-15.9%
Controls	2,660,095	2,554,896	-105,199	-4.0%
HVAC	7,218,810	6,754,348	-464,462	-6.4%
Lighting	10,552,833	10,051,283	-501,550	-4.8%
Other	465,618	388,137	-77,481	-16.6%
Process	6,901,930	6,577,808	-324,122	-4.7%
VFD	1,557,572	1,327,266	-230,306	-14.8%
Total	29,670,620	27,917,763	-1,752,857	-5.9%

4.5.3 Evaluation of Multifamily Whole Building Program

The Whole Building Multifamily Program (MFWB) is a collaborative program with the Southern California Gas Company that offers energy consultation, audit, and incentives for energy-efficient electric, water, and natural gas upgrades to owners of existing multi-family properties. The MFWB incentives apply to measures in individual residential units as well as common areas throughout the property, including no- and low-cost measures, modifications to system controls and building automation, operational changes, and potential capital upgrades.

MFWB offers efficiency upgrades for both individual residential units and common areas throughout the property. The efficiency measures include lighting upgrades, insulation, HVAC upgrades, water heating upgrades, weatherization, controls, low-flow showerheads and faucet aerators, appliance upgrades, pool pumps, and window/door replacement/repair.

The Evaluator performed a desk review of available MFWB program data and applied average Ex-Post realization rates from the CPP analysis to calculate Ex-Post savings for the MFWB. Below are the results of that analysis by fiscal year.

Table 4-7 MFWB Evaluation Results by Fiscal Year

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
17/18	46,990	46,683	99%	4.03	5.69	141%
19/20	382,927	353,176	92%	53.01	48.89	92%
Total	429,917	399,859	93%	57.04	54.57	96%

4.6 Program Conclusions and Recommendations

The Evaluator offers the following recommendations for the CPP program:

- Evaluation results indicate minimal impact from any incorrect analytical approaches, analysis errors, or baseline assumptions. The high annual energy savings realization rate indicates equipment installation and operation performed as expected.
    - Variations due to analytical approaches are mainly based on evaluation findings as well as assumptions in energy simulations. As these are custom projects, many fall outside the scope of Database for Energy Efficiency Resources (DEER) workpapers and require selection of the most appropriate industry standards.
    - Differences in operating hours are challenging in a retrospective evaluation. Ex-post findings are based on conditions reported (with COVID-19 operating conditions and current non-COVID-19 operating conditions) during the time of evaluation.
- The evaluation spanned projects initiated back in 2014, allowing the Evaluator a closer look at savings persistence. Instances were discovered where equipment is no longer functioning or has been replaced. The result is a program-level lifetime energy savings equivalent to 13.5 years.

- Verification efforts are difficult to accomplish for projects completed several years ago. Annual evaluations have the advantage of providing customer feedback and measure level findings in a timely manner.
- CPP projects tend to be complicated with many analyses and simulation iterations conducted throughout the application process. Detailed organization of documentation reduces savings discrepancies and provides resources for future inquiries. Structured identification of analysis files associated with filed results provides a clean documentation trail.
- EETAP provides customers with the opportunity to review potential EEMs and assist with energy savings priorities. The project documentation provided evidence of thorough energy audits and initial energy savings estimates. Tracking measure installations outside of associated projects was difficult. An independent tracking system of EETAP projects and measures spanning fiscal years could benefit the program in understanding customers' priorities. In addition, recurring communication with EETAP participants can assist with data collection of potential spillover (EEM installations outside of the program).

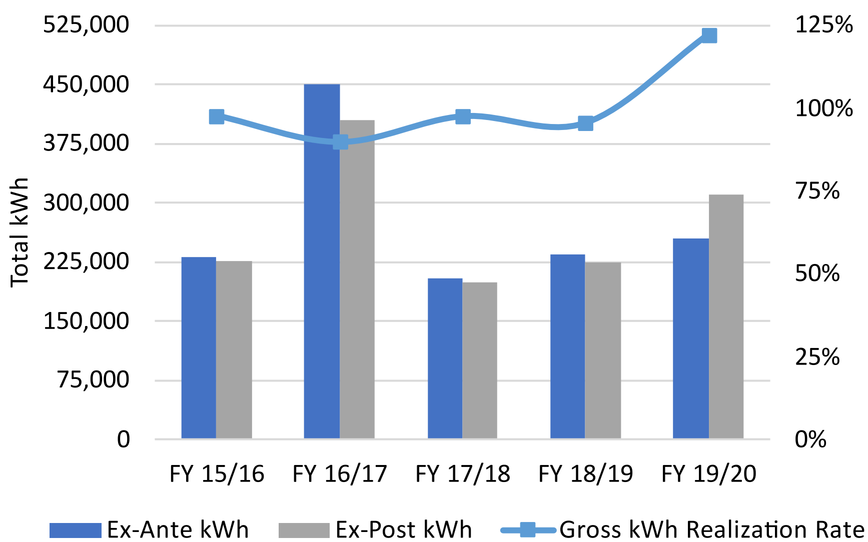
5 Food Service Program - Comprehensive

This chapter summarizes the impact evaluation of the Food Service Program - Comprehensive (FSPC) that LADWP offered customers from fiscal years (FY) 15/16 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the FSPC Program.

5.1 Program Performance Summary

FSPC provides rebates for efficient food service equipment, including cooking equipment, refrigerated and frozen food storage, and kitchen ventilation. Marketing efforts from the FSPC are intended to drive distributors and vendors to then encourage their customers to purchase high-efficiency options. Figure 5-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 5-1 Food Service Program - Comprehensive Performance Summary



5.1.1 Key Evaluation Takeaways

- The program had a 99% kWh realization rate, and Energy Savings Platform, Inc. (ESP) savings inputs were well-supported by program tracking. Hot holding cabinets had high a realization rate (123%). LADWP savings estimates assumed 25 $ft.^3$, when program-actual values averaged 41.3 $ft.^3$.
- The Evaluators recommend that LADWP and their implementers develop binned values by equipment capacity or efficiency grouping, taking advantage of the full level of granularity provided in the eTRM workpapers for food service measures.

5.2 Program Description

The FSPC is a program designed to assist grocery stores, liquor stores, convenience stores, restaurants, and other commercial customers with refrigeration and food service equipment. This program offers rebates for ice dispenser machines, glass and solid door freezers/refrigerators, commercial ovens, etc. The FSPC is designed to be utilized by major vendors and manufacturers to promote the highest efficiency refrigeration and food service equipment for retrofit projects.

Table 5-1 summarizes the program's ESP Ex-Ante energy and peak demand impacts and each fiscal year's contribution to Retrospective Period savings. The high Peak kW Savings in FY 16/17 is possibly from a data entry error; a single refrigerators/freezer line item was listed as having 9,600 kW savings.

Table 5-1 FSPC Retrospective Ex-Ante Savings Summary

Fiscal Year	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
15/16	231,379	16.8%	10.00	0.1%
16/17	451,068	32.8%	9,661.50	98.9%
17/18	204,024	14.8%	34.44	0.4%
18/19	234,054	17.0%	31.43	0.3%
19/20	254,568	18.5%	32.83	0.3%
Total	1,375,093	100.0%	9,770.20	100.0%

Table 5-2 provides a complete list of FSPC measure offerings for FY 15/16 through FY 19/20.

Table 5-2 FSPC Measure Offerings

Measure Category	Measures
Cooking Equipment	Combination Ovens Deck Ovens Convection Ovens Hot Food Cabinets Steamers Fryers On-Demand Hand Wrappers
Refrigeration Equipment	Ice Machines Refrigerators Freezers Evaporator Fan Motors Anti-Sweat Heat (ASH) Controls Night Covers
Kitchen Ventilation	Kitchen Hood DVC

Table 5-3 through Table 5-7 summarize the measures installed and total Ex-Ante kWh savings for each measure by fiscal year.

Table 5-3 FSPC FY 15/16 ESP Ex-Ante Savings by Measure

Measure	ESP Data Ex-Ante kWh Savings
Refrigerators/Freezers	5,718
Evaporator Fan Motors	107,449
Ice Machines	56,578
Anti-Sweat Heat (ASH) Controls	26,191
Night Covers	35,444
Total	231,379

Table 5-4 FSPC FY 16/17 ESP Ex-Ante Savings by Measure

Measure	ESP Data Ex-Ante kWh Savings
Refrigerators/Freezers	108,826
Kitchen Hood DVC	176,274
Ice Machines	49,209

Measure	ESP Data Ex-Ante kWh Savings
Combi Ovens	60,296
Deck Ovens	14,626
Hot Food Cabinets	5,421
Steamers	30,156
On Demand Hand Wrappers	6,260
Total	451,068

Table 5-5 FSPC FY 17/18 ESP Ex-Ante Savings by Measure

Measure	ESP Data Ex-Ante kWh Savings
Refrigerators/Freezers	17,692
Kitchen Hood DVC	29,379
Ice Machines	25,769
Combi Ovens	22,994
Deck Ovens	14,626
Hot Food Cabinets	21,189
Steamers	73,375
Total	204,024

Table 5-6 FSPC FY 18/19 ESP Ex-Ante Savings by Measure

Measure	ESP Data Ex-Ante kWh Savings
Refrigerators/Freezers	8,455
Ice Machines	2,789
Combi Ovens	22,994
Convection Ovens	1,951
Hot Food Cabinets	7,884
Steamers	189,981
Total	234,054

Table 5-7 FSPC FY 19/20 ESP Ex-Ante Savings by Measure

Measure	ESP Data Ex-Ante kWh Savings
Refrigerators/Freezers	10,485
Kitchen Hood DVC	33,576
Ice Machines	11,156
Combi Ovens	68,982
Convection Ovens	1,951
Fryer	14,581
Hot Food Cabinets	29,401
Steamers	84,436
Total	254,568

5.3 Methodology

This section presents a brief summary of the findings of the tracking data review and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program. As part of the impact evaluation, the Evaluator performed the following data collection activities outlined in Table 5-8.

Table 5-8 FSPC Data Sources for Impact Evaluation

Data	Source
Program Tracking Data	Data requested to LADWP for all data tracking program participation
Desk Review	Reviews of project documentation of a sample of customers who have participated in the program
On-Site & Virtual Verification	Site visits of a sample of customers to collect data for savings calculation, to verify installation, and determine operating parameters

LADWP provided the Evaluator with the available program tracking data for rebated measures. The evaluation methodology consisted of the following key components.

- Tracking data review
- M&V sample design
- Review of algorithms and references
- M&V approach

A detailed evaluation methodology is available in Appendix A, section A.4.1.

5.4 Impact Evaluation

This section provides a brief summary describing how Ex-Post kWh savings and peak kW reduction were calculated using the appropriate DEER workpapers. Important input parameters were based on information collected during verification site visits or by reviewing available project documentation. The impact evaluation consisted of the following key activities.

- Detailed program data review;
- Data collection and desk review activities; and
- Project-level impact evaluation.

A detailed impact evaluation is available in Appendix A, section A.4.2.

5.5 Ex-Post Gross Results and Findings

This section presents Ex-Post gross realized savings for FSPC. Table 5-9 compares Ex-Post energy savings to Ex-Ante claimed savings from the tracking data, while Table 5-10 compares Ex-Post energy savings to Ex-Ante claimed savings from ESP.

Table 5-9 FSPC Retrospective Evaluation Results by Strata

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	65,269	64,290	98%	7.36	7.43	101%
2	119,096	114,438	96%	14.16	14.14	100%
3	680,590	767,199	113%	111.64	136.04	122%
4	445,281	419,262	94%	57.30	44.19	77%
Certainty	21,109	0	0%	4.34	0.00	0%
Total	1,331,345	1,365,189	103%	194.81	201.80	104%

The program-level tracking data Ex-Post energy savings realization rate was 103%. The realization rate is a result of impacts in stratum 3, specifically sites with Steamers within that stratum. The Evaluator consistently found greater hours of use for the Steamers than the default DEER workpaper values. Additionally, the Ex-Post used the new Steamer's parameters (cooking efficiency, idle energy, etc.) sourced from the unit's cut sheets.

Table 5-10 FSPC Retrospective Evaluation Results by Fiscal Year

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
15/16	231,379	226,210	98%	10.00	26.58	266%
16/17	451,068	405,154	90%	9,661.50	56.43	1%
17/18	204,024	199,068	98%	34.44	25.15	73%
18/19	234,054	223,682	96%	31.43	28.68	91%
19/20	254,568	311,074	122%	32.83	40.07	122%
Total	1,375,093	1,365,189	99%	9,770.20	176.92	2%

The Evaluator presents an overall Retrospective gross realization rate of 99% compared to ESP Portfolio Ex-Ante kWh savings and a rate of 2% compared to ESP Ex-Ante kW savings; the high Peak kW Ex-Ante value in FY 16/17 is possibly from a data entry error from a single refrigerators/freezer line item claiming 9,600 kW savings. The Evaluator was unable to recreate the reported ESP Portfolio Ex-Ante kWh and kW savings values with the provided program tracking data, due to the discrepancy between program tracking and ESP Ex-Ante savings. The Evaluator was able to extrapolate project level savings to the unique number of projects presented in the program tracking data; Ex-Post savings were compared to ESP savings at the program level. This is an additional factor that may be affecting the gross realization rates.

5.5.1 Gross Realization Rate by Measure

Due to the methodology of impact evaluation, the Evaluator was only able to assess measure-level gross realization rate distribution at the M&V sample project level. Table 5-11 summarizes the M&V sample results by measure.

Table 5-11 FSPC Retrospective Evaluation Sample Savings by Measure Category

Measure Category	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate
Refrigerators/Freezers	48,576	50,919	105%
Ice Machines	4,419	4,523	102%
Kitchen Hood DVC	163,683	151,350	92%
Combi Oven	26,571	26,596	100%
Deck Oven	14,626	15,867	108%
Hot Food Cabinets	29,073	35,622	123%
Steamers	283,464	286,944	101%
On-Demand Hand Wrapper	1,565	1,565	100%
Convection Oven	1,951	771	40%

Measure Category	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate
Total	573,928	574,157	100%

Sample data gross realized savings had several factors affecting measure level savings. Specific measure realization rates were driven by;

- Refrigerator/freezers: There were instances of utilizing the wrong DEER workpaper values.
- Ice Machines: Incorrect DEER workpapers values utilized in the Ex-Ante estimate. For example, units purchased in 2018 but pre-2018 DEER workpaper values used.
- Kitchen Hood DVC: A project's Ex-Ante values that were greater than the DEER workpaper values. The DEER workpaper values for this measure have not changed since 2014, the Evaluator is unsure what the source of the Ex-Ante values were. The Ex-post analysis used the DEER workpaper savings values.
- Deck Ovens: Instances where the verified measure hours of use were greater than the default DEER workpaper values used in the Ex-Ante estimate. Additionally, Ex-Post utilized project-specific unit specifications such as idle energy rates, production capacities, and cooking efficiencies in lieu of the default DEER workpaper values utilized in the Ex-Ante estimate.
- Hot Food Cabinets: The realization rate is a result of several Hot Food Cabinet projects with a verified volume of 41.3 cu. ft., the Ex-Ante estimate utilized default DEER workpaper value of 25 cu. ft.
- Steamers: Instances where the verified hours of use were greater than the default DEER workpaper values used in the Ex-Ante estimate. Additionally, the Ex-post calculation utilized project-specific unit specifications such as idle energy rates, production capacities, and cooking efficiencies in lieu of the default DEER workpaper values utilized in the Ex-Ante estimate.
- Convection Ovens: The Ex-Post calculation used verified unit operating hours that were less than the Ex-Ante default values from the DEER workpapers.

5.5.2 COVID-19 Impacts on Energy Use

The program level tracking data Ex-Post COVID-19 energy savings were 4% less than the Ex-Post energy savings for FY 19/20. The 4% is a result of impacts in stratum 3, specifically a site with a Hot Food Holding Cabinet within that stratum. The Evaluator confirmed the site experienced a shutdown during the pandemic. Generally, the Evaluator found that the project sites remained open and only a few had reduced hours. This factor did not impact the COVID-19 savings because of the nature of the measures and the

DEER workpapers utilized to estimate savings. For example, Refrigerator and Ice Machine savings are only dependent on the size of the unit or ice production capacity, and these specifications are sourced from the equipment specification sheets.

Table 5-12 FSPC COVID-19 Era Impact on Ex-Post Gross Energy Savings

Stratum	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
1	5,761	5,761	-	-
2	22,387	22,387	-	-
3	178,889	164,428	-14,461	-8.1%
4	104,037	104,676	639	0.6%
Certainty	-	-	-	-
Total	311,074	297,252	-13,822	-4.4%

5.5.3 DEER 2020 Impacts on Energy Use

The Evaluator performed a what-if analysis utilizing the latest DEER workpaper values and the information collected during the virtual visits. The DEER 2020 Ex-Post energy savings are generally less than the Ex-Post energy savings. The DEER 2020 Ex-Post energy savings realization rate was 73%. The DEER 2020 Ex-Post energy savings was a result of impacts from four measures, HF Cabinets, Ice Machines, Refrigerators/Freezers, and Steamers. The Evaluator found that the referenced values from DEER 2020 workpapers were less than previous workpapers for these measures. This alternative analysis indicates that baseline conditions have been updated in recent workpapers such that savings will be reduced if efficient equipment does not become more efficient.

Table 5-13 Tracking Data DEER 2020 Summary

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Program Data Ex-Post kWh Savings (DEER 2020)	Gross kWh Realization Rate	Gross kWh Realization Rate (DEER 2020)
1	65,269	64,290	30,747	98%	47%
2	119,096	114,438	41,982	96%	35%
3	680,590	767,199	474,080	113%	70%
4	445,281	419,262	261,704	94%	59%
Certainty	21,109	0	0	0%	0%
Total	1,331,345	1,365,189	808,512	103%	61%

5.6 Program Recommendations

The Evaluator offers the following recommendations for the FSPC:

- Verify that incentivized units are listed in the LADWP qualifying equipment list.
- For cooking equipment, it is important to document actual cooking efficiency metrics and unit sizes. The program should utilize unit-specific parameters in lieu of default DEER workpaper values. Unit-specific parameters such as unit volume and cooking efficiencies are available in documentation such as the LADWP qualifying equipment list.
- Verification efforts are difficult to accomplish for projects completed several years ago. Annual evaluations have the advantage of providing customer feedback and measure level findings in a timely manner.

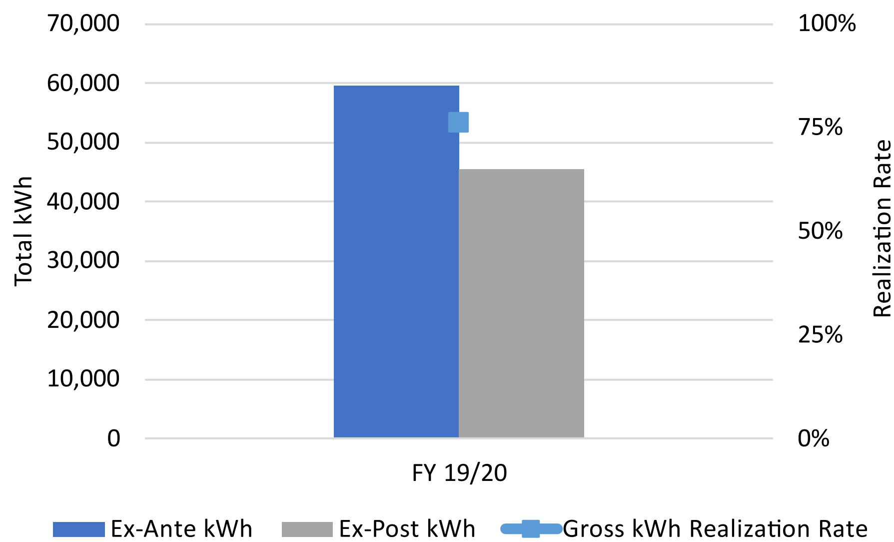
6 Food Service Program – Point-of-sale

This chapter summarizes the impact evaluation of the Food Service Program – Point of Sale (FSP- POS) that LADWP offered customers in fiscal year (FY) 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the FSP- POS.

6.1 Program Performance Summary

FSP-POS is a new initiative from LADWP that transitions the food service rebates to an instant rebate from the participating retailer or distributor. This removes the need for a project rebate application from the purchaser. The program launched in August of 2019, and the results presented in this report summarize 10 months of participation. Figure 6-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 6-1 Food Service Program -Point of Sale Performance Summary



6.1.1 Key Evaluation Takeaways

- The program had 76% kWh realization. This was driven by low realization for three projects:
    - Two projects where the equipment was no longer in use, received a 0% realization rate.
    - One project where it was found that equipment only operated 4.5 hours per week, compared to the 64.75 hours per week shown in Ex-Ante savings estimates.

6.2 Program Description

The FSP-POS is a program designed to assist grocery stores, liquor stores, convenience stores, restaurants, and other commercial customers with refrigeration and food service equipment. This Point-of-Sale component was added in FY 19/20 to enable customers to receive their rebate as a line item discount directly on their sales invoice for eligible equipment. The program targets the commercial market sector and is managed in collaboration with SoCal Gas. The program offers discounts for equipment including ice machines, glass, and solid door freezers/refrigerators, commercial ovens, etc. This program launched in August of 2019. The Evaluator received project tracking data listing twenty-five projects and claiming savings of 70,096 kWh.

Table 6-1 summarizes the program's Energy Savings Platform, Inc. (ESP) Ex-Ante energy savings and peak demand reduction and contributions to the Retrospective savings by fiscal year.

Table 6-1 FSP POS Retrospective Ex-Ante Savings Summary

Fiscal Year	ESP Data Ex-Ante kWh Savings	ESP Data Ex-Ante Peak kW Savings
19/20	59,607	7.69

Table 6-2 provides a complete list of FSP POS measures rebated in FY 19/20.

Table 6-2 FSP POS Rebated Measures

Measure Category	Measures
Cooking Equipment	Convection Ovens
	Hot Food Cabinets
Refrigeration Equipment	Ice Machines
	Refrigerators
	Freezers

6.3 Methodology

This section presents a brief summary of the findings of the tracking data review and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program. As part of the impact evaluation, the Evaluator performed the following data collection activities outlined in Table 6-3.

Table 6-3 FSP POS Data Sources for Impact Evaluation

Data	Source
Program Tracking Data	Data requested to LADWP for all data tracking program participation
Desk Review	Reviews of project documentation of a sample of customers who have participated in the program
On Site and Virtual Verification	Site visits of a sample of customers to collect data for savings calculation, to verify installation, and determine operating parameters

LADWP provided the Evaluator with the available program tracking data for rebated measures. The evaluation methodology consisted of the following key components.

- Tracking data review;
- M&V sample design;
- Review of algorithms and references; and
- M&V approach.

A detailed evaluation methodology is available in Appendix A, section A.5.1.

6.4 Impact Evaluation

This section provides a brief summary describing how Ex-Post kWh savings and peak kW reduction were calculated using the appropriate DEER workpapers. Critical input parameters were based on information collected during site verification or the available project documentation. The impact evaluation consisted of the following key components.

- Detailed program data review;
- Data collection and desk review activities; and
- Project-level impact evaluation.

A detailed impact evaluation is available in Appendix A, section A.5.2.

6.5 Ex-Post Gross Results and Findings

This section presents Ex-Post gross realized savings for FSPC. Table 6-4 compares Ex-Post energy impacts to Ex-Ante claimed savings from the tracking data, while Table 6-5 compares Ex-Post energy impacts to Ex-Ante claimed savings from ESP.

Table 6-4 FSP-POS Retrospective Evaluation Results by Strata

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	8,159	6,081	75%	0.80	0.59	73%
2	23,123	13,473	58%	3.92	2.38	61%
3	38,814	25,798	66%	6.75	4.80	71%
Total	70,096	45,352	65%	11.47	7.77	68%

The program-level tracking data Ex-Post energy savings realization rate was 65%. The realization rate is impacted by two factors. One factor is that the largest project in the program made up 31% of the program Ex-Ante savings. The project consisted of six Refrigerators and five Hot Food Cabinets. Regarding the Hot Food Cabinets at this site, the Ex-Post used the new unit's volume (16.3 cu. ft.) sourced from the unit's cut sheets, in place of the default DEER workpaper value of 25 cu. ft.

The second factor was the other five Hot Food Cabinets sites. The Evaluator consistently found fewer hours of use for the Hot Food Cabinets than the default DEER workpaper values. Additionally, the Ex-Post used the new unit's volume (3.9 cu. ft.) sourced from the unit's cut sheets, in place of the default DEER workpaper value of 10 cu. ft.

Table 6-5 FSP-POS Retrospective Evaluation Results by Fiscal Year

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
19/20	59,607	45,352	76%	7.69	7.77	101%

The Evaluator presents an overall Retrospective gross realization rate of 76% compared to ESP Portfolio Ex-Ante kWh savings and a rate of 101% compared to ESP Ex-Ante kW savings. The Evaluator was unable to recreate the reported ESP Portfolio Ex-Ante kWh savings and peak kW values with the provided program tracking data, due to the discrepancy between program tracking and ESP Ex-Ante savings. The Evaluator was able to extrapolate project level savings to the unique number of projects presented in the program tracking data; Ex-Post savings were compared to ESP savings at the program level. This is a factor that may have also affected the gross realization rates.

6.5.1 Gross Realization Rate by Measure

Due to the methodology of the impact evaluation, the Evaluator was only able to assess measure-level gross realization rate distribution at the sample level. Table 6-6 summarizes the sample results by measure.

Table 6-6 FSP-POS Retrospective Evaluation Sample Savings by Measure Category

Measure Category	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate
Refrigerators/Freezers	2,365	1,563	66%
Ice Machines	666	666	100%
Hot Food Cabinets	50,392	25,012	50%
Convection Oven	9,755	12,437	127%
Total	63,178	39,678	63%

Sample data gross realized savings had several factors that affected measure level savings. Specific measure realization rates were driven by;

- Hot Food Cabinets: The realization rate is a result of several Hot Food Cabinet projects with a verified volume of 3.9 cu. ft. and 16.3 cu. ft., the Ex-Ante estimate utilized the default DEER workpaper value of 10 cu. ft. and 25 cu. ft.
- Convection Ovens: Ex-post calculations utilized project-specific unit specifications such as idle energy rates, production capacities, and cooking efficiencies in lieu of the default DEER workpaper values the Ex-Ante utilized.

6.5.2 COVID-19 Impacts on Energy Use

The program level tracking data Ex-Post COVID-19 energy savings are 36% less than the Ex-Post energy savings. The 36% is a result of multiple sites not using their equipment at all during the Pandemic year. The Evaluator confirmed the units were not plugged in during the pandemic at these sites.

The Evaluator found that other program sites remained open and only a few had reduced hours. This did not impact the COVID-19 savings because of the nature of the measures and the DEER workpapers utilized to estimate savings. For example, savings for Refrigerators are only dependent on the size of the unit and door type, and these specifications are obtained from the specification sheets.

Table 6-7 FSP POS COVID-19 Era Impact on Ex-Post Gross Energy Savings

Stratum	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
1	6,081	4,425	-1,657	-27.2%
2	13,473	13,164	-309	-2.3%
3	25,798	11,178	-14,620	-56.7%
Total	45,352	28,767	-16,586	-36.6%

6.5.3 DEER 2020 Impacts on Energy Use

The Evaluator performed a what-if analysis utilizing the latest DEER workpaper values and the information collected during the virtual site visits. The DEER 2020 Ex-Post energy savings are generally less than the Ex-Post energy savings. The DEER 2020 Ex-Post energy savings realization rate was 40%. The DEER 2020 Ex-Post energy savings were impacted by three measures, Hot Food Cabinets, Ice Machines, and Refrigerators/Freezers. The Evaluator found that the referenced values from DEER 2020 workpapers were less than previous workpapers for these measures.

Table 6-8 FSP POS Tracking Data DEER 2020 Summary

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Program Data Ex-Post kWh Savings (DEER 2020)	Gross kWh Realization Rate	Gross kWh Realization Rate (DEER 2020)
1	8,159	6,081	3,377	75%	41%
2	23,123	13,473	9,182	58%	40%
3	38,814	25,798	15,359	66%	40%
Total	70,096	45,352	27,918	65%	40%

6.6 Program Recommendations

The Evaluator offers the following recommendations for the FSP- POS:

- For cooking equipment, it is important to document actual cooking efficiency metrics. Deemed savings for commercial kitchen equipment are often lower than efficiencies observed on the field. For example, a minimum qualifying natural gas ENERGY STAR fryer has at least 50% cooking efficiency and a maximum of 9,000 idle BTU. In our 2018 evaluation of CenterPoint Energy Arkansas' Commercial Food Service Program, the Evaluator found that model-specific inputs of equipment rebated in the program averaged 57% cooking efficiency and 6,631 idle BTU. While the fuel type differs, the lesson learned is nonetheless the same: Default assumptions in TRMs in general (including the DEER workpapers) take a conservative approach to assigning efficiency ratings to the “typical” efficient unit and often lag the market in terms of what is actually installed.

- Verify that incentivized units are listed in the LADWP qualifying equipment list.
- Verification efforts are difficult to accomplish for projects completed several years ago. Annual evaluations have the advantage of providing customer feedback and measure level findings in a timely manner.

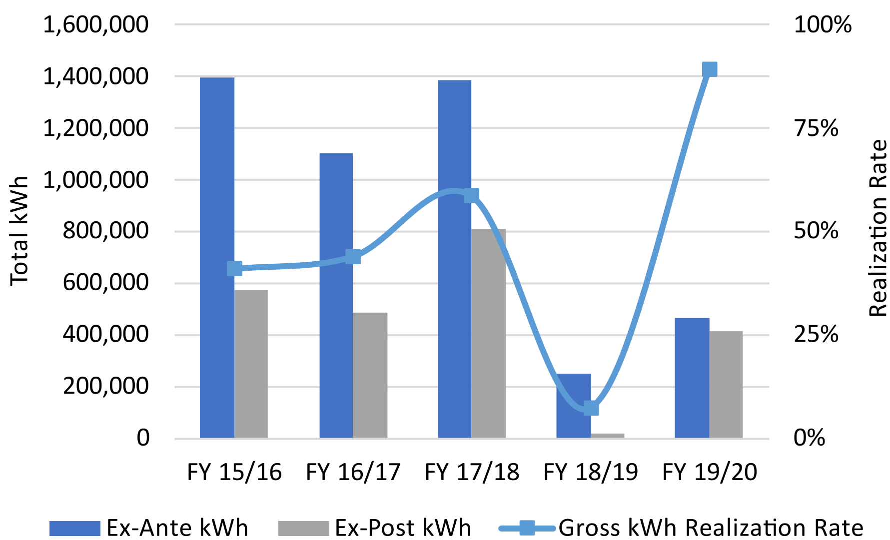
7 LADWP Facilities Program

This chapter summarizes the impact evaluation of the LADWP Facilities Program that LADWP offered customers from fiscal years (FY) 15/16 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the LADWP Facilities Program.

7.1 Program Performance Summary

The LADWP Facilities Program was established in 2009 in response to the City of Los Angeles Green LA Directive. The program provides funding for direct install improvements for LADWP facilities, from which operational cost reductions then become ratepayer benefits. Figure 7-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 7-1 LADWP Facilities Program Performance Summary



7.1.1 Key Evaluation Takeaways

- The program had 50% kWh realization, driven by deviations in hours of use compared to ex ante estimates. Projects often lacked the level of sophistication and detail in supporting documentation found in other commercial programs (such as CLIP, CPP, etc.).
- The Evaluators recommend that internal LADWP projects processed through this program have a formal application process, as this will ensure standardized data collection that parallels similar projects in other LADWP energy efficiency programs.

7.2 Program Description

The LADWP Facilities Program upgrades lighting technology to reduce energy consumption within LADWP facilities. The program is designed to achieve the City's Energy Efficiency goals and provides a functional and safe workspace for employees. Engineering staff provide expertise in retrofitting facilities with detailed design, energy savings calculations, and project management. Table 7-1 summarizes the program's Energy Savings Platform, Inc. (ESP) Ex-Ante energy savings and peak demand reduction and contribution to the Retrospective savings by fiscal year.

Table 7-1 LADWP Facilities Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Projects	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
15/16	12	1,395,552	30.3%	192.00	38.3%
16/17	11	1,104,281	24.0%	113.00	22.6%
17/18	7	1,383,033	30.1%	152.00	30.4%
18/19	5	250,597	5.4%	43.00	8.5%
19/20	7	466,175	10.1%	1.00	0.2%
Total	42	4,599,638	100%	501.00	100%

7.3 Methodology

This section presents a brief summary of the tracking data review and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program. As part of the impact evaluation, the Evaluator performed the following data collection activities outlined in Table 7-2:

Table 7-2 LADWP Facilities Data Sources for Impact Evaluation

Data	Source
Program Tracking Data	Data requested to LADWP for all data tracking program participation
Desk Review	Reviews of project documentation (Review of lighting fixture inventory and control types) of projects who have participated in the program
On-Site or Virtual Verification	Site visits of projects to collect data for savings calculation, to verify installation, and determine operating parameters

LADWP provided the Evaluator the available program tracking data for rebated measures. The evaluation methodology consisted of the following key components.

- Tracking data review;

- M&V sample design;
- Review of algorithms and references; and
- M&V approach.

A detailed evaluation methodology is available in Appendix A, section A.6.1.

7.4 Impact Evaluation

This section provides a brief summary describing how Ex-Post kWh savings and peak kW reduction were calculated using the appropriate DEER workpapers and other proven industry techniques. Important input parameters were based on information collected during on-site verifications or from available project documentation. The impact evaluation consisted of the following key components

- Detailed program data review;
- Data collection and desk review activities; and
- Project-level impact evaluation.

A detailed impact evaluation is available in Appendix A, section A.6.2.

7.5 Ex-Post Gross Results and Findings

This section presents Ex-Post gross realized savings for LADWP Facilities. Table 7-3 compares Ex-Post energy impacts to Ex-Ante claimed savings from the tracking data, while Table 7-4 compares Ex-Post energy impacts to Ex-Ante claimed savings from the ESP platform. The Evaluator calculated a kWh realization rate of 84% and a kW realization rate of 57% when comparing Ex-Post to Program Data Ex-Ante values, and a realization rate of 50% and a kW realization rate of 62% when comparing Ex-Post to ESP Ex-Ante values.

Table 7-3 LADWP Facilities Retrospective Evaluation Results by Strata

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	479,984	219,787	46%	159.00	20.58	13%
2	776,156	1,133,665	146%	183.00	159.52	87%
3	587,021	345,849	59%	71.00	29.44	41%
4	886,489	602,333	68%	104.00	87.48	84%
Total	2,729,650	2,301,634	84%	517.00	297.02	57%

Table 7-4 LADWP Facilities Retrospective Evaluation Results by Fiscal Year

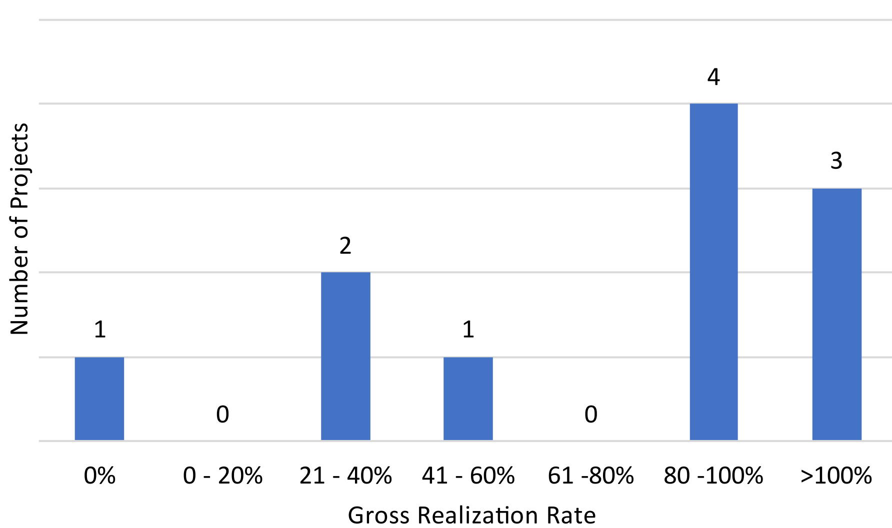
Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
15/16	1,395,552	571,894	41%	192.00	76.07	40%
16/17	1,104,281	485,279	44%	113.00	60.28	53%
17/18	1,383,033	810,806	59%	152.00	119.21	78%
18/19	250,597	18,486	7%	43.00	2.76	6%
19/20	466,175	415,168	89%	1.00	60.60	>100%
Total	4,599,638	2,301,634	50%	517.00	318.93	62%

LADWP Facilities program saw an increase in program savings from FY 16/17 to FY 17/18 as shown above. However, there was a decrease in savings in FY 18/19, possibly due to few energy efficiency projects being completed or little program activity. FY 19/20 shows higher savings and increased program activity.

7.5.1 Gross Realization Rate Distribution by Sampled Project

Results of the Ex-Post savings of the program sample were separated by stratum to determine a realization rate for energy savings, peak demand reduction, and EUL. The values determined from the Ex-Post analysis of the program sample were extrapolated to the other projects within the program by stratum. The distribution of realization rates of all projects within the random sample is illustrated below in Figure 7-2.

Figure 7-2 Gross Realization Rate Distribution for Sampled Projects



7.5.2 COVID-19 Impacts on Energy Use

The impact of COVID-19 was assessed based on findings of the virtual and on-site verification process. Generally, the occupancy at the LADWP facilities was reduced but the lighting usage was reported to not be impacted by COVID-19. Also, a few projects involved exterior or garage lighting only, which were not impacted by COVID-19 at all. Therefore, no adjustments were applied to quantify COVID-19 impacts on energy use.

7.6 Program Recommendations

The Evaluator offers the following recommendations for the LADWP Facilities program:

- Evaluation results indicate some impacts from differing hours of operation, incorrect analytical approaches, analysis errors, or baseline assumptions. A relatively low annual energy savings realization rate indicates that some installed equipment did not perform as expected.
- The evaluation spanned projects initiated back in 2014, allowing the Evaluator a closer look at savings persistence. Instances were discovered where equipment is no longer functioning as originally intended.
- Verification efforts are difficult to accomplish for projects completed several years ago. Annual evaluations have the advantage of providing customer feedback and measure level findings in a timely manner.
- Most LADWP facilities projects were missing detailed savings analyses, conducted throughout the application process. The Evaluator re-generated Ex-Ante savings based on the available information. For the lighting retrofit projects, calculation of fixture connected load (kW), corresponding hours of use, and resulting electricity consumption should have been provided by LADWP. For the fixtures using lighting controls, the factors used to adjust the hours of use were also desirable. Information on whether or not interactive effects were taken into consideration while estimating the savings would have been helpful. Detailed calculations and organization of documentation reduce savings discrepancies and reduces the number of future inquiries. Structured identification of analysis files associated with filed results helps provide a clean documentation trail.

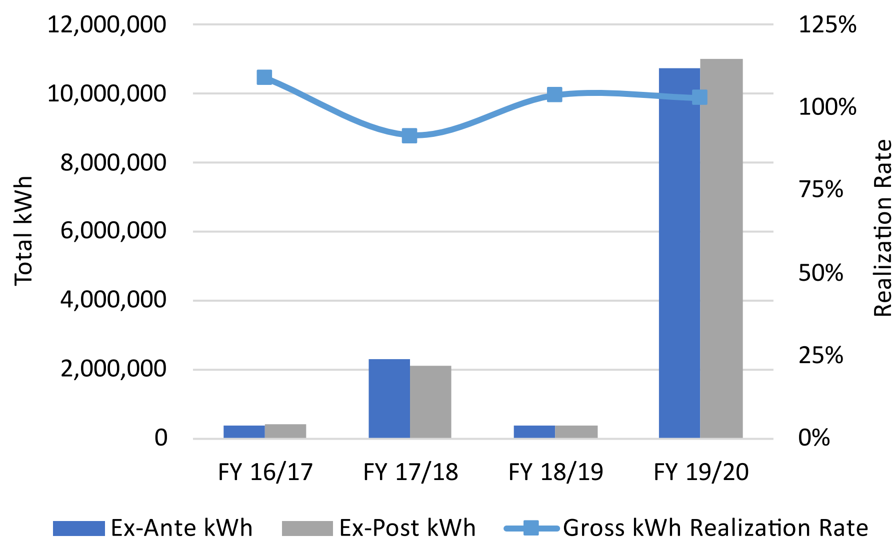
8 LAUSD Direct Install Program

This chapter summarizes the impact evaluation of the LAUSD Direct Install Program (LAUSD DI) that LADWP offered customers from fiscal years (FY) 16/17 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the LAUSD DI Program.

8.1 Program Performance Summary

LAUSD-DI targets facilities within the Los Angeles Unified School District with electric, water, and gas saving measures. LAUSD-DI was launched in 2012 in response to budget challenges faced by LAUSD, and the program also provided technical and project management assistance to facilitate project completion. Figure 8-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 8-1 LAUSD Direct Install Program Performance Summary



8.1.1 Key Evaluation Takeaways

- Though overall realization was greater than expected (101%), the Evaluator found that the level of detail in savings calculations for LAUSD-DI was lower than found in other commercial programs offering similar technologies.
- The realization rate for peak demand impacts was 77%. The Evaluators updated coincidence factors for interior spaces and addressed kW impacts separately for exterior fixtures that run on an overnight schedule.

8.2 Program Description

The LAUSD DI Program was launched in October 2012 in response to the opportunities for energy and water efficiency within the District, the District's budget challenges, and the numerous opportunities to be able to capture water, natural gas and electricity savings, as well as improve the financial standing of LAUSD and enhance the learning environment for the students of LAUSD. The initial program was designed to provide technical design, project management experience, and retrofit installation of lighting, HVAC, water, and natural gas measures, utilizing LADWP engineering and PCM staff in partnership with SoCalGas. The program entered a dormant period in FY 15/16 and was relaunched in May of 2016 with a focus on lighting. Table 8-1 summarizes the program's Energy Savings Platform, Inc. (ESP) Ex-Ante energy savings and peak demand reduction and contribution to the Retrospective savings by fiscal year.

Table 8-1 LAUSD DI Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Projects	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
16/17	2	376,228	2.7%	149.00	5.1%
17/18	9	2,286,462	16.6%	971.00	33.2%
18/19	1	364,407	2.7%	42.00	1.4%
19/20	38	10,717,685	78.0%	1764.00	60.3%
Total	50	13,744,782	100.0%	2,926.00	100.0%

8.3 Methodology

This section presents a brief summary of the tracking data review and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program. As part of the impact evaluation, the Evaluator performed the following data collection activities outlined in Table 8-2:

Table 8-2 LAUSD DI Data Sources for Impact Evaluation

Data	Source
Program Tracking Data	Data requested to LADWP for all data tracking program participation
Desk Review	Reviews of project documentation (Review of lighting fixture inventory and control types) of a sample of customers who have participated in the program
On-Site Verification	Site visits of a sample of customers to collect data for savings calculations, to verify installation, and determine operating parameters

LADWP provided the Evaluator with the available program tracking data for rebated measures. The evaluation methodology consisted of the following key components.

- Tracking data review;

- M&V sample design;
- Algorithms and references; and
- M&V approach.

A detailed evaluation methodology is available in Appendix A, section A.7.1.

8.4 Impact Evaluation

This section provides a brief summary describing how Ex-Post kWh savings and peak kW reduction were calculated using the appropriate DEER workpapers and other proven industry techniques. Important input parameters were based on information collected during on-site verifications or available project documentation. The impact evaluation consisted of the following key components.

- Detailed program data review;
- Data collection and desk review activities; and
- Project-level impact evaluation.

A detailed impact evaluation is available in Appendix A, section A.7.2.

8.5 Ex-Post Gross Results and Findings

The summary of Ex-Post results by strata and by fiscal year is presented below. Table 8-3 compares Ex-Post energy impacts to Ex-Ante claimed savings from the tracking data, while Table 8-4 compares Ex-Post energy impacts to Ex-Ante claimed savings from the ESP platform. The Evaluator calculated a kWh realization rate of 103% and a kW realization rate of 58% when comparing Ex-Post to Program Data Ex-Ante values, and a realization rate of 101% and a kW realization rate of 77% when comparing Ex-Post to ESP Ex-Ante values.

Table 8-3 LAUSD DI Retrospective Evaluation Results by Strata

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	3,699,764	4,126,231	112%	1,273.21	856.65	67%
2	5,486,928	5,649,852	103%	1,711.51	916.51	54%
3	4,318,564	4,119,348	95%	1,081.18	580.95	54%
Total	13,505,256	13,895,431	103%	4,065.90	2,354.12	58%

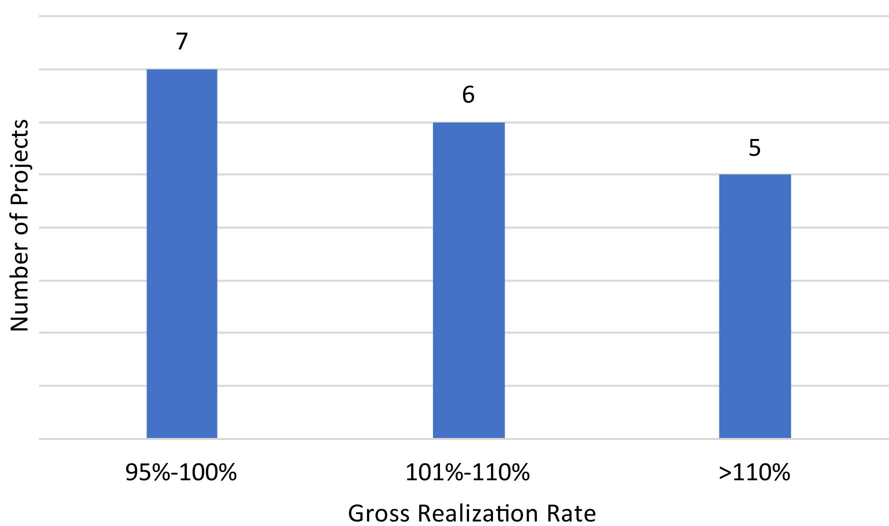
Table 8-4 LAUSD DI Retrospective Evaluation Results by Fiscal Year

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
16/17	376,228	409,759	109%	149.00	50.90	34%
17/18	2,286,462	2,090,260	91%	971.00	367.59	38%
18/19	364,407	377,815	104%	42.00	35.08	84%
19/20	10,717,685	11,017,598	103%	1,764.00	1,812.92	103%
Total	13,744,782	13,895,432	101%	2,926.00	2,266.50	77%

8.5.1 Gross Realization Rate Distribution by Sampled Project

Results of the Ex-Post savings of the program sample were separated by stratum to determine a realization rate for energy savings, peak demand reduction, and EUL. The values determined from the Ex-Post analysis of the program sample were extrapolated to the other projects within the program by stratum. The distribution of realization rates of all projects within the random sample are illustrated below in Figure 8-2.

Figure 8-2 Gross Realization Rate Distribution for Sampled Projects



8.5.2 COVID-19 Impacts on Energy Use

The impact of COVID-19 was assessed based on findings of the virtual or on-site verification process. Generally, the occupancy at the LAUSD schools was reduced significantly due to shutting down. It was reported by the site contact person that during the pandemic, the lighting operation was reduced by approximately 20% of normal. Table 8-8 below presents the COVID-19 impacts on energy use.

Table 8-5 LAUSD DI COVID-19 Era Impact on Ex-Post Gross Energy Savings

Fiscal Year	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
19/20	11,017,598	6,191,890	-4,825,708	-43.8%

8.6 Program Recommendations

The Evaluator offers the following recommendations for the LAUSD DI program:

- Evaluation results indicate some impacts from differing hours of operation, and incorrect analytical approaches. The high annual energy savings realization rate indicates equipment installation and operation performed as expected.
- The evaluation spanned projects initiated back in 2014, allowing the Evaluator a closer look at savings persistence. It appeared that the equipment was still functioning as originally intended.
- Verification efforts are difficult to accomplish for projects completed several years ago. Annual evaluations have the advantage of providing customer feedback and measure level findings in a timely manner.
- LAUSD DI projects tend to be missing detailed calculations of energy savings throughout the Retrospective Period. For the lighting retrofit projects, calculation of fixture connected load (kW), corresponding hours of use and resulting electricity consumption should have been provided. For the fixtures using lighting controls, the factors used to adjust the hours of use were also desirable. Information on whether or not interactive effects were taken into consideration while estimating the savings would have been helpful. The Evaluator re-generated Ex-Ante savings based on the available information. Detailed calculations and organization of documentation can reduce savings discrepancies and reduce the number of future inquiries. Structured identification of analysis files associated with filed results provides a clean documentation trail.

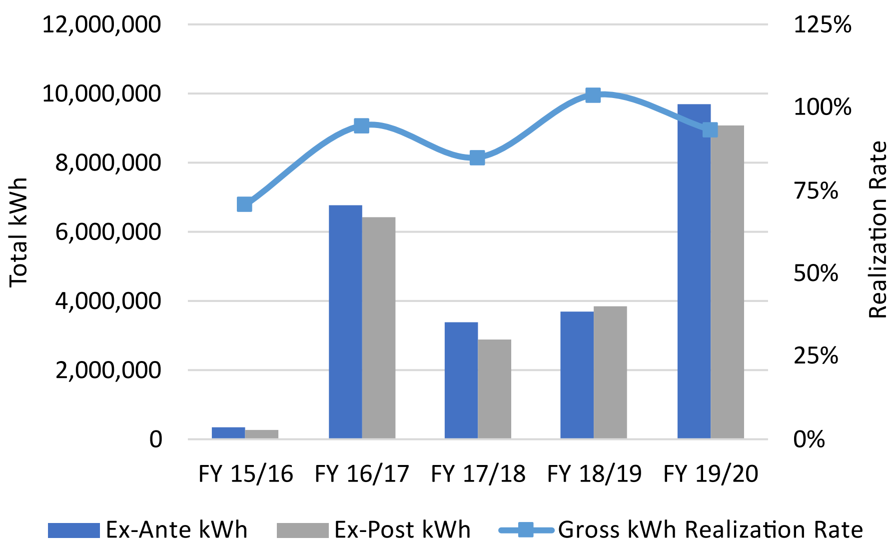
9 Savings by Design Program

This chapter presents an evaluation of the Saving by Design (SBD) program that LADWP offered customers during fiscal years (FY) 15/16 through FY 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the SBD program.

9.1 Program Performance Summary

SBD is a statewide program model that provides incentives for new construction and modernization ("gut rehab") projects that exceed Title 24 energy code requirements. SBD has been discontinued by LADWP and is to be replaced with a new program design that is unique to LADWP. Figure 9-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 9-1 Savings by Design Program Performance Summary



9.1.1 Key Evaluation Takeaways

- The overall realization was high (94%), though this differed significantly between new construction (105%) versus modernization (88%). Project evaluation was difficult due to a lack of availability of mechanical and electrical system plans as well as for projects that were single buildings in large multi-building campuses without a dedicated utility meter.
- Projects were submitted in numerous modeling platforms (EnergyPro, TRACE 700, eQUEST, BECC, and IES-VE). These tools each differ in terms of adjustments allowed. The Evaluator recommends that LADWP provide a suggested "short list" of modeling tools for project applicants to use.

9.2 Program Description

The non-residential SBD program provides incentives for New Construction or Modernization projects that exceed Title 24 energy standards. Table 9-1 summarizes the program's Energy Savings Platform, Inc. (ESP) Ex-Ante energy savings and peak demand reduction and contribution to the Retrospective Period savings by fiscal year.

Table 9-1 SBD Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Projects	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
15/16	3	357,573	1.5%	0.00	0.0%
16/17	32	6,784,429	28.3%	2010.00	31.0%
17/18	16	3,397,417	14.2%	1574.00	24.3%
18/19	10	3,706,131	15.5%	535.88	8.3%
19/20	30	9,710,617	40.5%	2362.52	36.4%
Total	90	23,956,167	100.0%	6,482.40	100.0%

9.3 Methodology

This section presents a brief summary of the methodology used to evaluate the SBD program. Ex-Post annual energy savings, lifetime energy savings, and peak demand reduction were determined using the methodologies described. A site-specific approach was used to determine Ex-Post site level impacts with extrapolation to the population based on the design of the SBD program. The methods employed included:

- Review of program tracking data for completeness and sampling;
- Project documentation review;
- Site-specific Measurement and Verification Plan (M&V Plans);
- Primary data collection from site contacts;
- Engineering analysis for each sampled project; and
- Extrapolation of sample level results to determine program level impact estimates.

A detailed evaluation methodology is available in Appendix A, section A.8.1.

9.4 Impact Evaluation

This section provides a brief summary describing how Ex-Post kWh savings and peak kW reduction were calculated through evaluation M&V efforts. Ex-Post kWh savings and peak kW reduction were estimated using proven industry techniques. Important input parameters were based on information collected during virtual or on-site verifications or available project documentation. The impact evaluation consisted of the following key components:

- Detailed program data review;
- Data collection and desk review activities; and
- Project-level impact evaluation.

A detailed evaluation methodology is available in Appendix A, section A.8.2.

9.5 Ex-Post Gross Results and Findings

The aggregated verified gross energy impacts from the sample (by project) were extrapolated to the population by stratum. The evaluation was achieved for 19 projects. Not all sampled projects were able to be evaluated but the projects verified resulted in a statistical precision of ±9.4% at the 90% confidence interval for annual energy savings. The precision for peak demand reduction was ±24.92%. Program level results are shown in Table 9-2. The Evaluator calculated a kWh realization rate of 92% and a kW realization rate of 121% when comparing Ex-Post to Program Data Ex-Ante values.

Table 9-2 SBD Retrospective Evaluation Results by Strata

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	2,192,648	2,163,603	99%	644.90	669.16	104%
2	6,406,898	4,537,801	71%	2,245.90	1,946.64	87%
3	7,940,521	6,994,943	88%	1,709.22	2,742.66	160%
4	7,893,329	8,819,697	112%	1,854.80	2,455.79	132%
Total	24,433,396	22,516,045	92%	6,454.82	7,814.25	121%

Program level results by fiscal year compared to ESP results are shown in Table 9-3. The Evaluator calculated a kWh realization rate of 94% and a kW realization rate of 62% when comparing Ex-Post to ESP Ex-Ante values.

Table 9-3 SBD Retrospective Evaluation Results by Fiscal Year

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
15/16	357,573	253,258	71%	0.00	33.69	-
16/17	6,784,429	6,429,324	95%	2,010.00	798.69	40%
17/18	3,397,417	2,893,138	85%	1,574.00	463.39	29%
18/19	3,706,131	3,858,033	104%	535.88	542.21	101%
19/20	9,710,617	9,082,292	94%	2,362.52	2,209.65	94%
Total	23,956,167	22,516,045	94%	6,482.40	4,047.62	62%

9.5.1 Gross Realization Rate by Measure

The most significant realization rate factors that impacted Ex-Post savings were the simulation anomalies and savings discrepancies. Simulation anomalies were determined for two stratum two projects and savings discrepancies were determined for one stratum one project. These factors resulted in realization rates of 60%, 56%, and 34% for these projects. For example, for project ID# SBD 2016034, the Ex-post savings were considerably different from Ex-Ante due to the following reasons:

1. There appeared to be some mismatch between the version of Energy Pro model and the report. Either the same model was not used to produce the report, or the correct report was not submitted.
2. When the Evaluator ran the EnergyPro model without making any changes, the results did not match. According to the original EnergyPro report, the electricity consumption had been modeled as 528,847 kWh, which was 43% higher than the bills. This did not meet the calibration criteria. However, with the revised EnergyPro run, the report showed electric consumption of 365,633 kWh, which was within a 1% error margin of electric bills.

All the verified measures were found to be accurately modeled. The Ex-Ante electricity savings based on the original report were 255,455 kWh and natural gas savings were 1,002 therms. The typical first year Ex-Post kWh savings were 87,344 kWh and natural gas savings were 2,146 therms.

Another example was the SBD2019004 project, which included an EnergyPro model that was used to derive Ex-Ante savings and within which the SBD code baseline was defined. The evaluation reviewed the model within EnergyPro to validate its inputs and confirmed that the Ex-Ante values could be replicated. Key inputs were modified based on data collected during virtual site visit and then further modified to ensure model values were consistent with project documentation/cutsheets. The Evaluator encountered the following error message when attempting to run the provided model:

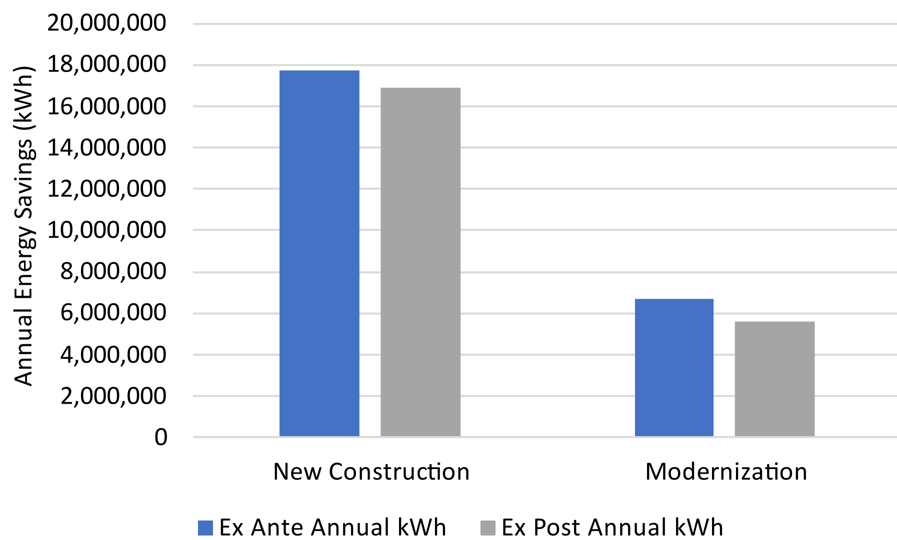
"TheDOE-2 based simulation does not support variable flow exhaust fans, nor exhaust system other than general exhaust."

The Evaluator changed the variable flow exhaust fans in the model to general exhaust fans to address this error.

The Evaluator found chiller capacity and efficiency discrepancies in the model and updated the model with the parameters from the provided documentation and ran the simulation.

The Evaluator's project category "New Construction" includes a majority of energy savings for the program. The impacts of realization rate factors by project type are shown in Figure 9-2.

Figure 9-2 SBD Energy Savings by Measure Category



Evaluation sample savings impacts by project type are shown in Table 9-4.

Table 9-4 SBD Retrospective Evaluation Sample Savings by Measure Category

Measure Category	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
New Construction	9,644,709	10,151,198	105%	2,036.02	2,611.71	128%
Modernization	2,881,162	2,549,405	88%	555.90	956.80	172%
Total	12,525,871	12,700,603	101%	2,591.92	3,568.51	138%

9.5.2 COVID-19 Impact on Energy Use

The Evaluator analyzed the impact of COVID-19 for each sampled measure on annual energy savings. Analysis included information from the site contact regarding changes in operation due to the pandemic. The possible causes of consumption change were due to occupancy changes and mechanical system setpoints. These results indicate the variance in annual energy savings expected if the impacts of COVID-19 were to persist into a typical fiscal year.

The analysis indicated an overall slight increase in annual energy savings compared to the typical year evaluation results. If billing data for the facility were available, the Evaluator would proportionally increase or decrease savings by the difference in overall energy consumption between 2020 and the year or years determined to be most typical of annual consumption. If billing data were not available, models would be adjusted to increase ventilation in accordance with ASHRAE recommendations for COVID-19 safety.

The impacts on energy savings vary based on the approach taken to adjust savings. The savings implications by measure type are shown in Table 9-5.

Table 9-5 SBD COVID-19 Era Impact on Ex-Post Gross Energy Savings

Measure Category	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
New Construction	6,426,981	7,156,003	729,022	11.3%
Modernization	2,655,311	2,704,118	48,807	1.8%
Total	9,082,292	9,860,121	777,829	8.6%

9.6 Program Recommendations

The Evaluator offers the following recommendations for the SBD program:

- Evaluation results indicate minimal overall impact from the simulation anomalies and savings discrepancies. However, these realization rate factors had significant impacts on individual projects. These issues are difficult to resolve during EM&V as it becomes unclear if the impact on savings is due to analytical or clerical errors.
- Data collection and equipment verification is difficult to accomplish for projects completed several years ago. Many site contacts identified in the project documentation were found to be either disconnected, no longer employed at the facility pertaining to the projects, or disinterested in participation due to the time since project completion. Annual evaluations have the advantage of providing customer feedback and project findings in a timely manner.
- The Evaluator was not provided with facility drawings (mechanical, electrical, and architectural) or equipment submittals. This documentation is paramount to verification as it provides a detailed scope of the projects and can be used to verify equipment that cannot be observed during data collection.

- Billing data for many facilities was not obtainable or unusable due to facilities having multiple meters, being part of a campus where individual meters could not be located on MV-Web, or individual meters serving additional spaces outside the scope of the project. Billing data is paramount to properly follow IPMVP Option D: Calibrated Simulation.
- SBD projects use a variety of simulation software including EnergyPro, TRACE 700, eQUEST, CBECC, and IES-VE. Each program varies in the adjustments that can be made to the baseline and proposed models, resulting verification limitations that may be present due to the software used on each individual project.
- Provided documentation for some projects appeared to inconsistently represent analysis versions. The Evaluator recommends a project documentation tracking system in which the final documents, including energy simulation files, are properly labeled as such.

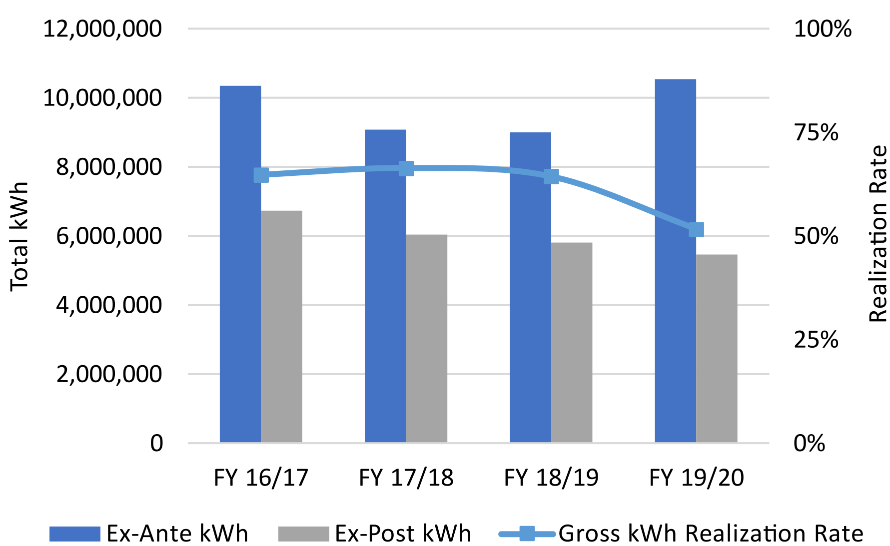
10 Upstream HVAC Program

This chapter presents an evaluation of the Upstream Heating, Ventilation and Air Conditioning Program (UHVAC) program that LADWP offered customers during fiscal years (FY) 16/17 through FY 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the UHVAC Program.

10.1 Program Performance Summary

UHVAC partners with distributors and manufacturers to provide incentives to upsell high efficiency HVAC equipment. The goal of this effort is to increase the availability of and marketing for high efficiency options, so that this will facilitate equipment selection by contractors and end-use customers. Figure 10-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 10-1 Upstream HVAC Program Performance Summary



10.1.1 Key Evaluation Takeaways

- The program had 62% kWh realization, driven by low realization for air conditioners (25%) and heat pumps (43%). Conversely, variable refrigerant flow (VRF) systems had 89% realization. Selection of replacement type was the driver of the realization rate for air conditioners and heat pumps.
- VRF workpapers reflected a very limited set of facility types. LADWP should endeavor to receive VRF models from DEER that may be edited to test this technology for new facility types.

- Though lower hours of use were found for projects in the Retrospective Period, sample sizes are not robust enough to warrant a revised deemed input. However, restaurants, primary schools, and office facilities should be flagged for extra review.

10.2 Program Description

Through an agreement with participating distributors and manufacturers, UHVAC provides incentives to participants to stock and upsell high efficiency HVAC equipment. Contractors and HVAC customers can then immediately access premium replacement technology that might not have been readily available to them without the program. The upstream approach allows LADWP to capture energy savings at the point of sale which would not have been applied for in LADWP's downstream programs. Table 10-1 outlines the number of projects, Energy Savings Platform, Inc. (ESP) Ex-Ante gross energy savings (kWh) and peak demand reduction, and the percentage of total savings across the Retrospective Period for the UHVAC Program.

Table 10-1 UHVAC Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Projects*	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
16/17	407	10,374,531	27%	4,773.00	28%
17/18	394	9,075,740	23%	4,163.00	24%
18/19	418	9,031,524	23%	3,149.09	18%
19/20	552	10,570,057	27%	4,990.22	29%
Total	1,771	39,051,852	100%	17,075.31	100%

*Number of projects is based on program tracking data

Starting in FY 16/17 the program included various types and sizes of heat pumps, unitary AC units, packaged AC units, and variable refrigerant flow (VRF) systems. Using the provided program tracking data, the Retrospective Period evaluation included the equipment types summarized in Table 10-2.

Table 10-2 UHVAC Retrospective Equipment Type Summary

Equipment Type	Number Line Items	Program Data Ex-Ante kWh Savings	Proportion of kWh Savings	Program Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
AC < 5.4	648	4,293,026	11.2%	2,165.98	13.1%
AC > 63.3	7	647,047	1.7%	281.33	1.7%
AC 11.3-20	30	399,918	1.0%	195.72	1.2%
AC 11.3-20.0	97	1,062,177	2.8%	558.39	3.4%

Equipment Type	Number Line Items	Program Data Ex-Ante kWh Savings	Proportion of kWh Savings	Program Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
AC 20-63.3	129	3,596,679	9.4%	1,602.88	9.7%
AC 5.4-11.3	322	2,449,090	6.4%	830.04	5.0%
ACC < 150	19	644,843	1.7%	84.11	0.5%
ACC > 150	3	756,819	2.0%	47.92	0.3%
Ductless Multi Split	24	67,379	0.2%	29.47	0.2%
Multi-Family VRF < 80	3	11,159	0.0%	6.81	0.0%
Multi-Family VRF > 80	14	578,100	1.5%	329.51	2.0%
PTAC	2	2,191	0.0%	0.77	0.0%
Single Phase < 5.4	46	299,825	0.8%	150.11	0.9%
VRF < 80	194	6,338,741	16.5%	2,980.53	18.0%
VRF > 80	152	14,497,106	37.7%	6,067.06	36.7%
WCAC > 20	1	2,290	0.0%	1.52	0.0%
WCAC or HP	93	510,885	1.3%	223.28	1.4%
WSHP < 5.4	174	1,612,651	4.2%	705.03	4.3%
WSHP > 20	2	172,302	0.4%	74.89	0.5%
WSHP 5.4-11.3	20	194,166	0.5%	84.60	0.5%
Not Identified	19	322,951	0.8%	109.33	0.7%
Total	1,999	38,459,346	100.0%	16,529.27	100.0%

10.3 Methodology

This section presents a brief summary of the methodology used to evaluate the UHVAC program. The retrospective impact evaluation consisted of a prescriptive savings approach with a thorough review of all available project documentation and customer data, followed by an analysis of energy savings methodologies. The prescriptive approach utilized applicable energy savings rates found in the Database for Energy Efficiency Resources (DEER) workpapers. Energy savings were also calculated using industry standard algorithms to benchmark results since some details are not available in the workpaper calculations. The approach can be summarized as:

- Tracking data review;
- Sample project database review;
- Sample measure and specification review;
- DEER Workpaper review and analysis;
- Industry standard analysis;
- Billing analysis; and
- COVID-19 impact analysis.

A detailed evaluation methodology is available in Appendix A, section A.9.1.

10.4 Impact Evaluation

This section provides a brief summary describing how Ex-Post kWh savings and peak kW reduction were calculated through evaluation M&V efforts. The Evaluator conducted an impact evaluation to determine Ex-Post annual energy savings, peak demand reduction, and lifetime energy savings for the Retrospective Period. The Evaluator incorporated the methodologies described in the previous section. Energy savings calculation results were reported by measure type.

A detailed impact evaluation is available in Appendix A, section A.9.2.

10.5 Ex-Post Gross Results and Findings

Ex-Post gross annual energy savings (kWh), and peak demand reduction (kW) were determined through a deemed savings approach using appropriate DEER workpapers. Results by fiscal year and equipment type are shown in Table 10-3. The Evaluator calculated a kWh realization rate of 63% and a kW realization rate of 64% when comparing Ex-Post to Program Data Ex-Ante values.

Table 10-3 UHVAC Retrospective Ex-Post Gross Results by Equipment and Fiscal Year

Fiscal Year	Measure Category	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
16/17	AC	3,460,403	593,982	17%	1,478.47	363.33	25%
	HP	516,430	221,110	43%	226.10	97.88	43%
	VRF	6,065,351	5,639,558	93%	2,959.18	2,768.38	94%
	Not Id.	322,951	272,547	84%	109.33	90.27	83%
17/18	AC	2,495,587	478,409	19%	1,174.80	291.21	25%
	HP	460,716	190,729	41%	200.18	83.77	42%
	VRF	6,123,789	5,364,679	88%	2,791.32	2,476.44	89%
18/19	AC	3,808,344	1,312,938	34%	1,294.71	327.73	25%
	HP	474,904	203,879	43%	207.48	90.05	43%
	VRF	4,748,276	4,305,408	91%	2,118.15	1,950.27	92%
19/20	AC	4,389,571	1,154,165	26%	1,970.78	461.14	23%
	HP	1,105,333	492,869	45%	483.51	218.09	45%
	VRF	4,487,691	3,826,755	85%	1,515.25	1,297.40	86%
Total		38,459,346	24,057,028	63%	16,529.27	10,515.97	64%

Ex-Post gross energy savings results by fiscal year are presented in Table 10-4.

Table 10-4 UHVAC Retrospective Evaluation Results by Fiscal Year

Fiscal Year	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
16/17	10,365,136	6,727,197	65%	4,773.09	3,319.85	70%
17/18	9,080,092	6,033,817	66%	4,166.30	2,851.43	68%
18/19	9,031,523	5,822,224	64%	3,620.34	2,368.06	65%
19/20	9,982,595	5,473,789	55%	3,969.54	1,976.63	50%
Total	38,459,346	24,057,028	63%	16,529.27	10,515.97	64%

Ex-Post gross energy savings compared to ESP Ex-Ante energy savings are shown in Table 10-5. The Evaluator calculated a kWh realization rate of 62% and a kW realization rate of 40% when comparing Ex-Post to Program Data Ex-Ante values.

Table 10-5 UHVAC Retrospective Evaluation Results by Equipment and Fiscal Year

Fiscal Year	Measure Category	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
16/17	AC	918,656	593,982	65%	422.65	118.97	28%
	HP	341,970	221,110	65%	157.33	32.05	20%
	VRF	8,722,173	5,639,558	65%	4,012.80	906.47	23%
	Not Id.	391,732	272,547	70%	180.22	29.56	16%
17/18	AC	719,597	478,409	66%	330.08	157.14	48%
	HP	286,884	190,729	66%	131.59	45.20	34%
	VRF	8,069,259	5,364,679	66%	3,701.33	1,336.33	36%
18/19	AC	2,036,649	1,312,938	64%	710.13	356.91	50%
	HP	316,260	203,879	64%	110.27	55.42	50%
	VRF	6,678,614	4,305,408	64%	2,328.68	1,170.38	50%
19/20	AC	2,228,729	1,154,165	52%	1,052.20	544.89	52%
	HP	951,745	492,869	52%	449.33	232.69	52%
	VRF	7,389,583	3,826,755	52%	3,488.69	1,806.64	52%
Total		39,051,852	24,057,028	62%	17,075.31	6,792.65	40%

The Evaluator determined that the use of DEER workpapers was the most relevant source of energy savings algorithms for the UHVAC program. When applying applicable workpaper assumptions, the Evaluator found discrepancies compared to Ex-Ante energy savings estimates. These discrepancies may be the result of variation in selection of equipment specifications, facility type, and installation type (replace on burnout or early retirement).

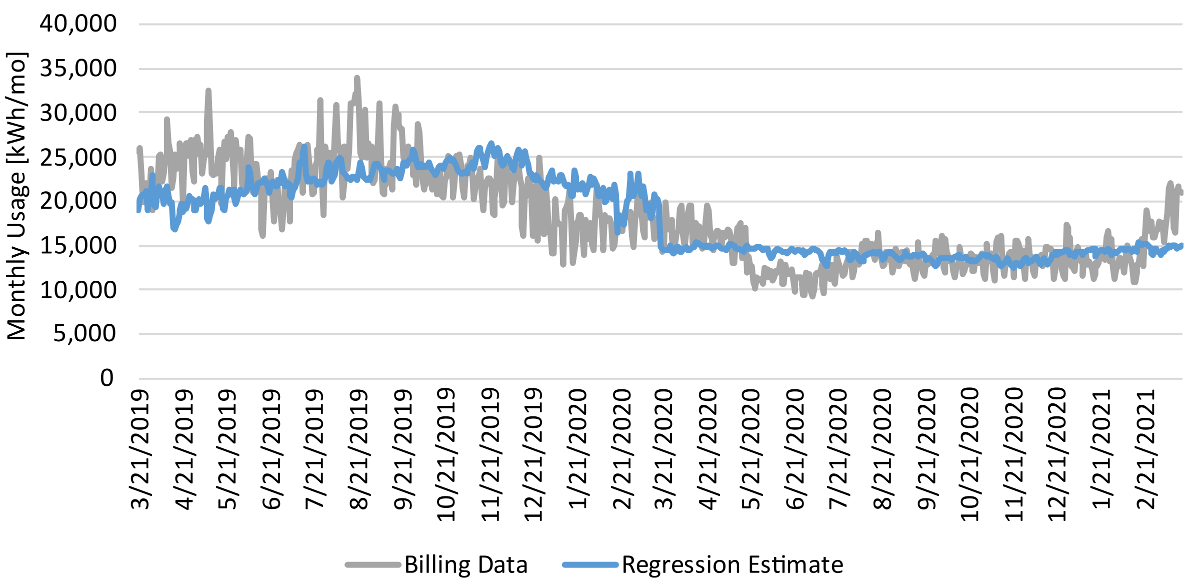
10.5.1 COVID-19 Impacts on Energy Use

During the pandemic, advice was provided by government and trade organizations to increase supply air ratios at businesses. At the same time, businesses were instructed to close their doors to customers and in some instances shut down all operations. It was expected that the influence of the pandemic would have mixed results on energy consumption based on the facility type.

The Evaluator performed a regression analysis on aggregated consumption data for sampled sites with relevant billing data and reduced impact from the installation of program energy efficiency measures. The result was an aggregation of billing data from five sites that includes a hotel, small industrial facility, primary school, small office (unitary AC), and small office (HP). The linear regression model accounted for cooling degree days (CDD), heating degree days (HDD) and a binary value to represent the start of COVID-19 impacts set on March 20th, 2020. Billing data was considered for twelve months prior to March 20th, 2020, and twelve months post.

The regression model predicted an overall reduction in consumption of 37% across these facilities with somewhat reliable predictability (r2 = 0.70). The model's consumption estimates compared to billing data is shown in Figure 10-2.

Figure 10-2 COVID-19 Billing Regression Estimate



While the regression results were a prediction of whole building consumption, the overall reduction indicated a reduction in consumption from mechanical systems, whether set point changes or turned off entirely. Reduced operation most likely also resulted in a reduction in lighting and plug load consumption. This could be estimated to account for roughly 15%-20% of a facilities usage. Therefore, the expected impact on mechanical systems was likely a 20% - 25% reduction in run time, or EFLH. A similar reduction in energy savings for newly installed measures is reasonable to assume. This would equate to an approximate reduction in Ex-Post annual energy savings of 1,368,447 kWh to 1,094,758 kWh.

Table 10-6 UHVAC COVID-19 Era Impact on Ex-Post Gross Energy Savings

Measure Category	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
AC	1,154,165	865,624	-288,541	-25.0%
HP	492,869	369,652	-123,217	-25.0%
VRF	3,826,755	2,870,068	-956,687	-25.0%
Total	5,473,789	4,105,344	-1,368,445	-25.0%

11 Consumer Rebate Program

This chapter presents the evaluation of the Consumer Rebate Program (CRP) that LADWP offered customers during fiscal years (FY) 15/16 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to CRP.

11.1 Program Recommendations

The Evaluator offers the following recommendations for the UHVAC program:

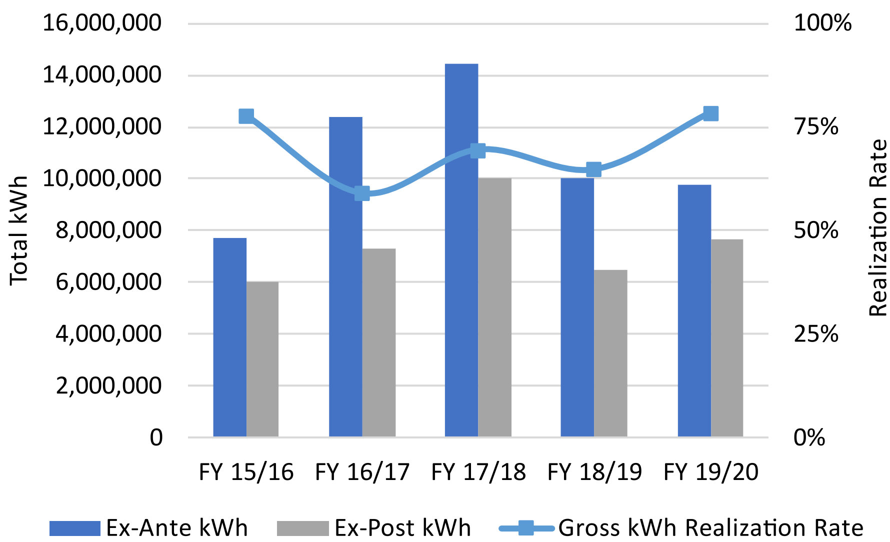
- While the Evaluator found varying EFLH based on energy simulations from DEER workpapers, The Evaluator recommends continuing to use the DEER workpaper EFLH for consistency in the continued use of DEER workpaper derived energy savings rates.
- Attention should be paid to the proper selection of installed equipment type and efficiency within the DEER workpapers such that the proper energy savings rate is applied.
- Ex-Ante energy savings rates should be reviewed for consistency with the appropriate DEER workpapers.
- The program remains to see large participation with VRF equipment. The DEER workpapers for VRF systems do not include a wide range of facility types to apply accurate energy savings rates. The workpapers state that additional energy simulations for VRF systems are available upon request but the Evaluator has so far been unable to acquire these models. Acquisition of these energy models may support accurate energy savings estimates for future participants.

- The evaluation sample included three measure line items for VRF systems in a multifamily high-rise. The Evaluator found a 67% realization rate using the provided energy simulation model. The Evaluator suggests a pre-evaluation review by the Evaluator of any measure items requiring energy simulation development or custom algorithm during the Concurrent Period evaluation.

11.2 Program Performance Summary

The CRP provides prescriptive incentives for a range of residential home energy improvements, including attic insulation, pool pumps, heating and cooling system replacement, cool roofs, dual pane windows, and appliances. Figure 11-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 11-1 Consumer Rebate Program Performance Summary



11.2.1 Key Evaluation Takeaways

- Savings were estimated using billing analysis for high-impact measures (HVAC, attic insulation, cool roofs, pool pumps) and deemed savings documentation review for low impact measures.
- Overall realization was 69%. Realization was 70% for Certified Install Pool Pumps and 265% for Self-Install Pool Pumps. There was no incremental increase in energy savings for certified installations vs. self-installations.
- Central ACs (34.8%), heat pumps (34.9%), and cool roofs (22.6%) had low realization. Cool roofs savings should be revised to:
    - 132 kWh per square foot
    - .00007 kW per square foot.

11.3 Program Description

The Consumer Rebate Program (CRP) is available to LADWP residential customers and provides both education and financial rebates for the purchase and installation of energy efficient products in the home. The following table lists the number of completed applications per program year and the Energy Savings Platform, Inc. (ESP) Ex-Ante energy savings for the program during the Retrospective Period. A completed application may have more than one energy saving measure implemented.

Table 11-1 CRP Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Applications	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
15/16	6,296	7,728,498	14.2%	3,273.83	12.5%
16/17	7,525	12,396,015	22.8%	5,699.80	21.7%
17/18	9,243	14,435,156	26.6%	6,435.45	24.5%
18/19	7,852	10,021,414	18.4%	4,759.27	18.1%
19/20	20,164	9,749,747	17.9%	6,060.11	23.1%
Total	51,080	54,330,829	100.0%	26,228.45	100.0%

The program offers the measures, listed in Table 11-2, by submission of a printed or online application. Additional documents may be required such as product label data, invoices, and building permits to complete the rebate.

Table 11-2 CRP Program Products with Rebates

Measure Category	Measures	Rebate
Attic Insulation	Attic insulating material	\$1/SF
Central Air Conditioner	SEER ≥15; SEER ≥16	\$100 - \$120/ton
Central Heat Pump	HSPF≥8.5; SEER ≥15	\$100/ton
Variable Speed/Flow Pool Pump and Motor	CRP pool pump Certified install pool pump	\$500/unit \$1,000/unit
Cool Roof	Roof material or coating meeting Solar Reflective Index	\$0.20 - \$0.30/SF
Dual Pane Windows	Windows and skylights	\$2/SF
Whole House Fan	Permanent installation of whole house ventilation fan	\$200/unit
Refrigerator	ENERGY STAR refrigerator/freezer	\$65/unit
Room Air Conditioner	ENERGY STAR room air conditioner	\$50/unit

*Attic insulation offered FY 18/19 & FY 19/20; Refrigerator & Room Air Conditioner Offered FY 15/16 and FY 16/17

11.4 Methodology

The gross energy savings were determined by billing analysis or TRM-based savings algorithms for the measures listed in Table 11-3. The ISR was determined by both field site visits and completed participant surveys.

Table 11-3 CRP Evaluation Methodology by Measure

Measure	Savings Calculation Method	Site Visits	Completed Participant Surveys
Attic Insulation	Billing Analysis	4	136
Cool Roof	Billing Analysis	-	37
HVAC	Billing Analysis	4	13
Variable Speed Pool Pump/Motor	Billing Analysis	17	97
ENERGY STAR Windows	Engineering Calculation	-	1
Whole House Fan	Engineering Calculation	-	0

A detailed description for the evaluation methodology for the CRP is available in Section A.10.1.

11.5 Impact Evaluation

Energy savings for attic insulation, central air conditioner, central heat pump, cool roof and pool pumps were determined by billing analysis. The energy savings for dual pane windows were calculated by the CMUA measure, “Energy Efficient Measures”, and the whole house fan savings by the Database for Energy Efficiency Resources (DEER) measure, “Whole House Fan, Residential”. A detailed impact evaluation is available in Appendix A, section A.10.2.

11.6 Ex-Post Gross Results and Findings

The ISR was determined from the participant survey and applied to the Ex-Post gross savings for the measures in the following table. The ISR was also determined for the measures with billing analysis calculated savings, but not applied to the savings, as the value is inherent to the analysis method; see Table 11-4 and Table 11-5.

Table 11-4 CRP Program In-Service Rates

Operating Condition	Dual Pane Windows	Refrigerator	Room AC	Whole House Fan
Installed	100%	97%	100%	100%
Removed/NW	0%	3%	0%	0%
Responses	2	38	4	1

Table 11-5 CRP Program In-Service Rates - Not Applied

Operating Condition	Attic Insulation	Central HVAC	Cool Roof	Pool Pump
Installed	100%	100%	100%	98%
Removed/not work	0%	0%	0%	2%
Responses	10	27	40	90

Table 11-6 shows the share of ROB compared to ER measures. The values show that almost all measures were replaced at the end of their useful life.

Table 11-6 CRP Retrospective ROB vs ER by Measure

Measure	Replace on Burnout Percentage of Projects	Early Replacement Percentage of Projects
Central HVAC	96.0%	4.0%
Whole House Fan	100.0%	0.0%
Refrigerator	100.0%	0.0%
Room AC	100.0%	0.0%

Table 11-7 lists the energy savings and peak demand reduction per verified unit, for the Retrospective Period. The values presented are aggregated from all the variable types, including home type, climate zone, replacement type, size of unit, efficiency of unit.

The pool pump and motor measure only considered one measure per pump, per home.

The ISR from the participant survey is indicated in the following tables with energy data. The ISR was not applied to the Ex-Post savings for measures evaluated with billing analysis, where the ISR value is already inherently included.

Table 11-7 CRP Retrospective Summary Ex-Post Per-unit Energy Savings

Measure (Units)	ISR	Per-unit Ex-Post kWh Savings	Per-unit Ex-Post Peak kW Savings
Attic Insulation (home)	1.00	227	0.27
Central Air Conditioner (Unit)	1.00	220	0.26
Central Heat Pump (Unit)	1.00	202	0.18
Cool Roof (Roof)	1.00	167	0.19
Dual Pane Windows (SF)	1.00	4	0.01
Pool Pump (Pump & Motor)	1.00	1,867	0.19
Certified Install Pool Pump	1.00	1,154	0.16
Refrigerator (Appliance)	0.97	64	0.01
Room Air Conditioner (RAC)	1.00	40	0.03

Measure (Units)	ISR	Per-unit Ex-Post kWh Savings	Per-unit Ex-Post Peak kW Savings
Whole House Fan (Fan)	1.00	341	0.78

For FY 15/16, the Ex-Post energy savings were 78% of the Ex-Ante energy savings. The primary contributor to a low realization rate is the CRP Pool Pump measure discussed in Section A.10.2.1.1.

Table 11-8 CRP FY 15/16 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
Central Air Conditioner	218	1.00	84,832	47,986	57%
Central Heat Pump	5	1.00	3,385	1,012	30%
Cool Roof	1,069,180	1.00	496,830	58,032	12%
Dual Pane Windows	29,403	1.00	13,762	120,152	873%
CRP Pool Pump	421	1.00	2,851,477	580,529	20%
Certified Install Pool Pump	3,696	1.00	4,084,751	5,107,212	125%
Refrigerator	1,273	0.97	153,477	81,034	53%
Room Air Conditioner	315	1.00	37,446	12,739	34%
Whole House Fan	4	1.00	2,539	1,287	51%
Total			7,728,498	6,009,984	78%

For FY 16/17, the Ex-Post energy savings were 59% of the Ex-Ante energy savings. The primary contributor to a low realization rate is the CRP Pool Pump discussed in Section A.10.2.1.1. The secondary contributor to a low realization rate was the Cool Roof measure, discussed previously in Section A.10.2.1.3.

Table 11-9 CRP FY 16/17 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
Central Air Conditioner	465	1.00	771,696	102,356	13%
Central Heat Pump	42	1.00	48,760	8,505	17%
Cool Roof	2,012,825	1.00	1,593,306	105,361	7%
Dual Pane Windows	31,260	1.00	15,228	124,610	818%
CRP Pool Pump	487	1.00	4,022,200	1,020,622	25%
Certified Install Pool Pump	5,439	1.00	5,890,696	5,930,686	101%
Refrigerator	372	0.97	44,696	23,413	52%
Room Air Conditioner	62	1.00	8,162	2,332	29%

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
Whole House Fan	3	1.00	1,272	1,124	88%
Total			12,396,015	7,319,008	59%

For the FY 17/18, the Ex-Post energy savings were 70% of the Ex-Ante energy savings. The primary contributor to a low realization rate was the CRP Pool Pump measure discussed in Section A.10.2.1.1. The secondary contributor to a low realization rate was the Cool Roof measure, discussed in Section A.10.2.1.3.

Table 11-10 CRP FY 17/18 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
Central Air Conditioner	660	1.00	242,238	145,279	60%
Central Heat Pump	42	1.00	17,808	8,505	48%
Cool Roof	2,842,790	1.00	1,952,997	153,861	8%
Dual Pane Windows	37,571	1.00	16,531	146,264	885%
CRP Pool Pump	513	1.00	4,899,050	1,129,603	23%
Certified Install Pool Pump	7,050	1.00	7,304,836	8,450,055	116%
Refrigerator	6	0.97	-	404	>100%
Room Air Conditioner	1	1.00	-	44	>100%
Whole House Fan	4	1.00	1,696	1,142	67%
Total			14,435,156	10,035,157	70%

For FY 18/19, the Ex-Post energy savings were 65% of the Ex-Ante energy savings. The primary contributor to a low realization rate was the CRP Pool Pump measure discussed in Section A.10.2.1.1. The secondary contributor to the low realization rate was the Cool Roof measure, discussed in Section A.10.2.1.3.

Table 11-11 CRP FY 18/19 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
Attic Insulation	2,210,056	1.00	418,613	342,556	82%
Central Air Conditioner	364	1.00	133,952	80,124	60%
Central Heat Pump	26	1.00	11,024	5,265	48%

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
Cool Roof	1,741,980	1.00	766,471	103,187	13%
Dual Pane Windows	23,077	1.00	10,154	93,750	923%
CRP Pool Pump	5,308	1.00	3,450,200	468,928	14%
Certified Install Pool Pump	5,048	1.00	5,229,728	5,396,312	103%
Whole House Fan	3	1.00	1,272	889	70%
Total			10,021,414	6,491,010	65%

For FY 19/20, the Ex-Post energy savings were 78% of the Ex-Ante energy savings. The primary contributor to a low realization rate was the CRP Pool Pump measure discussed in Section A.10.2.1.1. The secondary contributor to a low realization rate was the Cool Roof measure, discussed in Section A.10.2.1.3.

Table 11-12 CRP FY 19/20 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
Attic Insulation	21,167,655	1.00	3,245,185	3,567,441	110%
Central Air Conditioner	378	1.00	139,104	83,205	60%
Central Heat Pump	47	1.00	19,928	9,517	48%
Cool Roof	2,280,680	1.00	1,003,499	122,754	12%
Dual Pane Windows	80,488	1.00	35,415	334,283	944%
CRP Pool Pump	220	1.00	2,132,000	370,852	17%
Certified Install Pool Pump	3,061	1.00	3,172,496	3,158,647	100%
Whole House Fan	5	1.00	2,120	2,043	96%
Total			9,749,747	7,648,742	78%

Table 11-13 through Table 11-17 show summary measure-level peak demand reduction for CRP. The ISR obtained from the participant survey was not applied to the Ex-Post savings for measures evaluated through a billing analysis, where the ISR value is already inherently included.

Table 11-13 CRP FY 15/16 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Savings	Gross Realization Rate
Central Air Conditioner	218	1.00	88.52	64.51	73%

Measure	Quantity	ISR	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Savings	Gross Realization Rate
Central Heat Pump	5	1.00	3.19	1.36	43%
Certified Install Pool Pump	3,696	1.00	1,719.06	856.45	50%
Cool Roof	1,069,180	1.00	903.33	78.01	9%
CRP Pool Pump	4,109	1.00	456.24	97.35	21%
Dual Pane Skylights & Windows	29,043	1.00	25.02	161.52	646%
Refrigerator	1,273	0.97	21.95	13.59	62%
Room Air Conditioner	315	1.00	56.52	17.12	30%
Whole House Fan	4	1.00	-	1.73	>100%
Total			3,273.83	1,291.64	40%

Table 11-14 CRP FY 16/17 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Savings	Gross Realization Rate
Central Air Conditioner	465	1.00	805.25	55.64	7%
Central Heat Pump	42	1.00	46.00	4.62	10%
Certified Install Pool Pump	5,439	1.00	2,479.10	1,421.56	57%
Cool Roof	2,012,825	1.00	1,677.16	57.28	3%
CRP Pool Pump	5,905	1.00	643.55	244.64	38%
Dual Pane Skylights & Windows	31,260	1.00	27.69	67.74	245%
Refrigerator	372	0.97	6.39	5.61	88%
Room Air Conditioner	62	1.00	12.32	1.27	10%
Whole House Fan	3	1.00	2.34	0.61	26%
Total			5,699.80	1,858.98	33%

Table 11-15 CRP FY 17/18 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Savings	Gross Realization Rate
Central Air Conditioner	660	1.00	253.15	193.24	76%
Central Heat Pump	42	1.00	16.80	8.61	51%
Certified Install Pool Pump	7,050	1.00	3,074.24	1,648.96	54%
Cool Roof	2,842,790	1.00	2,274.23	204.65	9%
CRP Pool Pump	7,536	1.00	783.85	220.43	28%
Dual Pane Skylights & Windows	37,571	1.00	30.06	38.13	127%

Measure	Quantity	ISR	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Savings	Gross Realization Rate
Refrigerator	6	0.97	-	0.04	>100%
Room Air Conditioner	1	1.00	-	0.04	>100%
Whole House Fan	4	1.00	3.12	1.52	49%
Total			6,435.45	2,315.62	36%

Table 11-16 CRP FY 18/19 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Savings	Gross Realization Rate
Attic Insulation	2,210,056	1.00	441.74	407.55	92%
Central Air Conditioner	364	1.00	139.78	95.43	68%
Central Heat Pump	26	1.00	10.40	6.27	60%
Certified Install Pool Pump	5,048	1.00	2,200.93	1,310.20	60%
Cool Roof	1,741,980	1.00	1,393.58	122.90	9%
CRP Pool Pump	5,308	1.00	552.03	113.85	21%
Dual Pane Skylights & Windows	23,077	1.00	18.46	111.66	605%
Whole House Fan	3	1.00	2.34	1.06	45%
Total			4,759.27	2,168.94	46%

Table 11-17 CRP FY 19/20 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Savings	Gross Realization Rate
Attic Insulation	21,167,655	1.00	3,894.05	4,280.74	106%
Central Air Conditioner	378	1.00	167.26	100.05	60%
Central Heat Pump	47	1.00	18.24	8.71	48%
Certified Install Pool Pump	3,061	1.00	437.15	435.24	12%
Cool Roof	2,280,680	1.00	1,206.64	147.60	1130%
CRP Pool Pump	3,282	1.00	293.77	51.10	17%
Dual Pane Skylights & Windows	80,488	1.00	42.58	401.95	100%
Whole House Fan	5	1.00	0.41	0.40	267%
Total			6,060.11	5,425.79	90%

11.6.1 Gross Realization Rate by Measure

Figure 11-2 presents the energy realization rate by measure for each fiscal year. Note that Dual Pane Windows, has a value exceeding the Y-axis and therefore is not fully depicted in the figure. Although there is some variation in the per unit savings between fiscal years for measures evaluated through billing analysis, the realization rate for energy savings was similar for each measure, each year.

Figure 11-2 Gross Realization Rate by Measure and Fiscal Year

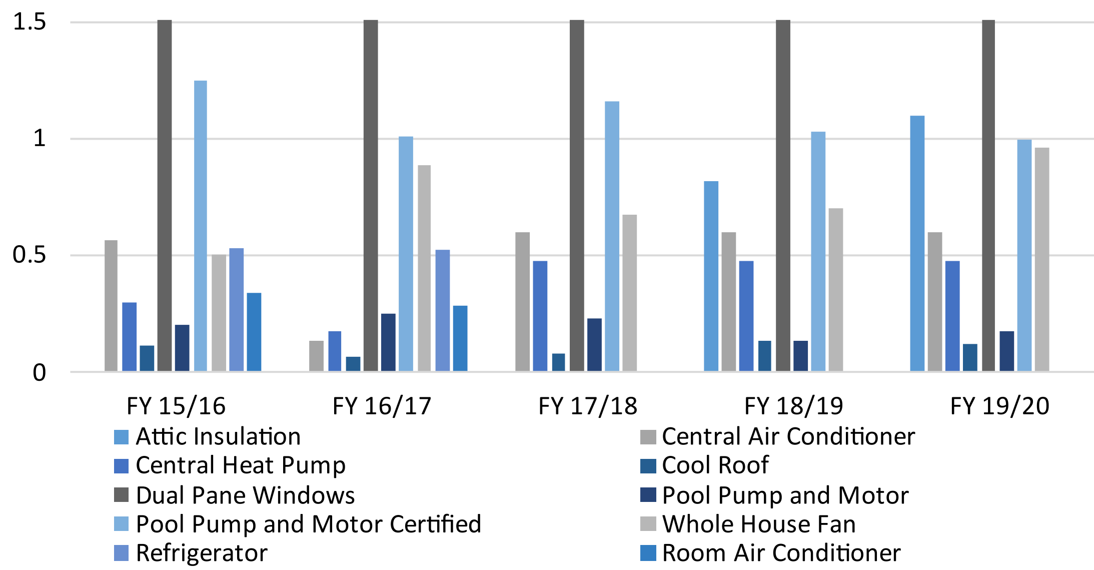
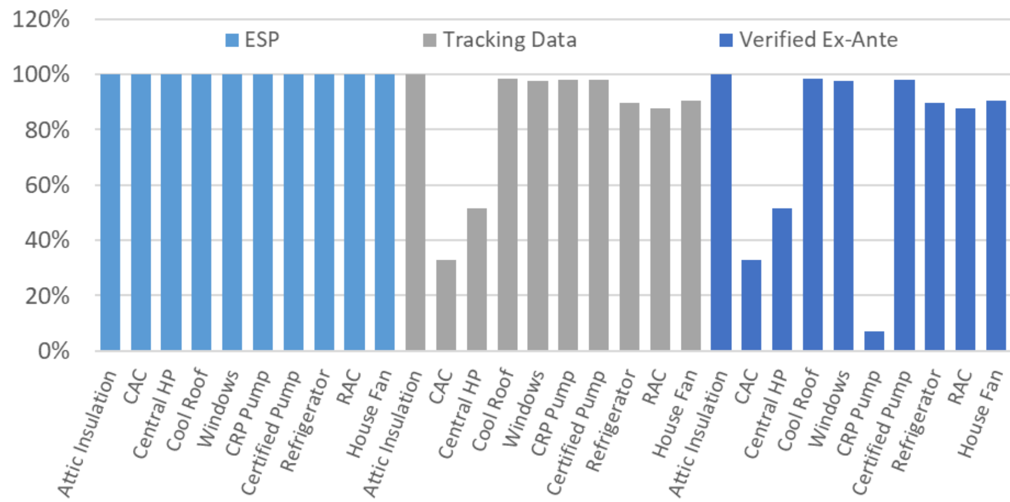


Figure 11-3 depicts only the unit quantity contribution to the difference in realization rates. The values are indicated as a percentage (i.e., the quantity of units for the category divided by the quantity of units in the ESP category). The only change from the Tracking Data quantity to the Verified Ex-Ante was to not double count pool pumps that received both the CRP Pool Pump and the Certified Pool Pump measure with Ex-Ante savings, as the billing analysis considered the pump and motor installation only.

Figure 11-3 Measure Unit Quantity Comparison by Database



11.6.2 COVID-19 Impacts on Energy Use

As part of this analysis, the Evaluator estimated the impact of COVID-19 on Gross Ex-Post savings. This analysis largely follows the method detailed in A.10.1.5 in which measures were assessed either using a billing data regression or billing data retrofit isolation approach, with additional considerations made for measures that had initially been assessed using engineering calculations.

The COVID-19 impacts for Pool Pump and Motors, as with the first-year impact analysis, used a billing data regression approach. The approach differs from the method detailed in A.10.1.5 in the following ways:

- To estimate the impact of COVID-19, program participants were combined across all program years by measure to provide greater statistical precision. The pool of participants was then isolated to participants with installation dates prior to March 1, 2019, to allow for a full year of typical year post installation data.
- The billing data regression model was modified to include post-data from January 1, 2019, through December 31, 2020, to allow for a direct comparison of the most recent typical year vs. the COVID-19 period. Additional dummy variables associated with COVID-19 were added to the regression model, with COVID-19 being defined as the period after March 1, 2020.

The COVID-19 impacts for measures that leveraged a billing data retrofit isolation approach including Attic Insulation, Central Air Conditioner, Central Heat Pump, and Cool Roof used the following approach to estimate COVID-19 adjusted savings:

- As with the billing data regression analysis, billing data retrofit isolation measures had their program participants combined across all program years by measure.

The pool of participants was isolated to participants with installation dates prior to March 1, 2019, to allow for a full year of typical year post installation data.

- Unlike the billing data regression approach, which compares the consumption of program participants to program non-participants and comparisons can be drawn directly in the period during the COVID-19 pandemic; the billing data retrofit isolation approach compares a customer's post-installation consumption to their historical consumption as a way of triangulating the energy savings. However, this pre/post comparison is predicated on the concept that other household factors remain largely unchanged, such as household occupancy. Therefore, a comparison of the period from March 2020 onward to a customer's pre-installation period may inadvertently understate the savings associated with energy-efficient equipment compared to baseline equipment as, in many cases, the hours of operation substantially increased from March 2020 onward. Thus, rather than compare the pre-installation period to post-March 2020 period, the Evaluator reviewed the change in energy consumption from a typical post-installation period (i.e., the period of March 2019 to February 2020) to the COVID-19 impacted period (March 2020 – onward) by end-use. The Evaluator thus assumed that any proportionate change in the energy consumption by end use could be applied to the typical year savings to estimate how savings would proportionately change. It is important to note that although the Evaluator hypothesizes that most end uses will have increased usage during COVID as a function of increased household occupancy, it is feasible that either a null change between the typical period and COVID-19 period or a reduction in operational use during the COVID-19 period as a means to reduce energy costs may be observed.
- As with the savings impact analysis, the method largely follows the method described in A.10.1.5 with regards to billing data preparation, weather normalization, and isolation of weather-dependent load vs. non-weather dependent load. However, rather than splitting the period into the 12 months of pre/post, these operations were performed on the typical post-installation period (March 2019 to February 2020) and the COVID-19 impacted period (March 2020 – onward).
- This resulted in the isolation of heating, cooling, and base (non-HVAC) load for the typical post and COVID-19 impacted periods. For each measure, the Evaluator isolated a COVID-19 era multiplier by using the relevant end-use consumption and the following equation:

$$COVID-19\ Era\ Multiplier_{end-use} = kWh_{COVID-19,end-use}/kWh_{typical,end-use}$$

Equation 11-1

- The Evaluator then multiplied the typical year savings by the COVID-19 era multiplier to estimate the COVID-19 adjusted savings.

Impact evaluation for several measures initially leveraged an engineering calculation. This was done primarily due to the number of installations not reaching a level at which a billing data analysis could return statistically viable results. Therefore, the COVID-19 impact analysis could not rely directly on customer billing data. The Evaluator therefore decided to compare, by end-use, how non-participating customers energy consumption changed between a typical year (March 2019 to February 2020) and the COVID-19 impacted period (March 2020 – onward). The proportionate changes by end-use for a non-participating home were thereby assumed to reflect the proportionate change in energy savings for measures evaluated via engineering calculation. The approach used by the Evaluator is described as follows:

- The method largely follows the COVID-19 era multiplier generation method developed for billing data retrofit isolation measures.
- Rather than isolating a typical post-installation year v. COVID-19 impacted installation period, an installation date had no bearing on the non-participant customers and thus the periods of consideration were simply a typical year (March 2019 to February 2020) to the COVID-19 impacted period (February 2020 – onward).
- The method largely follows the method described in A.10.1.5 with regards to billing data preparation, weather normalization, and isolation of weather-dependent load v. non-weather dependent load. However, rather than splitting the period into the 12 months of pre/post, these operations were performed on the typical period (March 2019 to February 2020) and the COVID-19 impacted period (March 2020 – onward).
- This resulted in the isolation of heating, cooling, and base (non-HVAC) load for the typical period and COVID-19 impacted periods. The formula used to generate a COVID-19 era multiplier is described in Equation 11-1.
- The Evaluator then multiplied the typical year savings by the COVID-19 era multiplier depending on the relevant end-use to estimate the COVID-19 adjusted savings.

Table 11-18 and Table 11-19 present the typical first year Gross Ex-Post savings and COVID-19 adjusted Gross Ex-Post savings. For interpretation purposes, the COVID-19 savings are presented as a full 12-month annual adjusted savings.

Table 11-18 CRP COVID-19 Era Impact to Ex-Post Gross Energy Savings

Billing Analysis Measures	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
Attic Insulation	3,567,441	4,327,306	759,865	21.3%
Central Air Conditioner	83,205	79,794	-3,411	-4.1%
Central Heat Pump	9,517	8,660	-857	-9.0%
Cool Roof	122,754	129,015	6,260	5.1%
Pool Pump and Motor	3,529,498	3,529,498	0	0.0%
Total	7,312,416	8,074,274	761,858	10.4%

Table 11-19 CRP COVID-19 Era Impact to Ex-Post Gross Energy Savings

Algorithmic Savings Measures	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Multiplier (B)	COVID-19 Era Savings (A*B=C)	COVID-19 Era Incremental Change Ex-Post kWh Savings (C-A)
Dual Pane Windows	334,283	1.075	359,247	24,964
Whole House Fan	2,043	1.078	2,201	158
Total	336,326		361,448	25,122

11.7 Program Recommendations

The Evaluator recommends that all program measures utilize application attribute data to characterize the appropriate fields in the tracking data, and to utilize these fields as inputs into energy and peak demand impact algorithms to better estimate savings.

The following sections will provide additional perspective and specific recommendations.

11.7.1 Variable Speed and Flow Pool Pumps and Motors

Although a comparison between the energy savings of the CRP Pool Pump (1,430 kWh to 2,252 kWh) and Certified Pool Pump (1,055 kWh to 1,433 kWh) has uncertainty due to the difference in sample size and resulting precision level, the Certified Pool Pump savings did not have an incremental increase in energy savings from the CRP Pool Pump. Some CPPR program participants did indicate the pump ran during the daytime peak demand period, but the survey did not discern whether the certified contractor set up only night operating schedules or the homeowner adjusted the schedule.

The method of providing either the “Part A” only incentive or the “Part A” with the CPPR program did not affect the Ex-Post savings methodology, as the method used was based on the billing data of one home representing one variable speed motor and pool pump. The Evaluator recommends narrowing the incremental increase in energy savings from the CRP to the Certified pool pump measures, as the billing analysis did not support the additional energy savings.

Code Changes

New Department of Energy Regulations effective July 19, 2021, mandated variable speed pumps for inground, self-priming pumps with a HHP (hydraulic horsepower) between 0.711 and 2.5. This range generally includes pumps with THP (total horsepower) ratings between 1.2 and 5.0.

The Evaluator recommends adding the existing pool pump/motor manufactured date and purchase date to the CRP application, along with its operating condition (working, not working, not working but repairable with cost data). This data establishes the equipment age and replacement type, to estimate savings for any remaining useful life.

The baseline for Normal Replacements and the period after the RUL for Early Replacements is a variable speed pool pump/motor, with four or more discrete operating speeds. The Evaluator recommends updating the CPPR application addendum, section Variable Speed Pump Controller Settings to capture the new controller settings in bins that align with the Prescriptive Requirements in the “Energy Conservation Program Standards for Dedicated-Purpose Pool Pump Motors”. The evaluator will consider the scheduling that exceeds the default pump schedule of equal hours for above 55% of full speed and below 55% of full speed.

Table 11-20 CRP Recommended Pool Pump Data Collection

Speed (% of full speed)		Start Time	End Time
85	100	Time; AM/PM	Time; AM/PM
56	85	Time; AM/PM	Time; AM/PM
41	55	Time; AM/PM	Time; AM/PM
0	40	Time; AM/PM	Time; AM/PM

11.7.2 Room Air Conditioners

Room Air Conditioners are not currently offered in the CRP program. If the measure is reinstated, The Evaluator recommends collecting the CEER efficiency, Cooling Capacity and zip code to inform the climate zone and binning each participant to the appropriate Room Air Conditioner measure.

11.7.3 Whole House Fan

Since changes in product CFM and home air volume is one of the factors used to aggregate the energy savings bins, the collection of the home size (or affected area size) and the fan maximum air flow rating would both better estimate the Ex-Ante energy savings and inform the customer of expected air flow for cooling in the evening.

The Evaluator recommends binning each participant’s application data to the appropriate Whole House Fan measure based or product CFM and home air volume, motor type (PSC, ECM) and climate zone.

11.7.4 Dual Pane Windows

The Ex-Ante deemed savings per square foot of window area underestimates the energy savings. The Evaluator recommends providing additional window product data with U-factor and SHGC in the tracking data along with the existing Manufacturer Name data. The Evaluator recommends obtaining basic data of the existing windows (single pane, double/triple pane) to select the appropriate deemed savings method for savings per square foot and climate zone.

11.7.5 Central HVAC

The Evaluator recommends updating application guidelines to specify the AHRI sheet to be inclusive of the system, and not just components to obtain the more accurate energy efficiency ratings. The Evaluator recommends utilizing the SEER and HSPF values in the savings estimate, particularly for those units that exceed the entry point SEER of 15 for central air conditioner and heat pump.

11.7.6 Attic Insulation

The existing measure bins (uninsulated, insulated) currently provide more granularity than the baseline cases. The Evaluator recommends including the R-38 base case bin from the CA eTRM. The Evaluator recommends migrating from the single deemed savings per installed square feet of insulation to savings aligned with the baseline case and measure case by climate zone.

11.7.7 Cool Roof

The Evaluator recommends reviewing the cost effectiveness of the “meets code” SRI roof replacement compared to the “beyond code” SRI roof replacement values, as the likelihood of free ridership is high for participants in the City of Los Angeles where Cool Roof rated materials are required for roof replacements of 50% or more of the roof surface area.

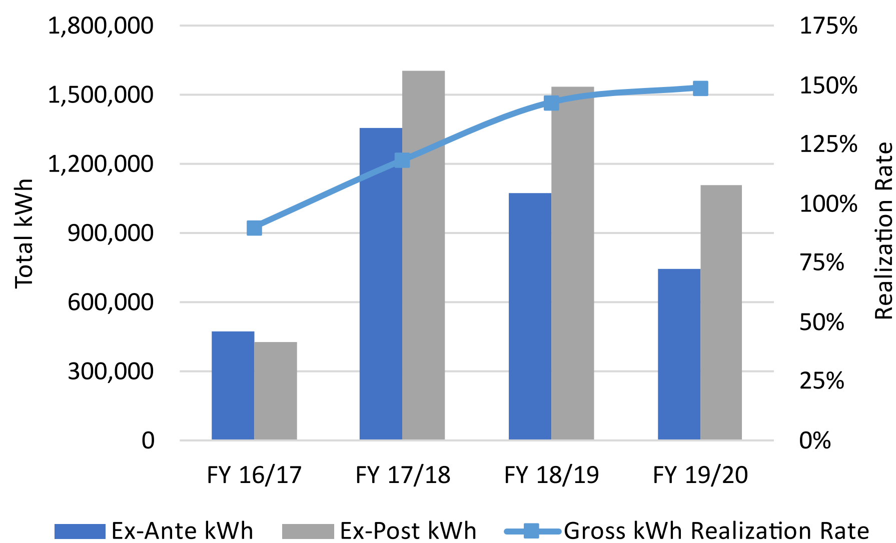
12 Efficient Product Marketplace

This chapter presents an evaluation of the Efficient Product Marketplace (EPM) that LADWP offered customers during fiscal years (FY) 16/17 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to EPM.

12.1 Program Performance Summary

EPM is an online marketplace for residential customers, offering efficient options including lighting, smart thermostats, advanced power strips, refrigerators, clothes washers, televisions, and room air conditioners. Figure 12-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 12-1 Efficient Product Marketplace Program Performance Summary



12.1.1 Key Evaluation Takeaways

- The program was successful, achieving 128% gross realization. Savings in FY18/19 were not aligned with Energy Savings Platform, Inc. (ESP) filed numbers - significant amounts of thermostats were missing or misclassified.
- Increased lighting standards will erode program savings to a very slight degree, due to more than 99% of EPM kWh savings coming from non-lighting measures.
- LADWP collected application data that would support more individualized savings calculations if tracking systems were programmed to do so.

12.2 Program Description

The EPM was relaunched in early 2016 on the Internet platform by the Enervee Corporation. This website was described in the LADWP press release, as “a website that points customers to vendors and retailers that sell energy-efficient products and that also allows customers to submit their receipts directly online for LADWP rebates to easily maximize their pocketbook savings as well as their in-home energy savings”. LADWP is one of fourteen utilities that offer energy efficient and ENERGY STAR certified products either directly through the website or rebated after a retail purchase. This chapter reports on the impact of those products on the websites that offer rebates.

Table 12-1 summarizes the number of products that received rebates during each fiscal year. The “ESP Ex-Ante kWh Savings”, “Peak kW savings” and “Number of Products” datasets were extracted from the ESP database, a cloud based IT platform. The ESP data was formatted as aggregated measure level data by program year.

Table 12-1 EPM Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Products	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
16/17	3,165	475,436	13.0%	70.09	3.7%
17/18	7,125	1,359,050	37.2%	77.16	4.0%
18/19	6,993	1,077,516	29.5%	994.38	52.1%
19/20	5,584	744,640	20.4%	765.22	40.1%
Total	22,867	3,656,642	100.0%	1,907	100.0%

The aggregated data from the previous table is the result of the program promoting energy efficient products on the LADWP Marketplace website. The site presents product offerings from both big box retailers and online websites, along with an energy efficiency store. Table 12-2 lists the product groups that have available rebates from EPM.

Table 12-2 EPM Measure Rebates

Measure Category	Measures	Rebate
Thermostat	Smart Thermostat Web Enabled Programmable Thermostat	$75 $50
Light Bulb	LED A-Lamp LED Decorative LED Candelabra LED Reflector, BR, PAR	$2.50 (single/pack)
Power Strip	Tier 1 (discontinued) Tier 2	$5 $15
Refrigerator	ENERGY STAR Refrigerator/Freezer ENERGY STAR Refrigerator/Freezer Most Efficient	$65 $75
Air Conditioner	Self-Contained Room Air Conditioner	$50
Washer*	Clothes Washer	Up to $400

*Clothes washer offered through LADWP Marketplace, but not tracked through the ESP database, with only one participant data in FY 18/19.

12.3 Methodology

The data collection activities for the EPM Program are listed in Table 12-3.

Table 12-3 EPM Data Collection

Data	Source
Program Tracking Data	Data requests to LADWP for all measure level program tracking data
Program Participant Surveys	A survey administered to a sample of program participants via email contact
Recipient and control group billing data	Data requests to LADWP for all relevant billing data in the study period
Participation in other LADWP programs	Data requests to LADWP for all residential program participation in the study period
Recipient and control group customer data	Data requests to LADWP for other customer information (e.g., demographics, contact permissions)

The savings were determined by a billing analysis or desk review based on DEER workpaper methodology, supplemented by participant survey respondent data.

Table 12-4 EPM Evaluation Methodology by Measure

Strata	Savings Calculation Method	Sample
Advanced Power Strips	Engineering Calculation	Census
ENERGY STAR Lighting	Engineering Calculation	Census
ENERGY STAR Refrigerator	Engineering Calculation	Census
ENERGY STAR Room AC	Engineering Calculation	Census
ENERGY STAR Television	Engineering Calculation	Census
Smart & Web Thermostats	Billing Analysis	Census

A detailed evaluation methodology for engineering calculations and billing analysis is available in Appendix A, section A.11.1.

12.4 Impact Evaluation

Energy savings for smart and web thermostats were determined by billing analysis. The energy savings for remaining measures were calculated using the Database for Energy Efficiency Resources (DEER).

A detailed impact evaluation is available in Appendix A, section A.11.2.

12.5 Ex-Post Gross Results and Findings

This section focuses on the causes for realization rates being above or below the expected Ex-Ante savings. Table 12-5 indicates that applying the participant survey ISRs did not have a significant effect on realized savings. The thermostat ISR is provided to understand the billing analysis savings results but was not factored by the per unit thermostat savings. The ENERGY STAR refrigerator measure had three survey responses, out of a total of 174 responses, indicating the refrigerator was broken and not repaired yielding an ISR of 98%.

Table 12-5 EPM Measure In-service Rates

Operating Condition	Room Air Conditioner	ENERGY STAR Lighting	Advanced Power Strip	ENERGY STAR Refrigerator	ENERGY STAR Television	Thermostat
Working	100%	100%	100%	98%	100%	97%
Removed/NW	0%	0%	0%	2%	0%	3%
Responses	16	16	6	174	5	268

The following tables summarize the binning of equipment replacements as either a Natural/Repair on Burnout (ROB) replacement or an Early Replacement (ER). The early replacement was defined as operating as intended with a Remaining Useful Life (RUL) less than the Equipment Useful Life (EUL).

Of the five survey responses for ENERGY STAR Televisions, the three respondents that replaced working televisions were all binned to ROB. The CRT television age exceeds the EUL, and the LED television was replaced by a “much larger” screen than the working existing television. The responses are summarized in Table 12-6.

Table 12-6 EPM ENERGY STAR Television ROB vs ER

Survey Response	Replace Existing	Existing Working	Existing Type	Screen Size	ROB/Natural or ER
1	Y	Y	CRT	Larger	ROB
2	N	N/A	N/A	Larger	ROB
3	Y	Y	LED	Much Larger	ROB
4	N	N/A	N/A	Same	ROB
5	Y	Y	CRT	Same	ROB

The participant survey results in Table 12-7 for ENERGY STAR Refrigerators identified that 50% of the193 respondents replaced a working refrigerator. Participants may also have obtained an incentive from the Refrigerator Turn in and Recycle Program. As the replaced refrigerator’s age was not known and to avoid any double counting of early replacement energy savings, all the EPM ENERGY STAR Refrigerator savings are for ROB baselines.

Table 12-7 EPM ENERGY STAR Refrigerator ROB vs ER

Survey Responses	Responses	% Responses	ROB/Natural or ER
Working	85	50%	ROB
Broken	50	30%	ROB
Additional	8	8%	ROB
Other	26	15%	ROB
Total	193	100%	ROB

The participant survey results in Table 12-8 for ENERGY STAR Room Air Conditioners identified that 39% of the 13 respondents replaced working room air conditioners. Of the three participants that could identify the age of the replaced unit, it was well past the EUL of a room air conditioner. The Ex-Post energy savings for ENERGY STAR Air Conditioners were all estimated with a ROB baseline.

Table 12-8 EPM ENERGY STAR Room Air Conditioner ROB vs ER

Survey Responses	Replace Existing	Existing Working	ROB or ER
Working	5	39%	ER
Not working	8	61%	ROB
If working, age	3	Pre 2006	ROB
Total	13	100%	ROB

The participant survey results in Table 12-9 for Smart Programmable Thermostats and Web Enabled Programmable Thermostats identified that 97% of respondents replaced existing thermostats with new ones. Of those respondents, 4% replaced Smart or Web thermostats, and would not be expected to have additional savings. As the savings method for thermostats was estimated by a billing analysis, the non-qualifying baseline is already considered in the analysis and not applied as a separate factor to the Ex-Post energy savings.

Table 12-9 EPM Smart and Web Thermostats ROB vs ER

Survey Responses	FY 16/17	FY 17/18	FY 18/19	FY 19/20	Total Responses
Replaced working	100%	91%	98%	96%	246
Programmable	67%	50%	41%	42%	102
Manual	33%	43%	57%	51%	234
Wi-Fi or Smart	0%	7%	2%	7%	14

Table 12-10 compares the Ex-Ante deemed per unit savings to the Ex-Post per unit savings for EPM. The data is more forward looking, intended to inform the concurrent period, as the lighting per unit values are post CA Title 20 Tier 2. The table data is drawn from FY 18/19 to FY 19/20 data only, as the energy savings in those fiscal years were provided in the tracking data for most measures. The Ex-Post values in the following tables do not include the ISR nor interactive factors for the measures. The ENERGY STAR lighting measure is presented in the following table with disaggregation between general service A-lamps and all other lighting, which includes globe, reflector, and candelabra lighting. The California Title 20 standard in 2018 had the largest impact on the baseline wattage for A-lamps. The Ex-ante deemed values were appropriate for A-lamps but significantly underestimated the energy savings for the remaining lamps in the program.

Table 12-10 EPM Retrospective Summary Ex-Post Per-unit Energy Savings

Measure	Average Per Unit kWh Savings	
	Ex-Ante	Ex-Post
Advanced Power Strips Tier 1	24	19
Advanced Power Strips Tier 2	212	240
ENERGY STAR Lighting: A-Lamp	1.9	1.4
ENERGY STAR Lighting: Other	1.9	15.5
ENERGY STAR Refrigerator	42	60
ENERGY STAR Ref. Most Efficient	78	57
ENERGY STAR Room Air Conditioner	29	43
ENERGY STAR Television	68	33
ENERGY STAR TV Most Efficient	86	37
Smart Programmable Thermostats	114-221	300
Web Enabled Thermostats	114-221	296

Table 12-11 summarizes the EPM program energy savings for FY 16/17. The realization rate for the program is 90% of the Ex-Ante energy savings. The largest variance was with the Smart and Web thermostats, where the Ex-Post savings were estimated by billing analysis and the Ex-Ante applied deemed savings by climate zone. The ENERGY STAR lighting measure had a high realization rate, as the Ex-Post applied the current base case logic from the Lighting Disposition papers along with the actual manufacturer product specification wattage, along with either surveyed hours of use for general service A-lamps or DEER interior hours of use for other lamps.

Table 12-11 EPM FY 16/17 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
Advanced Power Strips Tier 1	-	-	96	-	0%
Advanced Power Strips Tier 2	10	100%	1,908	2,570	135%
ENERGY STAR Lighting	712	100%	1,454	16,730	1151%
ENERGY STAR Refrigerator	1,449	100%	179,525	93,094	52%
ENERGY STAR Refrigerator Most Efficient	283	100%	65,474	18,147	28%
ENERGY STAR Room Air Conditioner	267	100%	35,588	11,705	33%
ENERGY STAR Television	202	100%	16,117	5,088	32%
ENERGY STAR TV Most Efficient	27	100%	2,413	319	13%
Smart Programmable Thermostats	888	100%*	164,260	266,274	162%
Web Enabled Thermostats	48	100%*	8,600	14,200	165%
Total	3,886		475,436	428,127	90%

*Billing analysis has inherent ISR, Survey ISR was not applied.

Table 12-12 summarizes EPM program energy savings for FY 17/18. The realization rate for the program is 118% as compared to the ESP Ex-Ante energy savings. The largest variance was with the Smart and Web Enabled thermostats, where the Ex-Post savings were estimated by billing analysis and the Ex-Ante applied deemed savings by climate zone. The ENERGY STAR lighting measure had a high realization rate, as the Ex-Post applied the current baseline case from the Lighting Disposition papers and the actual manufacturer product specification wattage, along with either surveyed hours of use for general service A-lamps or DEER interior hours of use for other lamps. The ISR obtained from survey responses is shown for Smart and Web Enabled thermostats but was not factored by the Ex-Post energy savings, as it was inherent to the billing analysis.

Table 12-12 EPM FY 17/18 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
Advanced Power Strips Tier 1	4	100%	72	83	115%
Advanced Power Strips Tier 2	18	100%	3,816	4,659	122%
ENERGY STAR Lighting	917	100%	13,680	18,470	135%
ENERGY STAR Refrigerator	1,660	100%	169,735	103,408	61%
ENERGY STAR Refrigerator Most Efficient	437	100%	92,829	29,867	32%
ENERGY STAR Room Air Conditioner	291	100%	38,543	11,473	30%
ENERGY STAR Television	213	100%	24,507	8,267	34%
ENERGY STAR TV Most Efficient	3	100%	-	183	
Smart Programmable Thermostats	4,307	94%*	983,876	1,373,351	140%
Web Enabled Thermostats	183	94%*	31,992	57,686	180%
Total	8,033		1,359,050	1,607,447	118%

*Billing analysis has inherent ISR, Survey ISR was not applied.

Table 12-13 summarizes the EPM program energy savings for FY 18/19. The realization rate for the program is 143% when compared to the ESP Ex-Ante energy savings. The largest variance was with the Smart and Web Enabled thermostats, where the Ex-Post savings were estimated by billing analysis and the Ex-Ante applied deemed savings by climate zone. The Ex-Ante measure binning method changed in FY 18/19 with all thermostat data being categorized under the Smart Programmable Thermostat group. The ENERGY STAR lighting measure had a high realization rate, as the Ex-Post applied the current baseline case from the Lighting Disposition papers and the actual manufacturer product specification wattage, along with either surveyed hours of use for general service A-lamps or DEER interior hours of use for other lamps.

Table 12-13 EPM FY 18/19 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
Advanced Power Strips Tier 1	5	100%	-	104	>100%
Advanced Power Strips Tier 2	190	100%	36,676	48,799	133%
ENERGY STAR Lighting	1,294	100%	2,350	11,060	471%
ENERGY STAR Refrigerator	1,659	97%	-	106,145	>100%
ENERGY STAR Refrigerator Most Efficient	506	98%	155,704	31,757	20%
ENERGY STAR Room Air Conditioner	353	100%	9,441	16,393	174%
ENERGY STAR Television	182	100%	12,808	8,102	63%
Smart Programmable Thermostats	3,957	94%*	-	1,262,404	>100%
Web Enabled Thermostats	168	94%*	858,445	52,952	6%
Washer & Home	-	-	2,091	0	0%
Total	8,315		1,077,516	1,537,716	143%

*Billing analysis has inherent ISR, Survey ISR was not applied.

Table 12-14 summarizes the EPM program energy savings for FY 19/20. The realization rate for the program is 149% when compared to the Ex-Ante energy savings. The largest variance was with the Smart and Web Enabled thermostats, where the Ex-Post savings were estimated by billing analysis and the Ex-Ante applied deemed savings by climate zone. The ENERGY STAR lighting measure had a high realization rate, as the Ex-Post applied the current baseline case from the Lighting Disposition papers and the actual manufacturer product specification wattage, along with either surveyed hours of use for general service A-lamps or DEER interior hours of use for other lamps.

Table 12-14 EPM FY 19/20 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
Advanced Power Strips Tier 2	74	100%	15,688	18,958	121%
ENERGY STAR Lighting	1,141	100%	2,191	10,891	497%
ENERGY STAR Refrigerator	1,782	100%	74,523	115,461	155%
ENERGY STAR Refrigerator Most Efficient	429	100%	33,432	20,870	62%
ENERGY STAR Room Air Conditioner	408	100%	11,736	20,761	177%
ENERGY STAR Television	30	100%	2,044	342	17%
ENERGY STAR TV Most Efficient	12	100%	1,034	1,196	116%
Smart Programmable Thermostats	2,761	99%*	546,419	833,606	153%
Web Enabled Thermostats	292	99%*	57,573	86,972	151%
Total	6,929		744,640	1,109,057	149%

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate

*Billing analysis has inherent ISR, Survey ISR was not applied.

Table 12-15 through Table 12-18 summarizes the EPM program peak demand reduction for FY 16/17 through FY 19/20. The realization rate for the program is greater than 100% as compared to the ESP Ex-Ante peak demand reduction. The ENERGY STAR room air conditioners, and refrigerators generally have the lowest realized peak demand impact compared to Ex-Ante peak demand.

Table 12-15 EPM FY 16/17 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post Gross kW Savings	Gross Realization Rate
Advanced Power Strips Tier 1	-	-	0.01	-	0%
Advanced Power Strips Tier 2	10	100%	0.28	0.62	220%
ENERGY STAR Lighting	712	100%	-	2.00	>100%
ENERGY STAR Refrigerator	1,449	100%	22.77	22.31	98%
ENERGY STAR Refrigerator Most Efficient	283	100%	4.38	4.35	99%
ENERGY STAR Room Air Conditioner	267	100%	42.40	6.36	15%
ENERGY STAR Television	202	100%	0.20	1.22	610%
ENERGY STAR TV Most Efficient	27	100%	0.05	0.08	153%
Smart Programmable Thermostats	888	100%*	-	144.75	>100%
Web Enabled Thermostats	48	100%*	-	7.72	>100%
Total	3,886		70.09	189.41	270%

*Billing analysis has inherent ISR, Survey ISR was not applied.

Table 12-16 EPM FY 17/18 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post Gross kW Savings	Gross Realization Rate
Advanced Power Strips Tier 1	4	100%	0.01	0.01	112%
Advanced Power Strips Tier 2	18	100%	0.56	0.63	113%
ENERGY STAR Lighting	917	100%	-	2.31	>100%
ENERGY STAR Refrigerator	1,660	100%	24.27	16.46	68%
ENERGY STAR Refrigerator Most Efficient	437	100%	6.21	4.75	77%
ENERGY STAR Room Air Conditioner	291	100%	45.92	15.26	33%
ENERGY STAR Television	213	100%	0.20	1.53	766%
ENERGY STAR TV Most Efficient	3	100%	-	-	-
Smart Programmable Thermostats	4,307	94%*	-	1,319.38	>100%
Web Enabled Thermostats	183	94%*	-	55.42	>100%
Total	8,033		77.16	1,415.75	>100%

*Billing analysis has inherent ISR, Survey ISR was not applied.

Table 12-17 EPM FY 18/19 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post Gross kW Savings	Gross Realization Rate
Advanced Power Strips Tier 1	5	100%	-	0.00	0%
Advanced Power Strips Tier 2	190	100%	5.04	11.85	235%
ENERGY STAR Lighting	1,294	100%	0.25	1.31	524%
ENERGY STAR Refrigerator	1,659	97%	-	25.77	>100%
ENERGY STAR Refrigerator Most Efficient	506	98%	32.29	7.71	24%
ENERGY STAR Room Air Conditioner	353	100%	10.38	19.53	188%
ENERGY STAR Television	182	100%	1.76	1.97	112%
Smart Programmable Thermostats	3,957	94%*	-	1,503.62	>100%
Web Enabled Thermostats	168	94%*	944.20	63.07	7%
Washer & Home	-	-	0.46	0.00	0%
Total	8,315		994.38	1,634.83	164%

*Billing analysis has inherent ISR, Survey ISR was not applied.

Table 12-18 EPM FY 19/20 Evaluation Demand Reduction Results by Measure

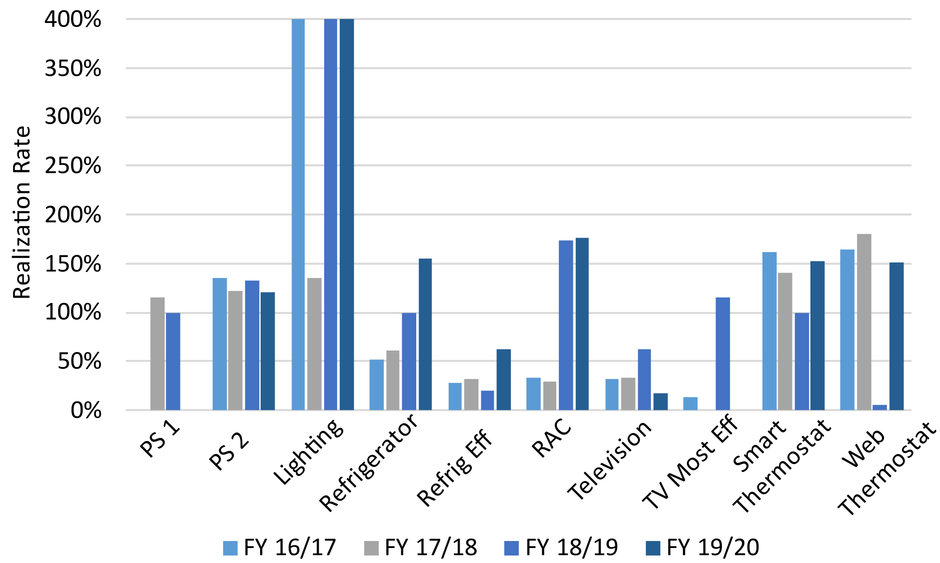
Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	ESP Data Ex-Post Gross kWh Savings	Gross Realization Rate
Advanced Power Strips Tier 2	74	100%	3.04	3.67	121%
ENERGY STAR Lighting	1,141	100%	0.29	1.45	500%
ENERGY STAR Refrigerator	1,782	100%	14.44	22.37	155%
ENERGY STAR Refrigerator Most Efficient	429	100%	6.48	4.04	62%
ENERGY STAR Room Air Conditioner	408	100%	14.11	24.96	177%
ENERGY STAR Television	30	100%	0.40	0.07	17%
ENERGY STAR TV Most Efficient	12	100%	0.20	0.23	116%
Smart Programmable Thermostats	2,761	99%*	657.03	1,002.36	153%
Web Enabled Thermostats	292	99%*	69.23	104.58	151%
Total	6,929		765.22	1,163.73	152%

*Billing analysis has inherent ISR, Survey ISR was not applied.

12.5.1 Gross Realization Rate by Measure

The gross realization rate variation by measure type and by fiscal year is shown in Figure 12-2 below. The gross energy savings per measure was similar each of the fiscal years, but the variation in the realization rate is primarily changes in the verified quantity through the tracking data as compared to the ESP report data. The realization rate for lighting was lowest in FY 17/18 when only 1,761 kWh was identified in the tracking data, whereas the ESP measure data was 13,680 kWh. Similarly, for room air conditioners, the tracking data kWh was less for FY 16/17 and FY 17/18 than FY 18/19 and FY 19/20.

Figure 12-2 Gross Realization Rate Distribution by Measure and Fiscal Year



12.5.2 COVID-19 Impacts on Energy Use

The approach for the EPM COVID-19 analysis follows the method described for participant billing data retrofit isolation for Smart and Web Enabled Programmable Thermostats and non-participant analysis in Section 11.5.2. The results are presented in Table 12-19 and Table 12-20.

Table 12-19 EPM COVID-19 Era Impact to Ex-Post Gross Energy Savings

Billing Analysis Measures	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
Smart Programmable Thermostats	830,622	920,945	90,323	10.9%
Web Enabled Programmable Thermostats	87,320	97,367	10,047	11.5%
Total	917,942	1,018,311	100,369	10.9%

Table 12-20 EPM COVID-19 Era Impact on Ex-Post Gross Energy Savings

Algorithmic Savings Measures	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Multiplier (B)	COVID-19 Era Savings (A*B=C)	COVID-19 Era Incremental Change Ex-Post kWh Savings (C-A)
Advanced Power Strips	18,958	1.075	20,380	1,422
ENERGY STAR Lighting	10,891	1.075	11,708	817
ENERGY STAR RAC	20,761	1.078	22,380	1,619
ENERGY STAR Television	342	1.075	368	26
ENERGY STAR Television Most Efficient	1,196	1.075	1,286	90
Total	52,148		56,122	3,974

12.6 Program Recommendations

The Evaluator has recommendations for the EPM program EM&V for the upcoming Concurrent Evaluation.

12.6.1 ENERGY STAR Lighting

ENERGY STAR Lighting has been a large contributor to energy efficiency programs, but as the lamp market will only offer lighting that meets CA Title 20 standards, the baseline case and efficient case approach equality, yielding low energy and peak demand impacts. The Evaluator recommends tracking the installation location to identify lighting operating hours such as dusk to dawn, which exceeds interior lighting hours of use.

12.6.2 Program Measures

The Evaluator recommends determining specific energy savings for each participant, using available application data. All measures in tracking data had a single deemed savings per unit, except for thermostats which varied by climate zone. The Evaluator recommends utilizing available product data such as size and efficiency to calculate participants energy savings.

The Evaluator recommends tracking peak demand savings for each participant. The peak demand can be estimated by the product of the energy savings and a kW/kWh conversion factor specific to the load shape of the product from the LADWP Marketplace. The conversion factor should be derived from the 8760 load shape bins in the ESP database annually, to reflect the most recent LADWP coincident peak demand window.

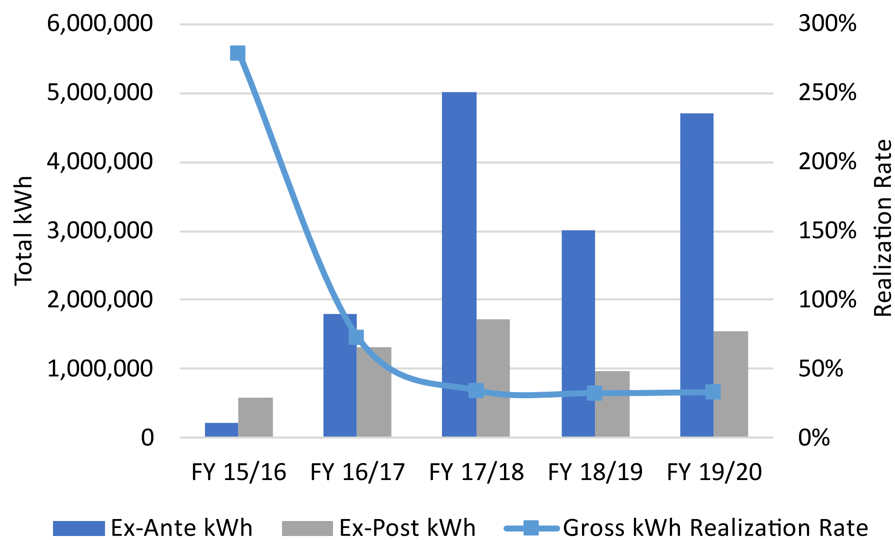
13 Energy Savings Assistance Program

This chapter presents an evaluation of the Energy Savings Assistance Program (ESAP) that LADWP offered customers during fiscal years (FY) 15/16 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to ESAP.

13.1 Program Performance Summary

ESAP is California's statewide low income weatherization program. LADWP partners with SoCal Gas to co-fund weatherization of electric and gas customers in Los Angeles. From FY 15/16 through FY 19/20, 19,045 low income residents had their home weatherized through the ESAP Program. Figure 13-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 13-1 Energy Savings Assistance Program Performance Summary



13.1.1 Key Evaluation Takeaways

- With estimates provided on the whole-house level, measure-level impacts cannot be determined.
- With the exception of FY 15/16, the ESAP trended towards low realization (averaging 43% for the remaining fiscal years).
- Under-performance compared to expected savings aligns with similar results observed by CA Investor Owned Utilities, but the program nonetheless provided savings verifiable in customer billing data (averaging 328 kWh per customer, annually).

13.2 Program Description

ESAP is a statewide low-income weatherization program administered by California utilities. This program targets income qualified residents living in multi-family housing, providing no-cost energy and water savings measures for residents with an income under 200% of the Federal Poverty Guidelines. ESAP offers efficiency upgrades for individual residential units. The efficiency measures include weather stripping, caulking, low-flow showerheads, water heater blankets, and door and building envelope repairs that reduce air infiltration. LADWP has partnered with SoCalGas to jointly implement certain programs to provide more comprehensive services to customers and save on program costs.

Table 13-1 summarizes the program's Energy Savings Platform, Inc. (ESP) Ex-Ante energy savings and peak demand reduction and savings contribution to the Retrospective Period by fiscal year.

Table 13-1 ESAP Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Projects	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
15/16	2,335	212,282	1%	0	0%
16/17	5,939	1,798,202	12%	0	0%
17/18	7,305	5,004,635	34%	0	0%
18/19	5,441	3,001,815	20%	295.68	30%
19/20	11,017	4,710,378	32%	691.90	70%
Total	32,037	14,727,312	100%	987.58	100%

Table 13-2 provides a complete list of ESAP measure offerings for the Retrospective Period.

Table 13-2 ESAP Measure Offerings

Measure Category	Measures
Lighting	LEDs
	LED Night Lights
	Torchieres (CFLs)
	Torchieres (LEDs)
Hot Water	Showerheads
	Aerators
	HE Clothes Washers
	Thermostatic Shower Valves

Measure Category	Measures
	Thermostatic Tub Spouts
Building Shell/HVAC	Furnace Clean & Tune
	Weatherization
	Air Sealing
Miscellaneous	Smart Power Strips

The following tables summarize the number of measures installed and total Tracking Data Ex-Ante kWh savings by measure and fiscal year.

Table 13-3 ESAP FY 15/16 Tracking Data Ex-Ante Savings by Measure

Measure	Quantity	Ex-Ante kWh Savings Per Unit	Program Data Ex-Ante kWh Savings
Showerheads*	1,266	-	-
Aerators*	2,100	-	-
Weatherization/Air Sealing	307	12	3,684
HE Clothes Washer	11	14	154
Thermostatic Shower Valve*	507	-	-
Furnace Clean & Tune*	421	-	-
CFLs	2,459	42	103,278
LED Night Lights	1,171	10	11,944
Smart Power Strips	419	58	24,470
Torchieres (CFLs)	176	49	8,624
Total	8,837	-	152,154

*These measures were not assigned electric savings in Ex-Ante savings.

Table 13-4 ESAP FY 16/17 Tracking Data Ex-Ante Savings by Measure

Measure	Quantity	Ex-Ante kWh Savings Per Unit	Program Data Ex-Ante kWh Savings
Showerheads*	6,447	-	-
Aerators*	11,294	-	-
Weatherization/Air Sealing	3,530	12	42,360
HE Clothes Washer	77	14	1,078
Thermostatic Shower Valve*	5,411	-	-
Furnace Clean & Tune*	2,714	-	-
CFLs	8,850	80	708,000

Measure	Quantity	Ex-Ante kWh Savings Per Unit	Program Data Ex-Ante kWh Savings
LEDs	6,824	92	627,808
LED Night Lights	5,464	19	103,816
Smart Power Strips	5,001	58	292,058
Torchieres (CFLs)	1,755	404	709,020
Torchieres (LEDs)	0	453	-
Total	57,367	-	2,484,140

*These measures were not assigned electric savings in Ex-Ante savings.

Table 13-5 ESAP FY 17/18 Tracking Data Ex-Ante Savings by Measure

Measure	Quantity	Ex-Ante kWh Savings Per Unit	Program Data Ex-Ante kWh Savings
Showerheads*	8,761	-	-
Aerators*	15,313	-	-
Weatherization/Air Sealing	1,936	12	23,232
HE Clothes Washer	300	14	4,200
Thermostatic Shower Valve*	6,518	-	-
Furnace Clean & Tune*	2,170	-	-
CFLs	1,655	80	132,400
LEDs	30,223	92	2,780,516
LED Night Lights	8,233	19	156,427
Smart Power Strips	8,150	58	475,960
Torchieres (LEDs)	3,499	453	1,585,047
Total	86,758	-	5,157,782

*These measures were not assigned electric savings in Ex-Ante savings.

Table 13-6 ESAP FY 18/19 Tracking Data Ex-Ante Savings by Measure

Measure	Quantity	Ex-Ante kWh Savings Per Unit	Program Data Ex-Ante kWh Savings
Showerheads*	3,932	-	-
Aerators*	6,200	-	-
Weatherization/Air Sealing	1,032	12	12,384
HE Clothes Washer	0	14	-
Thermostatic Shower Valve*	1,606	-	-

Measure	Quantity	Ex-Ante kWh Savings Per Unit	Program Data Ex-Ante kWh Savings
Thermostatic Tub Spout	9	-	-
Furnace Clean & Tune*	748	-	-
LEDs	20,053	92	1,844,876
LED Night Lights	4,389	19	83,391
Smart Power Strips	4,381	58	255,850
Torchieres (LEDs)	1,953	453	884,709
Total	44,303	-	3,081,210

*These measures were not assigned electric savings in Ex-Ante savings.

Table 13-7 ESAP FY 19/20 Tracking Data Ex-Ante Savings by Measure

Measure	Quantity	Ex-Ante kWh Savings Per Unit	Program Data Ex-Ante kWh Savings
Showerheads*	4,436	-	-
Aerators*	6,255	-	-
Weatherization/Air Sealing	1,067	12	12,804
HE Clothes Washer	0	14	-
Thermostatic Shower Valve*	2,495	-	-
Thermostatic Tub Spout	33	-	-
Furnace Clean & Tune*	623	-	-
LEDs	22,513	92	2,071,196
LED Night Lights	3,664	19	69,616
Smart Power Strips	3,362	58	196,341
Torchieres (LEDs)	2,976	453	1,348,128
Total	47,424	-	3,698,085

*These measures were not assigned electric savings in Ex-Ante savings.

13.3 Methodology

This section presents a brief summary of the tracking data review and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program. The evaluation methodology is summarized below.

- Tracking data review;
- Ex-Ante savings review;
- M&V approach; and

- Billing analysis approach

A detailed evaluation methodology is available in Appendix A, section A.12.1.

13.4 Impact Evaluation

The Evaluator estimated verified energy savings and peak demand reduction impacts from ESAP for the Retrospective Period using a billing analysis methodology which is presented in greater detail in section A.12.2.

13.5 Ex-Post Gross Results and Findings

Table 13-8 summarizes the household-level Ex-Post kWh savings and peak kW reduction for each fiscal year in the Retrospective Period.

Table 13-8 ESAP Retrospective Summary Ex-Post Per-household Energy Savings

Fiscal Year	Per-household Ex-Post kWh Savings	Per-household Ex-Post Peak kW Savings
15/16	276	0.05
16/17	216	0.04
17/18	201	0.04
18/19	143	0.03
19/20	190	0.04
Total	194	0.04

The verified household-level energy savings ranges from 143 kWh savings per year to 276 kWh savings per year with a total Retrospective average of 194 kWh savings per year. The verified household-level demand reduction ranges from 0.03 peak kW per year to 0.05 peak kW per year with a total Retrospective average of 0.04 peak kW reduction per year.

The Evaluator extrapolated the above household-level energy savings and peak demand reduction with the total number of unique households per Retrospective Period fiscal year presented in the program tracking data. Table 13-9 summarizes the program-level Ex-Ante and Ex-Post energy savings for each fiscal year in the Retrospective Period.

Table 13-9 ESAP Retrospective Evaluation Energy Savings Results by Fiscal Year

Fiscal Year	Quantity	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
15/16	2,147	212,282	592,269	279%
16/17	6,064	1,798,202	1,308,587	73%
17/18	8,554	5,004,635	1,716,086	34%
18/19	6,769	3,001,815	969,592	32%
19/20	8,202	4,710,378	1,554,640	33%
Total	31,736	14,727,312	6,141,174	42%

The Evaluator verified a total of 6,141,174 kWh energy savings for ESAP across 31,736 participating households. The verified gross realization rates range between 32% and 279% with an average of 42% across the Retrospective Period.

Table 13-10 summarizes the program-level Ex-Ante and Ex-Post peak demand reduction for each fiscal year in the Retrospective Period.

Table 13-10 ESAP Retrospective Evaluation Demand Reduction Results by Fiscal Year

Fiscal Year	Quantity	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Realization Rate
15/16	2,147	0.00	79.00	>100%
16/17	6,064	0.00	183.25	>100%
17/18	8,554	0.00	244.71	>100%
18/19	6,769	295.68	113.87	39%
19/20	8,202	691.90	228.36	33%
Total	31,736	987.58	849.20	86%

The Evaluator verified a total of 849.20 peak kW reduction for ESAP across 31,736 participating households. The verified gross realization rates range between 33% and 39% with an average of 86% across all fiscal years in the Retrospective Period. FY 15/16 through FY 17/18 did not receive an estimate for ESP Portfolio Ex-Ante peak kW reduction; however, the Evaluator estimated peak demand impacts for each fiscal year in the Retrospective Period. Therefore, the overall gross realization rate during those years for peak demand impacts is over 100%.

The Evaluator calculated an overall Retrospective Period gross kWh realization rate of 42% compared to ESP Portfolio Ex-Ante kWh savings and a rate of 86% against ESP Ex-Ante Peak kW reduction. The Evaluator was unable to recreate the reported ESP Portfolio Ex-Ante kWh and kW impact values with the provided program tracking data. It is likely the number of participants presented in the program tracking data provided by LADWP is lower than the number of customers and number of measures used to calculate the ESP Portfolio Ex-Ante kWh and kW impacts. The Evaluator was limited by this absence of data and was only able to extrapolate household level savings to the unique number of households presented in the program tracking data that was delivered. This is a factor that may be affecting the low kWh gross realization rate.

In addition, the peak kW gross realization rate is higher than the ESP Portfolio Ex-Ante peak kW due to lack of Ex-Ante peak kW reduction estimates for FY 15/16 through 17/18. The Evaluator was not provided with a calculation methodology for the measure-level Ex-Ante kWh or kW savings. However, the Evaluator assumed the Ex-Ante measure-level savings values were underrepresenting energy savings occurring during peak periods.

13.5.1 COVID-19 Impacts on Energy Use

The method for estimating COVID-19 impacts for ESAP follows the method detailed for billing data regression in Section 11.5.2. Table 13-11 present the typical first year Gross Ex-Post savings and COVID-19 adjusted Gross Ex-Post savings. For interpretation purposes, the COVID-19 savings are presented as a full 12-month annual adjusted savings.

Table 13-11 ESAP COVID-19 Era Impact to Ex-Post Gross Energy Savings

Billing Analysis Measure	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
Program level	2,088,206	2,475,743	387,537	18.6%

13.6 Program Recommendations

Since the methodology for validating program savings for ESAP is a whole building analysis, it is difficult for the Evaluator to point out areas under specific measures for improving gross realization rates. Therefore, the Evaluator is unable to provide actionable recommendations to improve the program.

The Evaluator found the monthly measure count and savings summaries difficult to match with the measure-level tracking data and therefore difficult to recreate measure-level counts using the available tracking data. Although annual reporting for ESAP did not provide specific measures for all years, it did provide measure breakdowns starting FY 18/19 and FY 19/20. However, of the measure breakdowns provided, project-level tracking data including customer name, customer address, measure name, measure quantity, and measure install date were difficult to match against monthly measure total summaries provided by LADWP. Totals from project-level tracking data were not consistent with monthly measure totals.

In addition, measure names across databases were inconsistent. For example, the measure name provided in the project-level data had altered formatting or alternate names compared to the monthly summaries or the measure-level kWh, kW, water, and gas savings summaries.

The Evaluator recommends tracking project-level customer identifiers, measure identifiers, measure energy savings, measure non-energy savings, measure price, measure install or labor cost, and project details for each individual project in one tracking database. This tracking database should be used to summarize monthly and measure-level savings. Measure names should also be consistent within each program year. This will ensure consistent summaries and reporting across the program. In addition, the Evaluator recommends providing data sources for referenced kWh and kW savings per measure.

The Evaluator recommends that measures are tracked consistently across program years and worksheets and that Ex-Ante savings estimates for residential lighting equipment adhere to EISA adjustments and CA Title 20 regulations.

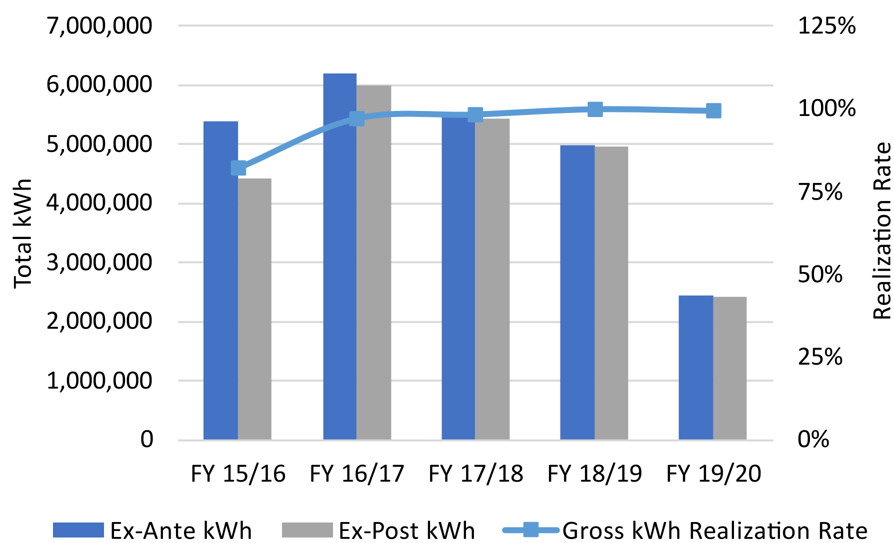
14 Home Energy Improvement Program

This chapter presents an evaluation of the Home Energy Improvement Program (HEIP) that LADWP offered customers during fiscal years 15/16 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the HEIP.

14.1 Program Performance Summary

HEIP provides free-of-charge home efficiency improvements, including building shell, plumbing, lighting, and HVAC improvements. HEIP targets LADWP's low income customers, though all residential customers are eligible. Figure 14-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 14-1 Home Energy Improvement Program Performance Summary



14.1.1 Key Evaluation Takeaways

- HEIP had high realization (95% over the entire Retrospective Period); impacts for baseload measures were estimated through verification of installation via participant surveys. Weather-sensitive measures had savings estimated through billing analysis.
- Most savings adjustments were due to installation rates determined through participant surveys; these installation rates can be used by LADWP going forward.
    - LEDs: 96%
    - CFLs (no longer offered in program): 83%

- Showerheads: 69%
- Aerators: 63%

14.2 Program Description

The table below outlines the number of projects, Energy Savings Platform, Inc. (ESP) Ex-Ante gross energy savings (kWh) and demand reduction (Peak kW), and the percentage of total savings across the Retrospective Period for the HEIP.

Table 14-1 HEIP Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Projects	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
15/16	10,236	5,806,561	22.9%	4,362.06	28.0%
16/17	9,543	6,525,162	25.8%	4,790.00	30.8%
17/18	8,197	5,581,224	22.0%	4,266.00	27.4%
18/19	8,488	4,974,722	19.6%	1,416.74	9.1%
19/20	4,393	2,445,935	9.7%	724.01	4.7%
Total	40,857	25,333,603	100.0%	15,558.81	100.0%

LADWP offers the HEIP to residential customers to improve the energy and water savings performance in their homes. The priority of the HEIP is to serve low-income customers but is also provided at no cost to any eligible customers. An assessment of the home is performed by trained technicians to identify the most appropriate and effective improvements. Recommendations for energy efficient upgrades and repairs are made, and repair technicians complete the work. A quality assurance review is done on all homes. Table 14-2 below outlines the measures offered in the HEIP during the Retrospective Period.

Table 14-2 HEIP Measures

Measure Category	Measures
Building Shell	Blower Door Diagnostic Testing Air Sealing Insulation Door Repair/Replacement Window Repair Weather-stripping
HVAC	Window AC
Plumbing	Low Flow Toilets Low Flow Showerheads Faucet Aerators Hot water pipe wrap

Measure Category	Measures
	Toilet gaskets
Lighting	Interior Energy Efficient Lamp & Fixtures Exterior Energy Efficient Lamps & Fixtures

Table 14-3 through Table 14-7 summarizes the number of measures installed and total Ex-Ante kWh savings for each measure in each fiscal year.

Table 14-3 HEIP FY 15/16 Ex-Ante Savings by Measure

Measure	Quantity	Program Data Ex-Ante kWh Savings	Ex-Ante kWh Savings Per Unit
Window AC	342	187,610	549
LED	3	5,702	1,901
CFL	2,603	4,786,795	1,839
Pipe Wrap	65	13,528	208
Toilet	1,059	71,499	68
Showerhead	2,195	114,821	52
Aerator	2,059	24,488	12
Attic Insulation	295	106,973	363
Duct Sealing	221	12,346	56
Air Sealing	1,376	462,010	336
Toilet Gasket	18	20,790	1,155
Total	10,236	5,806,561	6,537

Table 14-4 HEIP FY 16/17 Ex-Ante Savings by Measure

Measure	Quantity	Program Data Ex-Ante kWh Savings	Ex-Ante kWh Savings Per Unit
Window AC	252	144,905	575
LED	1,503	3,259,101	2,168
CFL	1,203	2,443,881	2,031
Pipe Wrap	37	6,612	179
Toilet	949	64,830	68
Showerhead	2,061	105,060	51
Aerator	1,864	21,528	12
Attic Insulation	152	12,595	83
Duct Sealing	188	7,002	37
Air Sealing	1,321	444,402	336
Toilet Gasket	13	15,246	1,173
Total	9,543	6,525,162	6,714

Table 14-5 HEIP FY 17/18 Ex-Ante Savings by Measure

Measure	Quantity	Program Data Ex-Ante kWh Savings	Ex-Ante kWh Savings Per Unit
Window AC	236	143,445	608
LED	2,184	4,551,689	2,084
CFL	128	209,734	1,639
Pipe Wrap	17	3,040	179
Toilet	835	58,324	70
Showerhead	1,690	90,318	53
Aerator	1,374	15,138	11
Attic Insulation	396	138,597	350
Duct Sealing	225	9,553	42
Air Sealing	1,102	350,694	318
Toilet Gasket	10	10,692	1,069
Total	8,197	5,581,224	6,423

Table 14-6 HEIP FY 18/19 Ex-Ante Savings by Measure

Measure	Quantity	Program Data Ex-Ante kWh Savings	Ex-Ante kWh Savings Per Unit
Window AC	224	128,845	575
LED	2,388	3,691,174	1,546
CFL	226	396,490	1,754
Pipe Wrap	21	2,508	119
Toilet	1,104	73,912	67
Showerhead	1,675	85,914	51
Aerator	1,121	11,487	10
Attic Insulation	292	138,712	475
Duct Sealing	140	8,056	58
Air Sealing	1,291	432,476	335
Toilet Gasket	6	5,148	858
Total	8,488	4,974,722	5,849

Table 14-7 HEIP FY 19/20 Ex-Ante Savings by Measure

Measure	Quantity	Program Data Ex-Ante kWh Savings	Ex-Ante kWh Savings Per Unit
Window AC	119	56,210	472
LED	1,466	1,967,073	1,342
CFL	11	11,804	1,073
Pipe Wrap	22	2,660	121

Measure	Quantity	Program Data Ex-Ante kWh Savings	Ex-Ante kWh Savings Per Unit
Toilet	604	38,837	64
Showerhead	936	48,599	52
Aerator	207	5,313	26
Attic Insulation	207	73,291	354
Duct Sealing	85	3,552	42
Air Sealing	734	238,398	325
Toilet Gasket	2	198	99
Total	4,393	2,445,935	3,970

14.3 Methodology

This section provides a brief summary of the methodology used by the Evaluator in the impact evaluation of the HEIP Program during the Retrospective Period. The following activities were performed:

- Tracking data review;
- Ex-Ante savings review;
- M&V approach; and
- Billing analysis approach.

A detailed evaluation methodology is available in Appendix A, section A.13.1.

14.4 Impact Evaluation

The Evaluator estimated verified energy savings and peak demand reduction impacts for HEIP for the Retrospective Period using TRM-based savings algorithms and a billing analysis methodology depending on measure type.

A detailed impact evaluation is available in Appendix A, section A.13.2.

14.5 Ex-Post Gross Results and Findings

Table 14-8 summarizes the measure-level in-service rates (ISRs) and per-unit energy savings and peak demand reduction.

Table 14-8 HEIP FY 15/16 Summary Ex-Post Per-unit Energy Savings

Measure	ISR*	Per-unit Ex-Post kWh Savings	Per-unit Ex-Post kW Savings
Window AC	N/A	371	0.169
LED	96%	221	0.068
CFL	72%	78	0.02

Measure	ISR*	Per-unit Ex-Post kWh Savings	Per-unit Ex-Post kW Savings
Pipe Wrap	N/A	21	0.002
Toilet	100%	52	0.01
Showerhead	68%	95	0.01
Aerator	33%	13	0.001
Attic Insulation	N/A	301	0.05
Duct Sealing	N/A	46	0.03
Air Sealing	N/A	279	0.17
Toilet Gasket	N/A	0	0
Total		1,475	0.523

**N/A - ISRs were not estimated for weather sensitive measures as they were inherent to billing analysis; toilet gaskets have zero savings.*

Table 14-9 HEIP FY 16/17 Summary Ex-Post Per-unit Energy Savings

Measure	ISR*	Per-unit Ex-Post kWh Savings	Per-unit Ex-Post kW Savings
Window AC	N/A	363	0.158
LED	98%	103	0.032
CFL	79%	70	0.019
Pipe Wrap	N/A	24	0.002
Toilet	100%	46	0.005
Showerhead	59%	76	0.008
Aerator	45%	16	0.002
Attic Insulation	N/A	77	0.01
Duct Sealing	N/A	35	0.02
Air Sealing	N/A	313	0.18
Toilet Gasket	N/A	0	0
Total		1,122	.436

**N/A - ISRs were not estimated for weather sensitive measures as they were inherent to billing analysis; toilet gaskets have zero savings.*

Table 14-10 HEIP FY 17/18 Summary Ex-Post Per-unit Energy Savings

Measure	ISR*	Per-unit Ex-Post kWh Savings	Per-unit Ex-Post kW Savings
Window AC	N/A	304	0.146
LED	96%	84	0.026
CFL	83%	73	0.02
Pipe Wrap	N/A	21	0.002
Toilet	100%	43	0.005
Showerhead	75%	88	0.009

Measure	ISR*	Per-unit Ex-Post kWh Savings	Per-unit Ex-Post kW Savings
Aerator	61%	20	0.002
Attic Insulation	N/A	292	0.05
Duct Sealing	N/A	35	0.02
Air Sealing	N/A	265	0.18
Toilet Gasket	N/A	0	0
Total		1,225	0.45

**N/A - ISRs were not estimated for weather sensitive measures as they were inherent to billing analysis; toilet gaskets have zero savings.*

Table 14-11 HEIP FY 18/19 Summary Ex-Post Per-unit Energy Savings

Measure	ISR*	Per-unit Ex-Post kWh Savings	Per-unit Ex-Post kW Savings
Window AC	N/A	310	0.150
LED	97%	82	0.025
CFL	99%	80	0.022
Pipe Wrap	N/A	21	0.002
Toilet	100%	43	0.005
Showerhead	71%	83	0.008
Aerator	74%	24	0.002
Attic Insulation	N/A	403	0.07
Duct Sealing	N/A	49	0.03
Air Sealing	N/A	284	0.18
Toilet Gasket	N/A	0	0
Total		1,380	0.49

**N/A - ISRs were not estimated for weather sensitive measures as they were inherent to billing analysis; toilet gaskets have zero savings.*

Table 14-12 HEIP FY 19/20 Summary Ex-Post Per-unit Energy Savings

Measure	ISR*	Per-unit Ex-Post kWh Savings	Per-unit Ex-Post kW Savings
Window AC	N/A	340	0.161
LED	94%	80	.024
CFL	83%	73	.02
Pipe Wrap	N/A	24	0.002
Toilet	100%	43	0.005
Showerhead	74%	87	0.009
Aerator	100%	33	0.003
Attic Insulation	N/A	329	0.05
Duct Sealing	N/A	39	0.02

Measure	ISR*	Per-unit Ex-Post kWh Savings	Per-unit Ex-Post kW Savings
Air Sealing	N/A	302	0.19
Toilet Gasket	N/A	0	0
Total		1,349	0.493

**N/A - ISRs were not estimated for weather sensitive measures as they were inherent to billing analysis; toilet gaskets have zero savings.*

Table 14-13 through Table 14-17 summarize the measure and program-level gross kWh savings compared to the ESP Portfolio Ex-Ante kWh savings for each fiscal year. The overall kWh realization rate is 95% and overall kW realization rate is 26%. Showerheads and faucet aerators had consistently high realization rates during the Retrospective Period since the Ex-Ante estimates used inappropriate deemed savings for these measures.

Table 14-13 HEIP FY 15/16 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate
Window AC	342	N/A	174,407	155,631	89%
LED	3	96%	5,300	5,078	96%
CFL	2,603	72%	4,449,921	3,369,889	76%
Pipe Wrap	65	N/A	12,576	11,222	89%
Toilet	1,059	100%	66,467	70,529	106%
Showerhead	2,195	68%	106,740	285,214	267%
Aerator	2,059	33%	22,765	49,385	217%
Attic Insulation	295	N/A	99,444	88,739	89%
Duct Sealing	221	N/A	11,477	10,241	89%
Air Sealing	1,376	N/A	429,496	383,258	89%
Toilet Gasket	18	N/A	19,327	0	N/A
Total	10,236		5,397,920	4,429,186	82%

Table 14-14 HEIP FY 16/17 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate
Window AC	252	N/A	137,411	134,930	98%
LED	1,503	98%	3,090,541	3,184,016	103%
CFL	1,203	79%	2,317,483	1,898,617	82%
Pipe Wrap	37	N/A	6,270	6,157	98%

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate
Toilet	949	100%	61,477	63,171	103%
Showerhead	2,061	59%	99,626	226,521	227%
Aerator	1,864	45%	20,414	59,301	290%
Attic Insulation	152	N/A	11,944	11,728	98%
Duct Sealing	188	N/A	6,640	6,520	98%
Air Sealing	1,321	N/A	421,418	413,810	98%
Toilet Gasket	13	N/A	14,457	0	N/A
Total	9,543		6,187,681	6,004,771	97%

Table 14-15 HEIP FY 17/18 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate
Window AC	236	N/A	142,205	119,511	84%
LED	2,184	96%	4,512,352	4,365,133	97%
CFL	128	83%	207,921	172,213	83%
Pipe Wrap	17	N/A	3,014	2,533	84%
Toilet	835	100%	57,820	59,427	103%
Showerhead	1,690	75%	89,537	247,618	277%
Aerator	1,374	61%	15,007	56,715	378%
Attic Insulation	396	N/A	137,399	115,472	84%
Duct Sealing	225	N/A	9,470	7,959	84%
Air Sealing	1,102	N/A	347,663	292,180	84%
Toilet Gasket	10	N/A	10,600	0	N/A
Total	8,197		5,532,990	5,438,761	98%

Table 14-16 HEIP FY 18/19 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate
Window AC	224	N/A	128,845	109,278	85%
LED	2,388	97%	3,690,943	3,612,932	98%
CFL	226	99%	396,470	396,751	100%
Pipe Wrap	21	N/A	2,508	2,127	85%
Toilet	1,104	100%	74,130	81,115	109%
Showerhead	1,675	71%	86,355	223,098	258%
Aerator	1,121	74%	11,758	52,406	446%
Attic Insulation	292	N/A	138,693	117,646	85%

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate
Duct Sealing	140	N/A	8,054	6,833	85%
Air Sealing	1,291	N/A	432,476	366,797	85%
Toilet Gasket	6	N/A	5,148	0	N/A
Total	8,488		4,975,380	4,968,983	100%

Table 14-17 HEIP FY 19/20 Evaluation Energy Savings Results by Measure

Measure	Quantity	ISR	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate
Window AC	119	N/A	56,210	52,306	93%
LED	1,466	94%	1,966,988	1,866,823	95%
CFL	11	83%	11,804	9,667	82%
Pipe Wrap	22	N/A	2,660	2,475	93%
Toilet	604	100%	38,951	42,602	109%
Showerhead	936	74%	48,844	131,521	269%
Aerator	207	100%	5,447	32,805	602%
Attic Insulation	207	N/A	73,272	68,201	93%
Duct Sealing	85	N/A	3,549	3,305	93%
Air Sealing	734	N/A	238,306	221,840	93%
Toilet Gasket	2	N/A	198	0	N/A
Total	4,393		2,446,230	2,431,545	99%

Table 14-18 through Table 14-22 summarize the measure and program-level gross peak kW reduction compared to the ESP Portfolio Ex-Ante peak kW reduction for each fiscal year.

Table 14-18 HEIP FY 15/16 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Saving	Gross kW Realization Rate
AC Window Unit	342	261.90	32.19	12%
Aerator	2,059	4.61	2.25	49%
Air Sealing	1,376	879.04	108.05	12%
Attic Insulation	295	51.34	6.31	12%
CFL	2,603	3,042.76	421.56	14%
Duct Sealing	221	21.76	2.67	12%
LED	3	3.62	0.71	20%
Pipe Wrap	65	3.30	0.40	12%
Showerhead	2,195	21.60	13.01	60%
Toilet Gasket	18	36.06	0.00	0%
Toilet	1,059	0.00	3.65	>100%
Total	10,236	4,325.99	590.82	14%

Table 14-19 HEIP FY 16/17 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Saving	Gross kW Realization Rate
AC Window Unit	252	205.39	26.85	13%
Aerator	1,864	4.11	2.72	66%
Air Sealing	1,321	832.24	108.80	13%
Attic Insulation	152	6.27	0.82	13%
CFL	1,203	1,577.40	239.20	15%
Duct Sealing	188	12.45	1.63	13%
LED	1,503	2,103.57	446.97	21%
Pipe Wrap	37	1.64	0.21	13%
Showerhead	2,061	20.07	10.41	52%
Toilet Gasket	13	26.85	0.00	0%
Toilet	949	0.00	3.30	>100%
Total	9,543	4,789.99	840.90	18%

Table 14-20 HEIP FY 17/18 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Saving	Gross kW Realization Rate
AC Window Unit	236	212.65	23.03	11%
Aerator	1,374	3.02	2.28	76%
Air Sealing	1,102	708.76	77.64	11%

Measure	Quantity	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Saving	Gross kW Realization Rate
Attic Insulation	396	71.41	7.73	11%
CFL	128	141.58	19.01	13%
Duct Sealing	225	17.46	1.89	11%
LED	2,184	3,072.59	537.04	17%
Pipe Wrap	17	0.79	0.08	11%
Showerhead	1,690	18.05	9.97	55%
Toilet Gasket	10	19.69	0.00	0%
Toilet	835	0.00	2.72	>100%
Total	8,197	4,266.00	681.40	16%

Table 14-21 HEIP FY 18/19 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Saving	Gross kW Realization Rate
AC Window Unit	224	172.84	130.16	75%
Aerator	1,121	2.83	12.44	440%
Air Sealing	1,291	567.88	436.88	77%
Attic Insulation	292	186.05	140.13	75%
CFL	226	41.78	47.01	113%
Duct Sealing	140	10.79	4.36	40%
LED	2,388	388.87	428.07	110%
Pipe Wrap	21	0.19	0.19	99%
Showerhead	1,675	20.77	52.96	255%
Toilet	1,104	17.83	19.26	108%
Toilet Gasket	6	6.91	0.00	0%
Total	8,488	1,416.74	1,271.46	90%

Table 14-22 HEIP FY 19/20 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Saving	Gross kW Realization Rate
AC Window Unit	119	67.59	62.89	93%
Aerator	207	1.24	7.46	602%
Air Sealing	734	279.10	259.82	93%
Attic Insulation	207	88.10	82.01	93%
CFL	11	1.57	1.29	82%
Duct Sealing	85	4.27	3.97	93%
LED	1,466	261.66	248.34	95%
Pipe Wrap	22	0.28	0.26	92%
Showerhead	936	11.11	29.91	269%
Toilet	604	8.86	9.69	109%
Toilet Gasket	2	0.24	0.00	0%
Total	4,393	724.01	705.63	97%

14.5.1 Gross Realization Rate Distribution by Household

This section summarizes the gross realization rate distribution by premise. The following figures summarize the number of premises that displayed gross realization rates of 80%, 100%, 150%, 200%, and 250% for each FY.

Figure 14-2 FY 15/16 kWh Realization Rate Distribution by Household

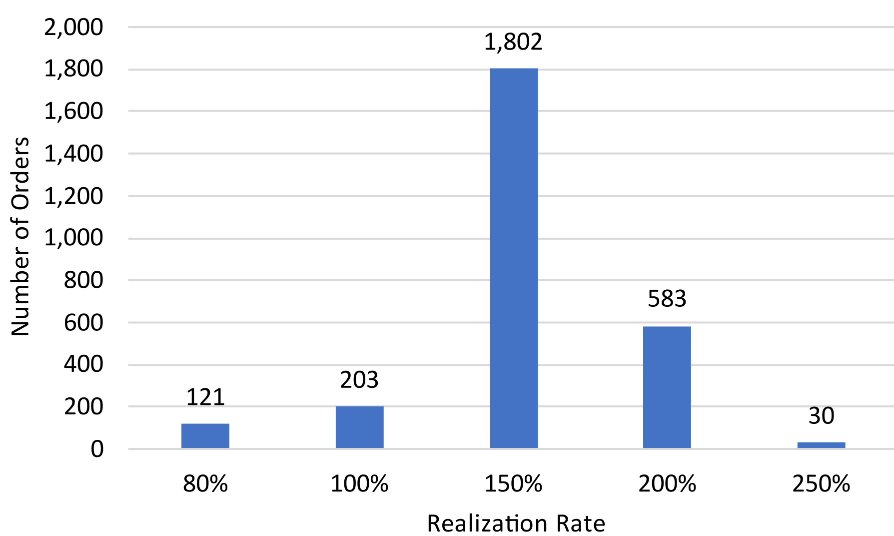


Figure 14-3 FY 16/17 kWh Realization Rate Distribution by Household

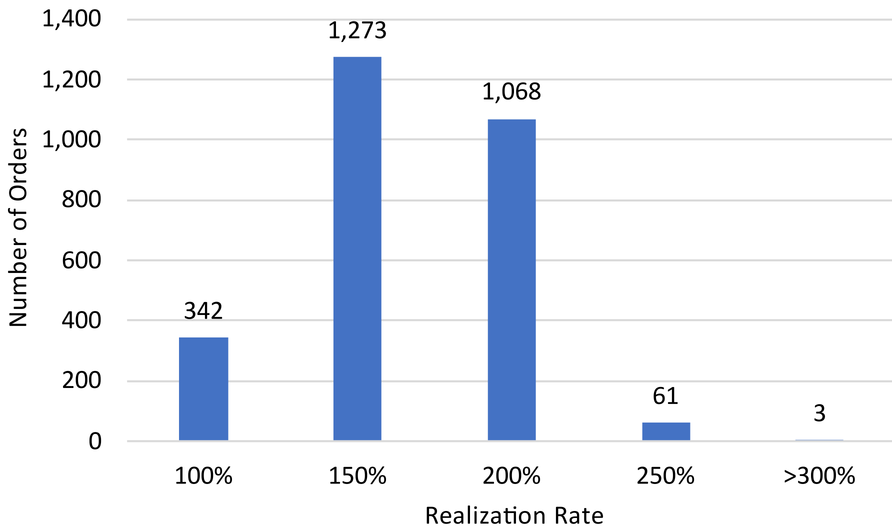


Figure 14-4 FY 17/18 kWh Realization Rate Distribution by Household

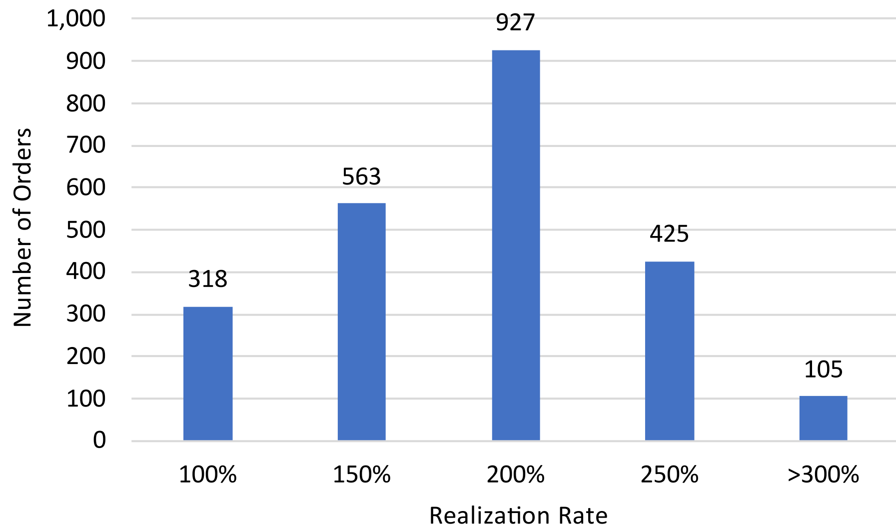


Figure 14-5 FY 18/19 kWh Realization Rate Distribution by Household

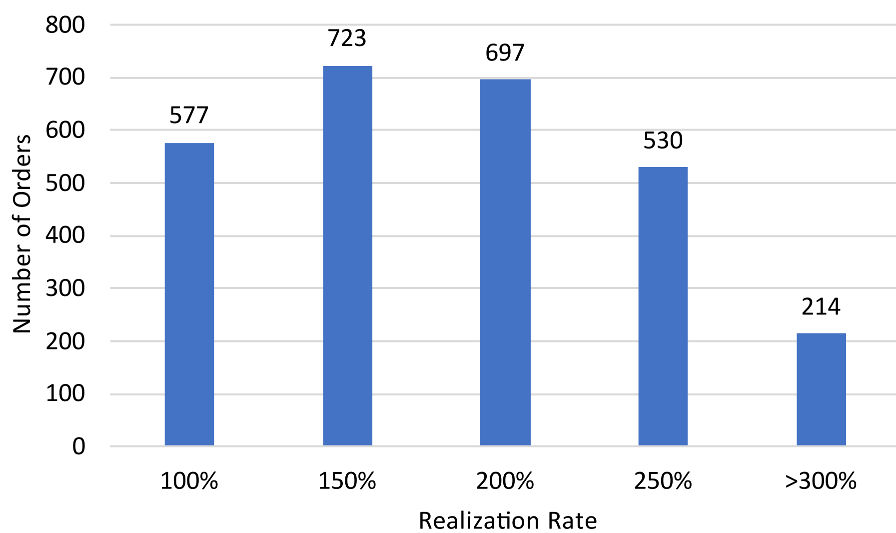
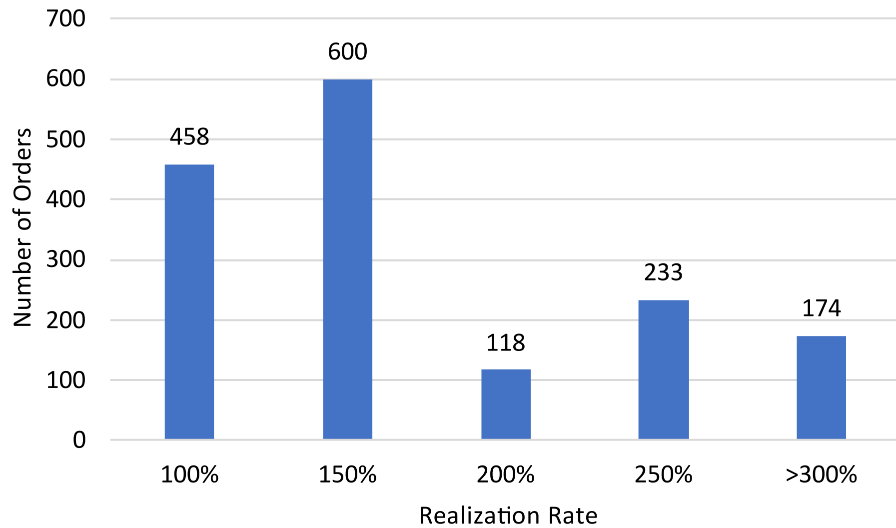


Figure 14-6 FY 19/20 kWh Realization Rate Distribution by Household



14.5.2 COVID-19 Impacts on Energy Use

The COVID-19 impact analysis largely follows the method described in Section 11.5.2. Weather-sensitive measures follow the method described for billing data regression with the modification that the regression was performed on weather-sensitive load as opposed to whole house load. Non-weather sensitive measures that were analyzed via an engineering approach for the Retrospective evaluation leveraged the non-participant analysis to determine COVID-19 impacts. COVID-19 impacts are presented in Table 14-23 and Table 14-24.

Table 14-23 HEIP COVID-19 Era Impact to Ex-Post Gross Energy Savings

Billing Analysis Measures	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
Window AC	52,306	20,224	-32,082	-61.3%
Pipe Wrap	2,475	957	-1,518	-61.3%
Attic Insulation	68,201	26,370	-41,831	-61.3%
Duct Sealing	3,305	1,278	-2,027	-61.3%
Air Sealing	221,840	85,773	-136,067	-61.3%
Total	348,127	134,602	-213,525	-61.3%

Table 14-24 HEIP COVID-19 Era Impact to Ex-Post Gross Energy Savings

Algorithmic Savings Measures	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Multiplier (B)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (A*B=C)	COVID-19 Era Incremental Change Ex-Post kWh Savings (C-A)
LED	1,866,823	1.173	2,190,073	323,250
CFL	9,667	1.173	11,340	1,674
Toilet	42,602	1.089	46,383	3,782
Showerhead	131,521	1.089	143,197	11,675
Aerator	32,805	1.089	35,717	2,912
Toilet Gasket	0	1.173	0	0
Total	2,083,418		2,426,711	343,293

14.6 Program Recommendations

In general, program gross realized savings have been near 100% throughout the Retrospective Period. Therefore, the Evaluator does not recommend further modifications to the assumptions or inputs used to calculate energy and peak demand impacts for the HEIP.

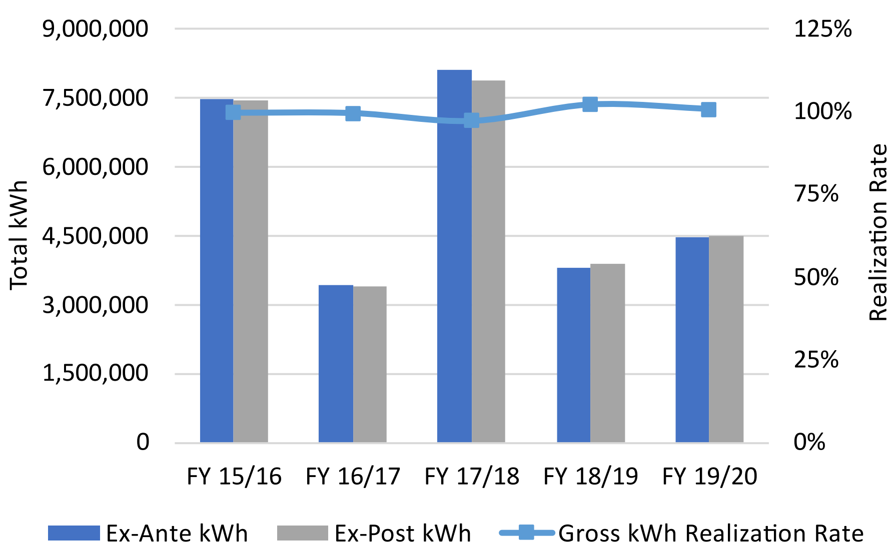
15 Low Income Refrigerator Exchange Program

This chapter presents an evaluation of the Low Income Refrigerator Exchange Program (REP) that LADWP offered customers during fiscal years (FY) 15/16 through 19/20 (Retrospective Period). The REP Program was administered by LADWP with implementation services provided by ARCA, Inc. (ARCA). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the REP.

15.1 Program Performance Summary

REP targets low income customers and replaces old, operable refrigerators in their homes with new ENERGY STAR-rated units. Once replaced, 95% of the materials from the removed refrigerator are recycled. This prevents the resale of old, inefficient units in the secondary market. Figure 15-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 15-1 Refrigerator Exchange Program Performance Summary



15.1.1 Key Evaluation Takeaways

- Savings were calculated for each unit based on the ENERGY STAR Unit Energy Consumption (UEC) formula, estimating energy use based on system capacity.
- The Evaluators found that kWh savings estimates from LADWP were highly accurate (99% realization). Peak demand impacts were higher than expected (117% realization).
- Through proper recycling of removed units, more than 4,000 tons of landfill waste was avoided through the program.

15.2 Program Description

LADWP's REP Program is designed to help customers reduce their energy consumption by removing old, working refrigerators from their homes to recycle them and providing a new ENERGY STAR rater refrigerator, free of charge. As an added environmental benefit, 95% of the materials from the old units can be recycled (metals, plastic, glass, oil, etc.) and disposed of in an environmentally responsible manner, thus preventing the materials from reaching landfills and contaminating the environment.

By offering a new energy efficient refrigerator and free pick up services, LADWP seeks to remove old inefficient units, prevent the continued use of older appliances as secondary units after new primary units are purchased, and prevent older units from being resold or transferred to other LADWP customers when no longer needed in the participant home.

LADWP's REP Program is operated as a turn-key program implemented by ARCA. The program is open to any LADWP income-qualified residential customer, or multi-residential or non-profit customer. The old refrigerator must be a minimum size of 14 cubic feet. Customers can request a home pick up through an online portal or over the phone with ARCA representatives.

In addition to pickup and delivery services of refrigerator units, LADWP offered residential customers a free kit containing LED bulbs. The energy impacts attributed to the LED kits is described in Chapter 17.

Table 15-1 presents Energy Savings Platform, Inc. (ESP) summary savings for the REP Retrospective Evaluation.

Table 15-1 REP Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Units	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
15/16	9,746	7,472,186	27.4%	1,126.00	22.5%
16/17	4,202	3,414,844	12.5%	506.64	10.1%
17/18	9,943	8,096,652	29.7%	1,213.00	24.2%
18/19	4,800	3,817,056	14.0%	975.96	19.5%
19/20	5,545	4,475,788	16.4%	1,181.00	23.6%
Total	34,236	27,276,526	100.0%	5,002.60	100.0%

15.3 Methodology

This section provides a brief summary of the methodology used by the Evaluator in the impact evaluation of the REP Program during the Retrospective Period. The following activities were performed:

- Tracking data review;
- Ex-Ante savings review; and
- M&V approach;

A detailed evaluation methodology is available in Appendix A, section A.14.1.

15.4 Impact Evaluation

This section presents a brief summary of the impact evaluation of the REP during the Retrospective Period. The following impact evaluation activities were performed:

- Full-year UEC calculation;
- Per-unit gross peak demand reduction; and
- Description of factors affecting gross realized savings.

A detailed impact evaluation is available in Appendix A, section A.14.2.

15.5 Ex-Post Gross Results and Findings

This section presents program-level Ex-Post gross energy savings and demand reduction by fiscal year. Table 15-2 and Table 15-3 combine the number of exchanged refrigerators through the program with per-unit Ex-Post gross impact estimates to show program-level gross energy savings and peak demand reduction. The overall kWh realization rate is 99% while overall kW realization rate is 117%.

Table 15-2 REP Retrospective Evaluation Energy Savings Results by Fiscal Year

Fiscal Year	Measure	Quantity	Verification Rate	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post Gross kWh Savings	Gross kWh Realization Rate
15/16	Refrigerator	9,746	100%	7,472,186	7,447,674	100%
16/17	Refrigerator	4,202	100%	3,414,844	3,399,936	100%
17/18	Refrigerator	9,943	100%	8,096,652	7,880,114	97%
18/19	Refrigerator	4,800	100%	3,817,056	3,895,226	102%
19/20	Refrigerator	5,545	100%	4,475,788	4,510,004	101%
Total		34,236		27,276,526	27,132,953	99%

Table 15-3 REP Retrospective Evaluation Demand Reduction Results by Fiscal Year

Fiscal Year	Measure	Quantity	Verification Rate	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post Gross kW Savings	Gross kW Realization Rate
15/16	Refrigerator	9,746	100%	1,126.00	1,248.93	111%
16/17	Refrigerator	4,202	100%	506.64	785.57	155%

Fiscal Year	Measure	Quantity	Verification Rate	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post Gross kW Savings	Gross kW Realization Rate
17/18	Refrigerator	9,943	100%	1,213.00	1,537.74	127%
18/19	Refrigerator	4,800	100%	975.96	1,092.54	112%
19/20	Refrigerator	5,545	100%	1,181.00	1,190.03	101%
Total		34,236		5,002.60	5,854.80	117%

15.5.1 Gross Realization Rate Distribution by Household

This section describes the distribution of Ex-Post Gross kWh realization rates by household for the REP Retrospective Evaluation. Figure 15-2 through Figure 15-6 show the distribution of realization rates for refrigerators installed during each fiscal year.

Figure 15-2 FY 15/16 kWh Realization Rate Distribution by Household

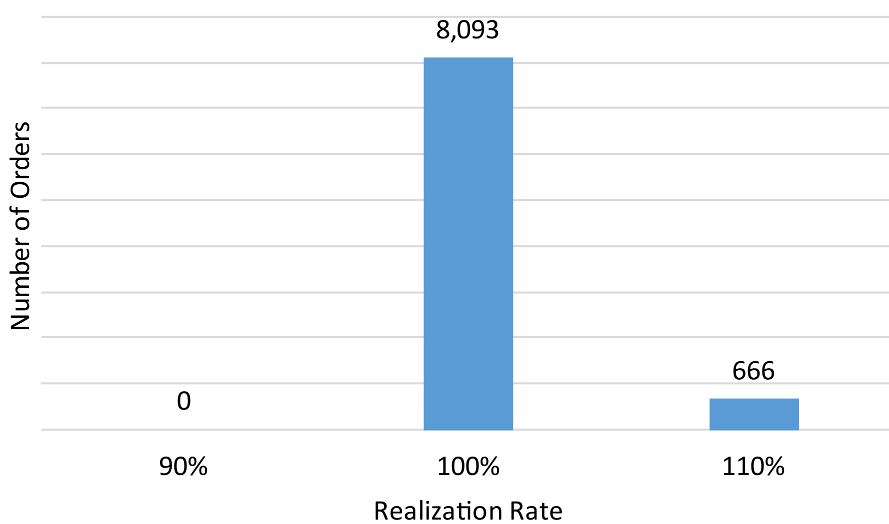


Figure 15-3 FY 16/17 kWh Realization Rate Distribution by Household

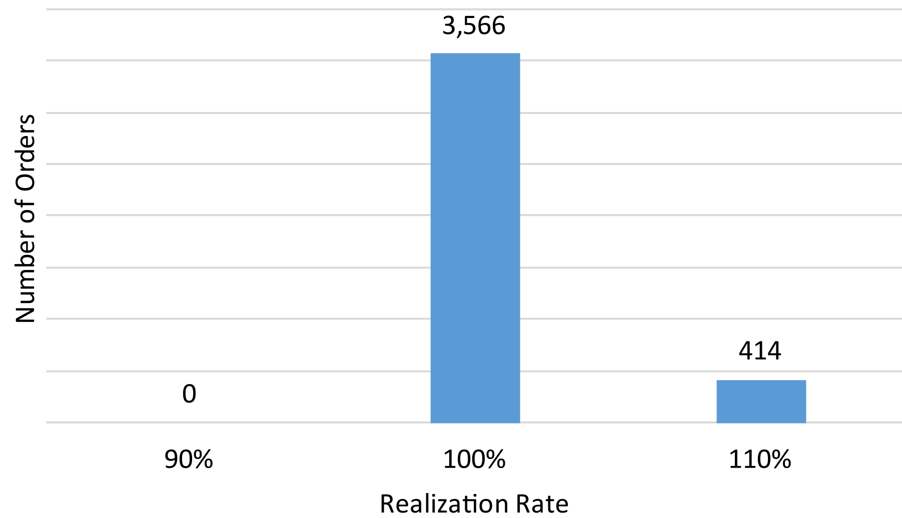


Figure 15-4 FY 17/18 kWh Realization Rate Distribution by Household

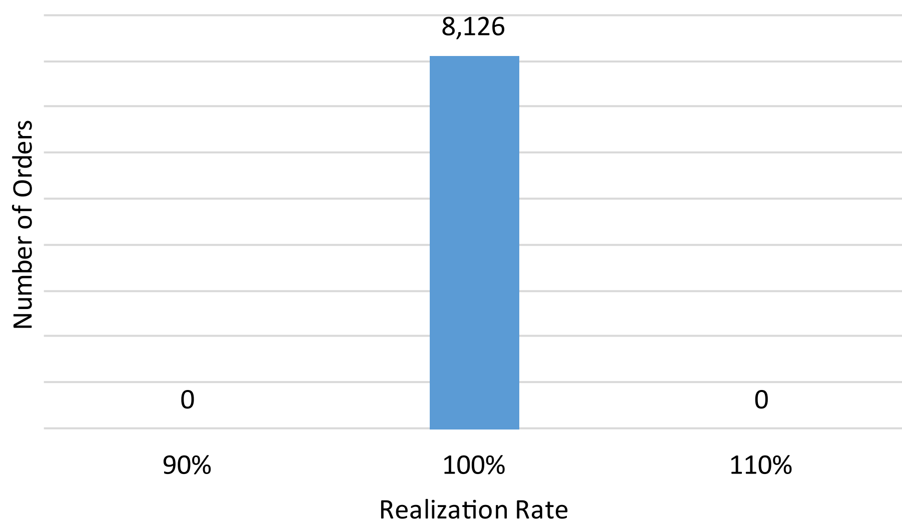


Figure 15-5 FY 18/19 kWh Realization Rate Distribution by Household

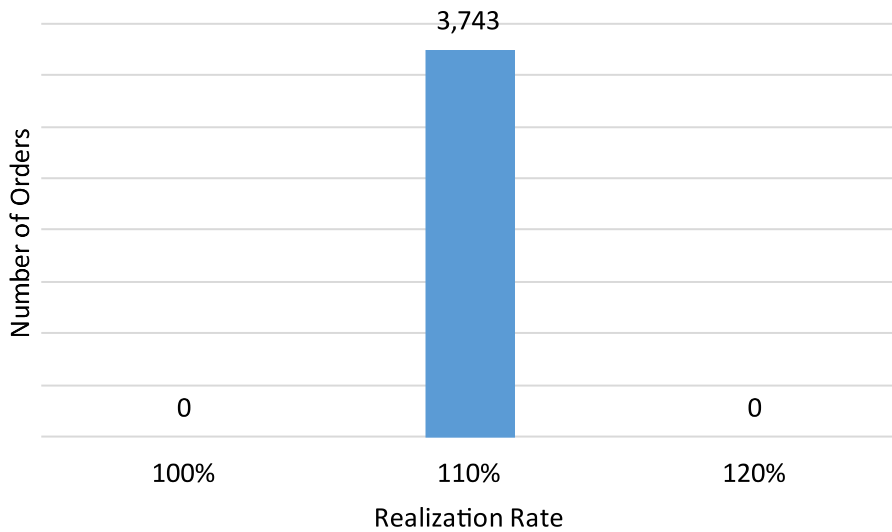
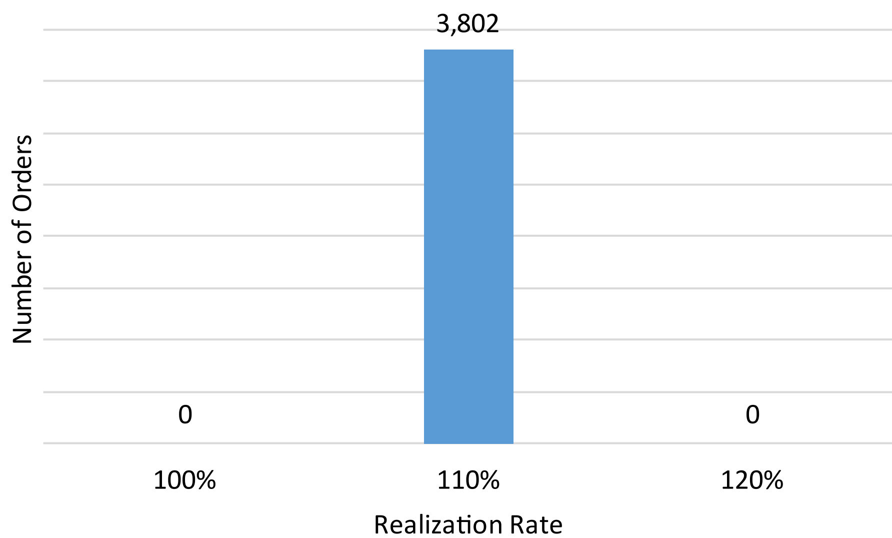


Figure 15-6 FY 19/20 kWh Realization Rate Distribution by Household



15.5.2 COVID-19 Impacts on Energy Use

COVID-19 impacts were not calculated for refrigerators because there was no significant indication that COVID-19 had an impact on refrigerator energy use or appliances that operate 8,760 annual hours.

15.6 Program Recommendations

In general, program gross realized savings have been near 100% throughout the Retrospective Period. Therefore, the Evaluator does not recommend further modifications to the assumptions or inputs used to calculate energy and peak demand impacts for the REP.

The ARCA tracking data could not be easily tied to the LADWP ESP summary reports to verify that both sources represented the same number of refrigerators delivered during the Retrospective Period. Therefore, the Evaluator recommends that data entered into ESP is checked to ensure that measure quantities match tracking data measure quantities.

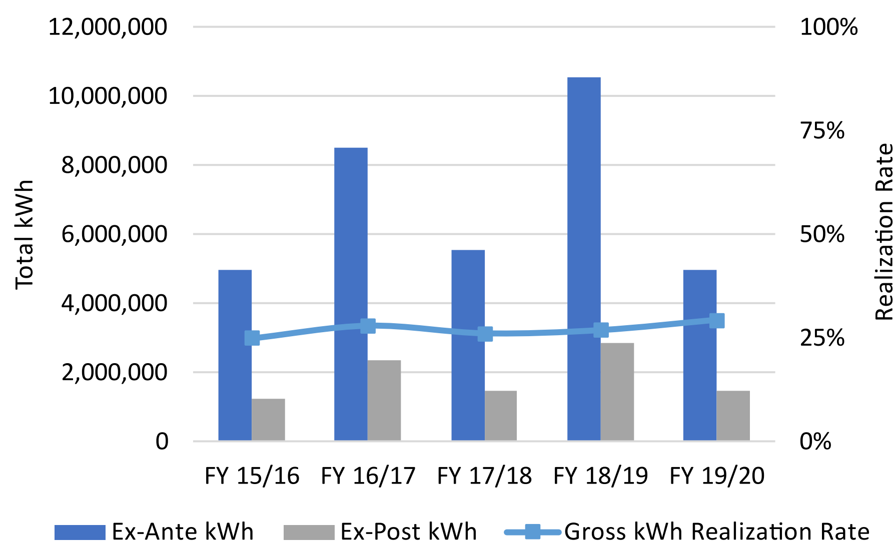
16 Refrigerator Turn-In and Recycle Program

This chapter presents an evaluation of the Refrigerator Turn-in and Recycle Program (RETIRE) that LADWP offered customers during fiscal years (FY) 15/16 through 19/20 (Retrospective Period). The RETIRE Program was administered by LADWP with implementation services provided by ARCA, Inc. (ARCA). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the RETIRE Program.

16.1 Program Performance Summary

RETIRE provides incentives for LADWP residential customers to recycle and dispose of older, operable refrigerators in an environmentally conscientious manner. Units include older models that customers are replacing with a new unit as well as secondary refrigerators, stand-alone freezers, and portable room and window air conditioners. Figure 16-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 16-1 Refrigerator Turn-in and Recycle Program Performance Summary



16.1.1 Key Evaluation Takeaways

- Savings were calculated for each unit based on the ENERGY STAR Unit Energy Consumption (UEC) formula, estimating energy use based on system capacity and survey responses addressing whether the unit would have been taken off the grid in the absence of the program. Realization for RETIRE was low (27% over the evaluation period).
- The Evaluators recommend revising energy savings as follows:

- Refrigerators: 528 kWh, .061 kW
- Freezers: 664 kWh, .079 kW

- Through proper recycling of removed units, more than 2,000 tons of landfill waste was avoided through the program.

16.2 Program Description

LADWP's RETIRE Program is designed to help customers reduce their energy consumption by removing old, working refrigerators and freezers from their homes to recycle them. The program provides annual electric energy savings for the remaining life of the unit by permanently removing the appliance from service. As an added environmental benefit, 95% of the materials from these units can be recycled (metals, plastic, glass, oil, etc.) and disposed of in an environmentally responsible manner, thus preventing the materials from reaching landfills and contaminating the environment.

The RETIRE Program provides free refrigerator/freezer pick up and recycling services for LADWP customers in addition to a $50 rebate for each unit. By offering financial incentives and free pick up services, LADWP seeks to remove unnecessary secondary units, prevent the continued use of older appliances as secondary units after new primary units are purchased, and prevent older units from being resold or transferred to other LADWP customers when no longer needed in the participant home.

Recycled refrigerators and freezers are typically quite old, are often located in unconditioned space such as a garage, and generally require more electricity for cooling compared to a newer unit. The recycling process halts their inefficient use of electric energy and safely disposes of environmentally harmful materials.

LADWP's RETIRE Program is operated as a turn-key program implemented by ARCA. The program is open to any LADWP residential or institutional customer. Customers may recycle up to two units per residential address per year. The units can range in size from 10 to 27 cubic feet. Customers can request a home pick up through an online portal or over the phone with ARCA representatives.

In addition to pick up and recycling services of refrigerator and freezer units, LADWP offered residential customers pick up and recycling services of old room air conditioners (ACs), and a free kit containing LED bulbs. The energy impacts attributed to room ACs are described later in this chapter. The energy impacts attributed to the LED kits are described in Chapter 17.

Table 16-1 presents Energy Savings Platform, Inc. (ESP) summary savings for the RETIRE Program Retrospective Evaluation.

Table 16-1 RETIRE Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Units	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
15/16	2,561	4,983,706	14.4%	758.00	17.3%
16/17	4,554	8,498,182	24.6%	1,310.10	29.9%
17/18	2,870	5,551,938	16.1%	0.30	0.0%
18/19	5,463	10,555,438	30.5%	995.37	22.7%
19/20	2,814	4,982,326	14.4%	1,322.08	30.1%
Total	18,262	34,571,590	100.0%	4,385.85	100.0%

16.3 Methodology

This section provides a brief summary of the methodology used by the Evaluator in the impact evaluation of the RETIRE Program during the Retrospective Period. The following activities were performed:

- Tracking data review;
- Ex-Ante savings review; and
- M&V approach;

A detailed evaluation methodology is available in Appendix A, section A.15.1.

16.4 Impact Evaluation

This section presents a brief summary of the impact evaluation of the RETIRE during the Retrospective Period. The following impact evaluation activities were performed:

- Verification of units recycled;
- Full-year UEC calculation;
- Part-use factors and counterfactual actions
- Per-unit gross peak demand reduction; and
- Description of factors affecting gross realized savings.

A detailed impact evaluation is available in Appendix A, section A.15.2.

16.5 Ex-Post Gross Results and Findings

This section presents program-level Ex-Post gross energy savings and demand reduction by fiscal year. Table 16-2 and Table 16-3 combine the number of verified refrigerators and freezers recycled through the program with per-unit Ex-Post gross impact estimates to show program-level gross energy savings and peak demand reduction. Room AC savings impacts are also included in the tables. The overall kWh realization rate is 27% and overall kW realization rate is 52%.

Table 16-2 RETIRE Retrospective Evaluation Energy Savings Results by Fiscal Year

Fiscal Year	Measure	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate
15/16	Freezer	251,034	84,095	33.5%
	Refrigerator	4,732,672	1,159,716	24.5%
16/17	Freezer	537,096	202,159	37.6%
	Refrigerator	7,961,086	2,165,512	27.2%
17/18	Air Conditioner	8,865	14,476	163.3%
	Freezer	261,724	85,569	32.7%
	Refrigerator	5,281,350	1,349,413	25.6%
18/19	Air Conditioner	2,280	33,895	1,486.6%
	Freezer	552,664	186,260	33.7%
	Refrigerator	10,000,494	2,614,881	26.1%
19/20	Air Conditioner	8,350	72,599	869.4%
	Freezer	214,060	81,348	38.0%
	Refrigerator	4,759,916	1,301,867	27.4%
Total		34,571,590	9,351,790	27.1%

Table 16-3 RETIRE Retrospective Evaluation Demand Reduction Results by Fiscal Year

Fiscal Year	Measure	ESP Data Ex-Ante kW Savings	ESP Data Ex-Post kW Savings	Gross kW Realization Rate
15/16	Freezer	38.18	14.05	37%
	Refrigerator	719.82	194.53	27%
16/17	Freezer	82.80	48.46	59%
	Refrigerator	1,227.30	519.07	42%
17/18	Air Conditioner	0.00	1.68	>100%
	Freezer	0.01	13.85	>100%
	Refrigerator	0.29	215.14	>100%
18/19	Air Conditioner	13.68	38.74	283%
	Freezer	52.23	52.24	100%
	Refrigerator	929.46	733.42	79%
19/20	Air Conditioner	9.62	83.66	869%
	Freezer	56.48	21.46	38%
	Refrigerator	1,255.97	343.52	27%
Total		4,385.85	2,279.83	52%

16.5.1 Gross Realization Rate Distribution by Household

This section describes the distribution of Ex-Post gross kWh realization rates by household for the RETIRE Retrospective Evaluation. The order number from program data was used to identify the households that participated. The total number of households may differ from total units recycled because one household could have recycled more than one appliance. Figure 16-2 through Figure 16-6 show the realization rate distribution for the RETIRE Program.

Figure 16-2 FY 15/16 kWh Realization Rate Distribution by Household

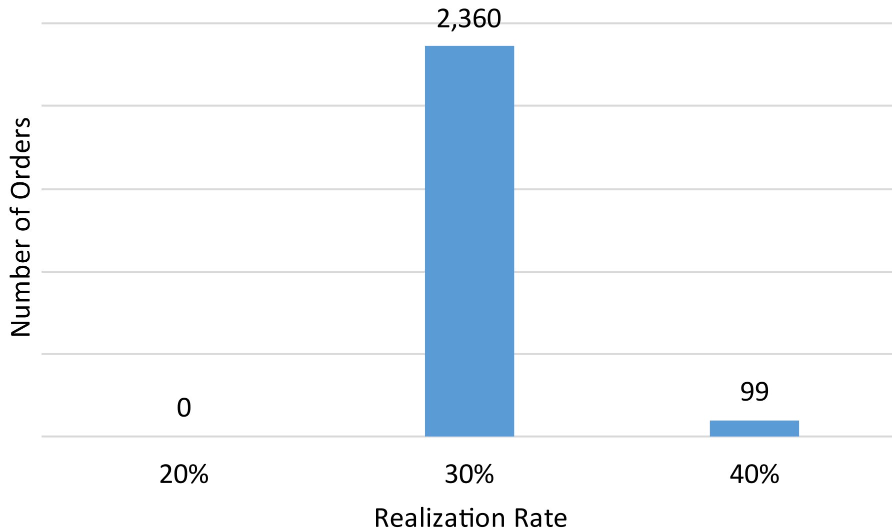


Figure 16-3 FY 16/17 kWh Realization Rate Distribution by Household

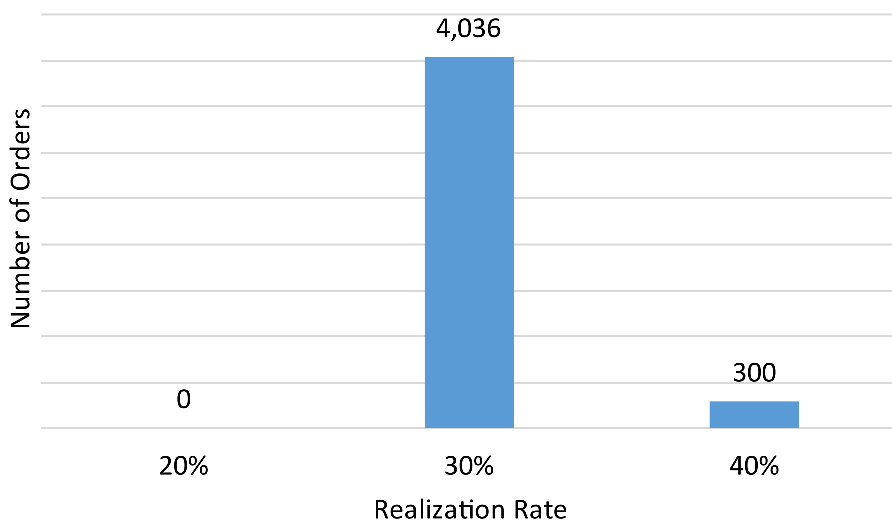


Figure 16-4 FY 17/18 kWh Realization Rate Distribution by Household

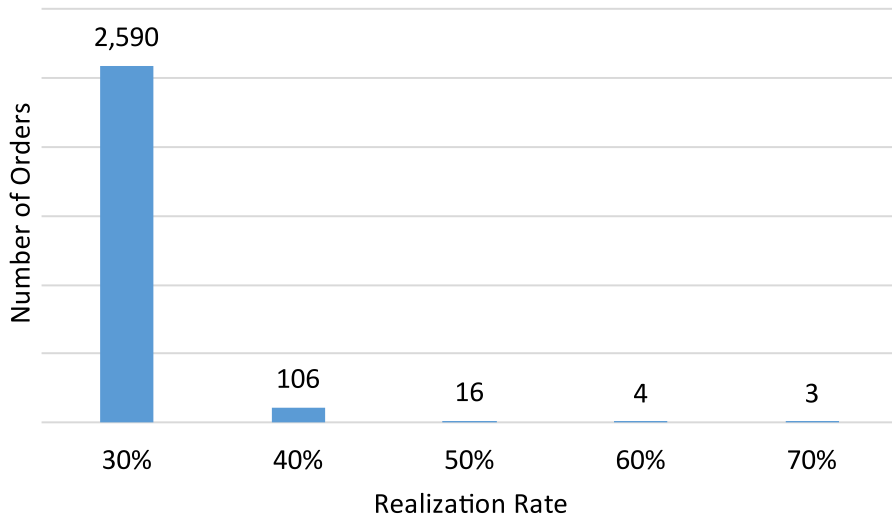


Figure 16-5 FY 18/19 kWh Realization Rate Distribution by Household

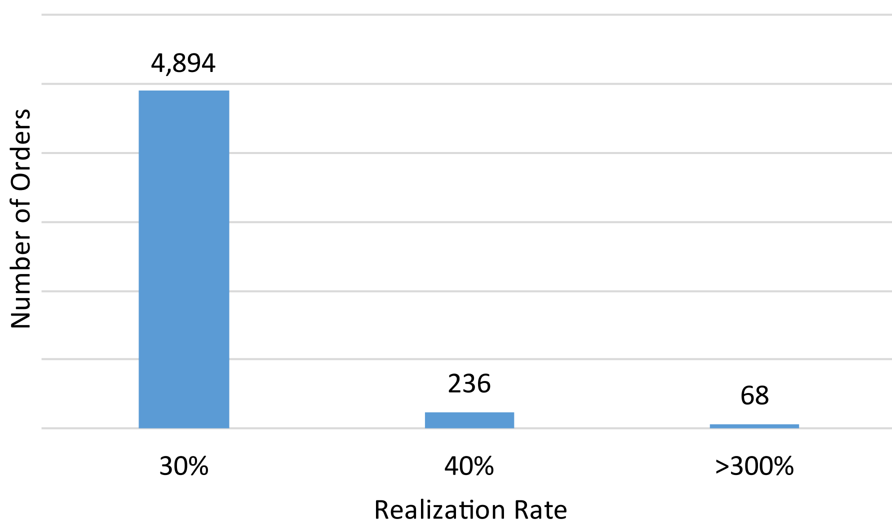
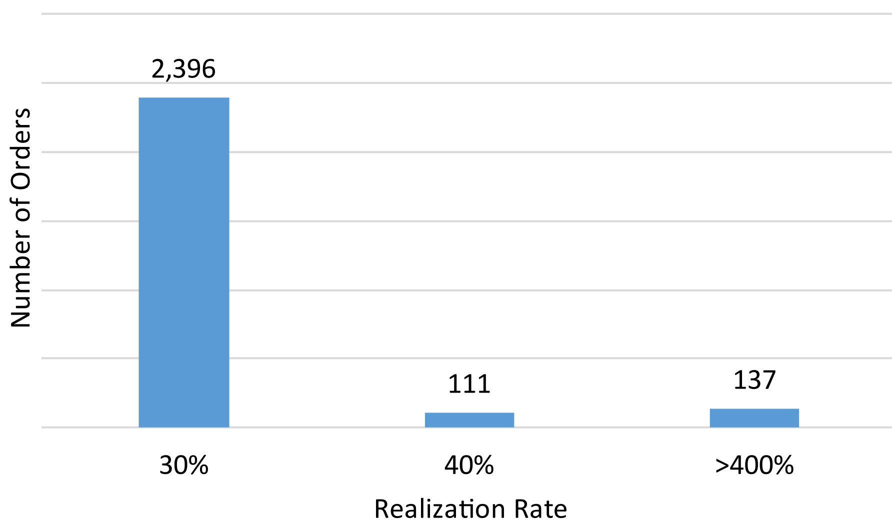


Figure 16-6 FY 19/20 kWh Realization Rate Distribution by Household



16.5.2 COVID-19 Impacts on Energy Use

COVID-19 impacts were not calculated for Refrigerators and Freezers because there was no significant indication that COVID-19 had an impact on refrigerator or freezer energy use. The method for estimating COVID-19 impacts for RETIRE for Room Air Conditioners follows the method detailed for billing data retrofit isolation in Section 11.5.2. COVID-19 impacts for Room ACs were calculated using FY 19/20 typical 1st year Ex-Post gross kWh savings as reference.

Table 16-4 RETIRE COVID-19 Era Impact to Ex-Post Gross Energy Savings

Measure	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Multiplier (B)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (A*B=C)	COVID-19 Era Incremental Change Ex-Post kWh Savings (C-A)
Room Air Conditioner	72,599	1.081	78,444	5,845

16.6 Program Recommendations

The Evaluator recommends that refrigerator and freezer full year UEC is adjusted using the UMP Protocol as well as calculating part use adjusted UEC using the 2010-2012 CA ARP evaluation methodology, in order to achieve the desired Ex-Post gross realized savings for the program.

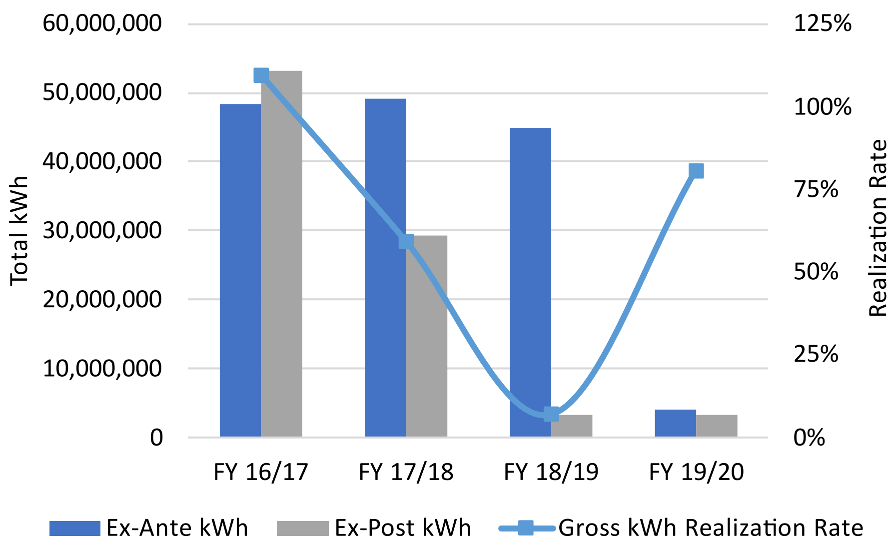
17 Residential Lighting Efficiency Program

This chapter presents the evaluation of the Residential Lighting Efficiency Program (RLEP) that LADWP offered to their residential customers during fiscal years (FY) 16/17 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the RLEP program.

17.1 Program Performance Summary

RLEP is designed to distribute free LED bulbs in a cost effective way and to deliver energy efficiency directly to all LADWP residential customers, both in single family and multifamily homes. LADWP has distributed free LED bulbs to all its customers (nearly 125,000 homes in its service territory) in each of three major campaigns. LED bulb kits are also distributed for free through the REP and the RETIRE Program, and other community outreach events. Figure 17-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 17-1 Residential Lighting Efficiency Program Performance Summary



17.1.1 Key Evaluation Takeaways

- From FY 16/17 to FY 19/20, LADWP distributed 4,333,552 LED kits to residents throughout Los Angeles, providing free-of-charge energy savings to all customers.
- Savings from LED kits are expected to diminish year to year because the baseline lamp disposition is expected to shift to a more efficient one as LED bulbs become the dominant installed technology in residential buildings; LED bulbs currently represent 44% of installed light bulbs in Los Angeles homes.

17.2 Program Description

The RLEP distributed LED lighting kits door-to-door to LADWP residential customers across three phases. Also, lesser quantities were distributed within the Refrigerator Exchange Program and also through community outreach events. The LED light kit consisted of two 12 watt LED lamps in a reusable bag assembled by AM Conservation group and distributed by the front door marketing company, Power Direct. Marketing material stated the LED light kit had the potential to save 138 kWh over their lifetime of 23 years.[1]

Each household received a door-hanger reusable bag, information sheet, and two LED lamps with the following features:

- A-lamp, omnidirectional, medium base, dimmable;
- ENERGY STAR listed, indoor/outdoor, 25,000 hour life;
- 12 Watts each, color temperature 2,700K; and
- >80 lumens per watt efficacy; 1,000-1,350 lumens.

In addition to the lighting kits, there were also LED bulbs distributed without the reusable bag through other programs, such as REP and RETIRE.

Table 17-1 lists the number of kits distributed during Retrospective Period fiscal years along with the energy and peak demand impacts from the Energy Savings Platform, Inc. (ESP) tracking system. FY 15/16 did not have energy savings, but costs were incurred for program planning and rollout.

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[1] "LADWP delivers energy efficiency directly to its residential customers", https://www.ladwpnews.com/ladwp-delivers-energy-efficiency-directly-to-its-residential-customers/, June 17,2019

Table 17-1 RLEP Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of LED Kits	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
16/17	1,394,714	48,382,070	33.0%	5097.00	33.1%
17/18	1,415,288	49,095,775	33.5%	5173.00	33.6%
18/19	1,292,474	44,835,406	30.6%	4,723.65	30.6%
19/20	231,076	4,147,835	2.8%	422.26	2.7%
Total	4,333,552	146,461,086	100.0%	15,415.91	100.0%

17.3 Methodology

Tracking data was reviewed to ensure that the data provided sufficient information to verify program participation and to calculate energy and peak demand impacts.

Data collection was leveraged by the General Population Survey completed for FY 15/16 through FY 19/20. Savings were evaluated via the efficient product specifications, referenced workpapers for interactive factors, and survey response data for lamp usage in the household.

A detailed evaluation methodology is available in Appendix A, section A.16.1.

17.4 Impact Evaluation

Energy savings for LED bulbs were calculated using engineering equations. Collected data used for inputs in the savings algorithm are listed in Table 17-2.

Table 17-2 RLEP Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
kWh, kW	Measure savings per program year	Algorithm from Database for Energy Efficiency Resources (DEER) workpapers	Equation A-49 and Equation A-50
Qty_{ver}	Quantity verified in tracking data to ESP data	RLEP tracking data	100% aligned
HOU	Annual hours of use	RLEP General Population Survey, 2021	Interior: 716 hours Exterior: 2,884 hours
$Watts_{base}$	Weighted baseline mix of existing lamps	California Statewide Residential Appliance Saturation Study 2019	LADWP service area weighted baseline mix: 29.9 W
$Watts_{efficient}$	LED Lamp wattage	RLEP Program	12 W
IE	Interactive Effects Factor by climate zone	LA Assessor Data & DEER Lighting Interactive Factors	Varies by climate zone
ISR	In Service Rate	RLEP General Population Survey, 2021	14,716 Surveys Deployed
CDF	Coincident Demand Factor	LA Assessor Data & DEER Lighting Interactive Factors	Varies by climate zone

A detailed impact evaluation is available in Appendix A, section A.16.2.

17.5 Ex-Post Gross Results and Findings

This section presents program-level Ex-Post gross energy savings and demand reduction by fiscal year. Table 17-3 list the Ex-Post Gross kWh Savings by fiscal year. The overall kWh realization rate is 59%. The realization rates by fiscal year decrease substantially starting in FY 18/19 due to the enactment of the CA Title 20, requiring general service, medium base, A-lamps to only be sold with an efficacy of 80 lumens per watt or greater. During this time, however, the 2019 Residential Appliance Saturation Study (RASS) was conducted with California residents from August 2019 through February 2020. The RASS provided customer responses that indicated a baseline wattage of 29.9, which is a lower value than the CA Title 20 baseline standard and results in greater energy savings. The Evaluator did not apply the RASS baseline condition to FY 19/20 but will apply it for the Concurrent evaluation.

Table 17-3 RLEP Retrospective Evaluation Energy Savings Results by Fiscal Year

Fiscal Year	Measure	Lamp Quantity	ISR	HOU	IE	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross Realization Rate
16/17	LED Lamps	2,789,428	75%	1,328	1.04	48,382,070	53,093,779	110%
17/18	LED Lamps	2,831,160	75%	1,328	1.04	49,095,775	29,258,124	60%
18/19	LED Lamps	2,584,948	75%	1,328	1.04	44,835,406	3,208,990	7%
19/20	LED Lamps	231,076	75%	1,328	1.04	4,147,835	3,344,105	81%
Total		8,436,612				146,461,086	88,904,998	51%

Table 17-4 list the Ex-Post peak kW reduction by fiscal year. The overall kW realization rate is 68%.

Table 17-4 RLEP Retrospective Evaluation Demand Reduction Results by Fiscal Year

Fiscal Year	Measure	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Peak kW Savings	Gross Realization Rate
16/17	LED Lamps	5,097.00	6,349.31	125%
17/18	LED Lamps	5,173.00	3,665.60	71%
18/19	LED Lamps	4,723.00	380.21	8%
19/20	LED Lamps	422.26	444.85	9%
Total		15,415.26	10,839.97	70%

17.5.1 COVID-19 Impacts on Energy Use

FY 19/20 was further analyzed for the effect of the COVID-19 pandemic on energy usage at home. A billing analysis was performed to determine baseline energy usage by climate zone. The city of Los Angeles Assessor data for the location of homes by climate zone was weighted with its respective COVID-19 Era energy usage to estimate the change in savings from the installed lighting measure. The result of the analysis is shown in Table 17-5.

Table 17-5 RLEP COVID-19 Era Impact to Ex-Post Gross Energy Savings

Measure	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Multiplier (B)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (A*B=C)	COVID-19 Era Incremental Change Ex-Post kWh Savings (C-A)
Lighting	3,344,105	1.065	3,561,472	217,367

17.6 Program Recommendations

With the enactment of the CA Title 20, requiring general service, medium base, A-lamps to only be sold with an efficacy of 80 lumens per watt or greater, normal replacements may not realize any measurable energy savings. Early replacements of existing incandescent, CFL or halogen A-lamps would realize savings for their remaining life, but their remaining life is much less than the LED EUL, resulting in a low value for lifetime energy savings. For example, a halogen lamp has a remaining useful life of two years in which case early replacement energy savings starting in the third year would be drastically reduced with CA Title 20 enacted.

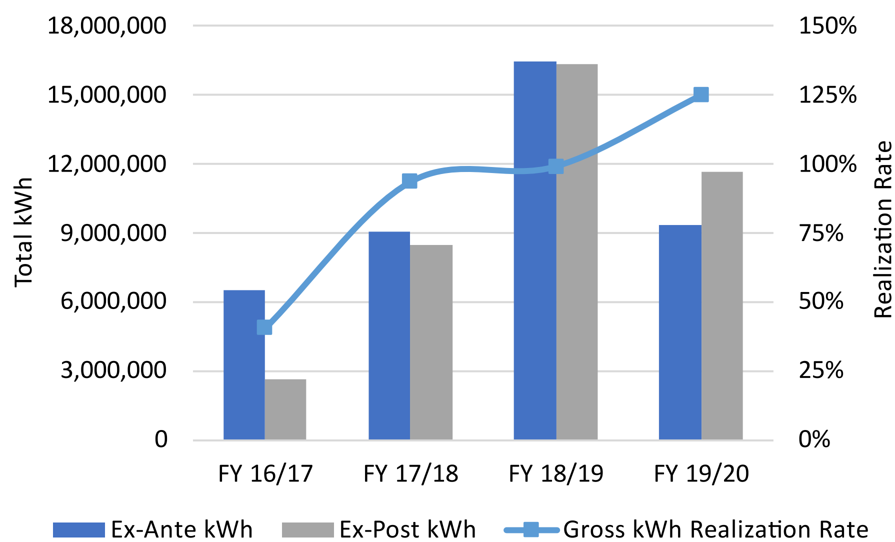
18 Air Conditioning Optimization Program

This chapter presents an evaluation of the Air Conditioning Optimization Program (ACOP) that LADWP offered customers during fiscal years (FY) 16/17 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the ACOP.

18.1 Program Performance Summary

ACOP is a cross-sector program that provides incentives for heating and cooling system tune-ups, replacements, and installation of system controls that reduce energy use through reduction of systems' dehumidification process. Figure 18-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 18-1 Air Conditioning Optimization Program Performance Summary



18.1.1 Key Evaluation Takeaways

- The program had 90% kWh realization, though realization rates ranged from 44% in FY 16/17 to 125% in FY 19/20.
- Low realization was driven most often by shortfalls in savings from multifamily projects. Though multifamily projects from FY 19/20 had 101% realization, for FY 16/17 through FY 18/19 multifamily projects averaged 66% realization. Commercial projects consistently overperformed compared to LADWP expectations, culminating with 230% realization in FY 18/19 and 406% realization in FY 19/20.

18.2 Program Description

ACOP provides services to LADWP residential and commercial customers by licensed, certified HVAC technicians to service space cooling systems and provide free of charge maintenance and energy efficiency services.

Free of charge services offered include:

- Replacement or cleaning of standard air filters;
- Outdoor coil cleaning;
- System diagnostic test;
- Refrigerant charge adjustment (up to 2 lbs. of refrigerant will be provided, if applicable);
- Installation of smart, Wi-Fi enabled thermostat (for compatible residential systems only, if customer does not already have a smart thermostat);
    - Zoned systems only qualify for one thermostat; and
- If the customer's home is not Wi-Fi enabled, or would prefer not to have a smart thermostat installed, the following AC system or Heat Pump alternatives can be installed at no charge to the customer:
    - Western Cooling Control

Table 18-1 summarizes the ACOP Energy Savings Platform, Inc. (ESP) Ex-Ante energy savings and peak demand reduction and each fiscal year's contribution to Retrospective savings.

Table 18-1 ACOP Retrospective Ex-Ante Savings Summary

Fiscal Year	Number of Projects	ESP Data Ex-Ante kWh Savings	Proportion of kWh Savings	ESP Data Ex-Ante Peak kW Savings	Proportion of Peak kW Savings
16/17	3,589	6,520,555	15.8%	N/A	N/A
17/18	11,981	9,073,741	21.9%	N/A	N/A
18/19	23,603	16,454,977	39.8%	15,903.91	69.4%
19/20	17,562	9,339,043	22.6%	7,007.70	30.6%
Total	56,735	41,388,316	100.0%	22,911.61	100.0%

18.3 Methodology and Impact Evaluation

This section presents a brief summary of the tracking data review, and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program. The following key activities were performed:

- Tracking Data Review;
- Ex-Ante Savings Review;
- M&V Approach; and
- Billing Analysis Approach.

A detailed evaluation methodology and impact evaluation is available in Appendix A, section A.17.1.

18.4 Ex-Post Gross Results and Findings

Table 18-2 summarizes the measure-level per-unit Ex-Post kWh savings and peak kW reduction for the Retrospective Period.

Table 18-2 ESAP Retrospective Summary Ex-Post Per-unit Energy Savings

Fiscal Year	Measure	Per-unit Ex-Post kWh Savings	Per-unit Ex-Post Peak kW Savings
16/17	Commercial	2,173	0.607
	Multi-Residential	447	0.246
	Single Family	770	0.366
	Undetermined	425	0.219
17/18	Commercial	1,257	0.351
	Multi-Residential	447	0.246
	Single Family	770	0.366
	Undetermined	425	0.219
18/19	Commercial	1,606	0.449
	Multi-Residential	447	0.246
	Single Family	770	0.366
	Undetermined	425	0.219
19/20	Commercial	3,256	0.910
	Multi-Residential	447	0.246
	Single Family	770	0.366
	Undetermined	425	0.219
Total		689	0.330

The Evaluator extrapolated the above measure-level energy and demand savings with the total number of unique measures per Retrospective fiscal year presented in the program tracking data. Table 18-3 through Table 18-6 summarize the program-level ESP Ex-Ante and Ex-Post energy savings for each Retrospective fiscal year. The overall kWh realization rate is 94%.

Table 18-3 ACOP FY 16/17 Evaluation Energy Savings Results by Measure

Measure	Quantity	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post Gross kWh Savings	Gross Realization Rate
Commercial	62	112,643	134,751	120%
Multi-Residential	30	54,504	13,413	25%
Single Family	2,960	5,377,777	2,279,041	42%
Undetermined	537	975,631	228,094	23%
Total	3,589	6,520,555	2,655,299	41%

Table 18-4 ACOP FY 17/18 Evaluation Energy Savings Results by Measure

Measure	Quantity	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post Gross kWh Savings	Gross Realization Rate
Commercial	248	344,537	311,674	90%
Multi-Residential	2,493	1,564,512	1,114,606	71%
Single Family	9,081	7,085,377	6,991,884	99%
Undetermined	159	79,315	67,536	85%
Total	11,981	9,073,741	8,485,700	94%

Table 18-5 ACOP FY 18/19 Evaluation Energy Savings Results by Measure

Measure	Quantity	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post Gross kWh Savings	Gross Realization Rate
Commercial	387	269,799	621,339	230%
Multi-Residential	6,430	4,482,714	2,874,816	64%
Single Family	16,450	11,468,220	12,665,619	110%
Undetermined	336	234,244	142,718	61%
Total	23,603	16,454,977	16,304,492	99%

Table 18-6 ACOP FY 19/20 Evaluation Energy Savings Results by Measure

Measure	Quantity	ESP Data Ex-Ante kWh Savings	Program Data Ex-Post Gross kWh Savings	Gross Realization Rate
Commercial	469	375,725	1,527,167	406%
Multi-Residential	9,211	4,058,951	4,118,185	101%
Single Family	7,702	4,857,440	5,930,128	122%
Undetermined	180	46,927	76,456	163%
Total	17,562	9,339,043	11,651,936	125%

Table 18-7 through Table 18-10 summarize the program-level Ex-Ante and Ex-Post peak demand savings for each Retrospective fiscal year. The overall kW realization rate is 160%.

Table 18-7 ACOP FY 16/17 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Gross Peak kW Savings	Gross Realization Rate
Commercial	62	N/A	43.58	>100%
Multi-Residential	30	N/A	8.55	>100%
Single Family	2,960	N/A	1,255.12	>100%
Undetermined	537	N/A	136.21	>100%
Total	3,589	N/A	1,443.46	>100%

Table 18-8 ACOP FY 17/18 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Gross Peak kW Savings	Gross Realization Rate
Commercial	248	N/A	174.76	>100%
Multi-Residential	2,493	N/A	1,232.31	>100%
Single Family	9,081	N/A	6,675.20	>100%
Undetermined	159	N/A	69.92	>100%
Total	11,981	N/A	8,152.19	>100%

Table 18-9 ACOP FY 18/19 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Gross Peak kW Savings	Gross Realization Rate
Commercial	387	260.76	137.36	53%
Multi-Residential	6,430	4,332.59	3,285.89	76%
Single Family	16,450	11,084.16	15,085.77	136%
Undetermined	336	226.40	31.55	14%
Total	23,603	15,903.91	18,540.56	117%

Table 18-10 ACOP FY 19/20 Evaluation Demand Reduction Results by Measure

Measure	Quantity	ESP Data Ex-Ante Peak kW Savings	ESP Data Ex-Post Gross Peak kW Savings	Gross Realization Rate
Commercial	469	97.83	397.65	406%
Multi-Residential	9,211	1,056.89	1,072.31	101%
Single Family	7,702	5,840.76	7,130.59	122%
Undetermined	180	12.22	19.91	163%
Total	17,562	7,007.70	8,620.46	123%

18.4.1 COVID-19 Impacts on Energy Use

The method for estimating COVID-19 impacts for ACOP for Multi-Residential, Single Family, and Undetermined follows the method detailed for billing data retrofit isolation in Section 11.5.2. For the Commercial measure, because a within-participants billing data regression was used to perform the retrospective isolation, a within-participants billing data regression like the regression detailed in Section A.17.1.4 was performed on the post-installation period preceding and during COVID-19, to assess the change in overall consumption between a typical year and COVID-19. The Evaluator used this change in overall consumption as a best approximation of the impact of COVID-19 on ACOP Gross Ex-Post for the Commercial measure. Consistent with temporary business closures associated with the COVID-19 pandemic, energy consumption for Commercial participants was substantially reduced. Thus, a similar reduction was inferred for ACOP Commercial adjusted Gross Ex-Post savings; see Table 18-11.

Table 18-11 ACOP COVID-19 Era Impact to Ex-Post Gross Energy Savings

Measure	Typical 1st Year Ex-Post kWh Savings (A)	COVID-19 Era Adjusted Annual Ex-Post kWh Savings (B)	COVID-19 Era Incremental Change Ex-Post kWh Savings (B-A)	COVID-19 Era % Change Ex-Post Savings [(B-A)/A]
Commercial	1,527,167	-64,129	-1,591,296	-104.2%
Multi-Residential	4,118,185	4,609,412	491,227	11.9%
Single Family	5,930,128	6,856,614	926,486	15.6%
Undetermined	76,456	86,366	9,910	13.0%
Total	11,651,936	11,488,262	-163,674	-1.4%

18.5 Program Recommendations

The Evaluator has recommendations for the ACOP EM&V for the upcoming Concurrent Evaluation.

A review of the program tracking data and ex-post results show a realization rate of 71% and 64% respectively for FY 17/18 and FY 18/19 for Multifamily (Table 18-4 and Table 18-5), although the realization rate increased for FY 19/20 (Table 18-6). This discrepancy appears to be due to overstated Ex-Ante values for Multifamily, the value of which was reduced in FY 19/20 (i.e., 697 kWh/household in FY 18/19 vs. 440 kWh/household in FY 19/20). In general, the Evaluator recommends maintaining these reduced Ex-Ante savings moving forward.

In general, realization rates were high for Commercial with high volatility for each of the four fiscal years. Although a formal analysis of the different business types was not performed, this is mostly likely attributable both to the nature of the Commercial sector, where savings fluctuates depending on the business type and size, and an understatement of Ex-Ante savings by measure. Moving forward, the Evaluator recommends adopting different Ex-Ante measure savings values by business type and increasing Ex-Ante savings with consideration to the hours of operation and size of that respective business type.

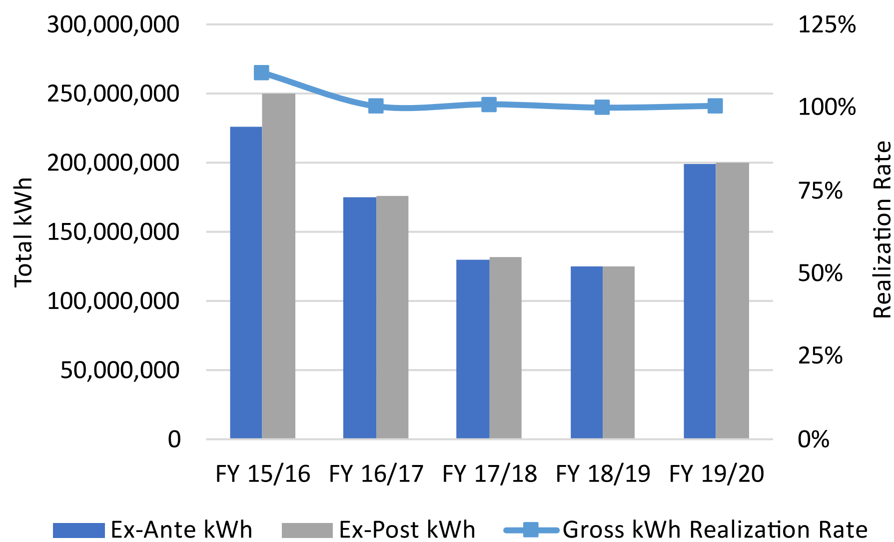
19 Codes, Standards, and Ordinances Program

This chapter presents an evaluation of the Codes, Standards, and Ordinances (CSO) Program that LADWP offered customers during fiscal years (FY) 15/16 through 19/20 (Retrospective Period). The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the CSO Program.

19.1 Program Performance Summary

CSO conducts advocacy to improve code requirements for building, appliance, and water use efficiency. CSO aggregates the impacts of enhancements to statewide codes and standards (Title 20 and Title 24) in addition to local codes. This evaluation period included Title 24, LA Plumbing Ordinance, and LA Cool Roof Ordinance. Figure 19-1 compares Ex-Ante and Ex-Post energy savings across the Retrospective Period.

Figure 19-1 Codes, Standards, and Ordinances Program Performance Summary



19.1.1 Key Evaluation Takeaways

- The bulk of program impacts are derived from Title 24, and LADWP's methodology for parsing impacts from statewide results and applying them to their service territory was sound.
- The Evaluator found opportunities to update city-wide assumptions based on the 2019 Residential Appliance Saturation Survey (RASS), such as the percent of existing homes with air conditioning.
- LADWP was discontinuing savings from cool roofs once incorporated into Title 24; the Evaluators recommend extending inclusion by 6 months since Title 24 is updated by calendar-year.

19.2 Program Description

The Codes, Standards, and Ordinances (CSO) program conducts advocacy to improve code requirements for building, appliance, and water use efficiency. The CSO program aggregates the impacts of enhancements to statewide codes and standards (Title 20 and Title 24) in addition to local codes adopted in the City of Los Angeles. The history of code adoptions is summarized below.

Table 19-1 Title 24 Editions & Adoption Dates

Title 24 Edition	Effective Date
2013 Edition	1/1/2014
2016 Edition	1/1/2017
2019 Edition	1/1/2020

In addition, the CSO program incorporates impacts from the following Los Angeles ordinances:

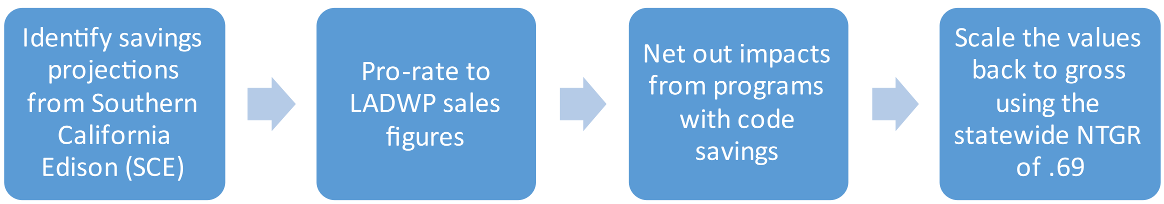
- Cool Roof Ordinances
  - Requires installation of cool roofs on new construction and for permitted roof replacements
  - Low-slope ≤ 2:12: .63 solar reflectance, .75 solar emittance, 75 solar reflectance index (SRI)
  - Steep-slope > 2:12: .20 solar reflectance, .75 solar emittance, 16 SRI
- Plumbing Ordinances – Residential
  - Toilets: ≤ 1.28 gallons per flush (GPF)
  - Showerheads: ≤ 2.0 GPM
  - Urinals: ≤.5 GPF
  - Prohibited use of single-pass cooling systems
- Plumbing Ordinances – Non-residential
  - Urinals: ≤.5 GPF
  - Public lavatory faucets: ≤ .5 gallons per minute (GPM)
  - Pre-rinse spray valves (PRSVs): ≤ 1.6 GPM
  - Dishwashers: lower high-temp and chemical gallons/rack by system type
  - Cooling Towers: minimum 5.5 cycles of concentration

- Prohibited use of single-pass cooling systems

19.3 Methodology

The methodology for evaluation of impacts for the CSO Program entailed a review of the allocation procedure applied by LADWP to allocate Title 24 impacts to the LADWP service territory and to scale the impacts of the Cool Roof and Plumbing Ordinances. LADWP applies the FY 14/15 Electric Resource Assessment Model (ELRAM) Potential Study projection for Codes and Standards impacts. These are scaled as:

Figure 19-2 CSO Savings Estimation Process Flow



LADWP uses the CPUC's Integrated Standard Savings Model (ISSM) to estimate the attribution factor for statewide codes and standards savings. Attribution factors are analogous to net-to-gross factors for standard programs. Attribution factors range from 53% to 75% for Title 20 and Title 20/24, and the weighted average of these factors is 69.2%. SCE's estimates are then scaled up by this factor to convert attribution factors into gross impacts.

19.3.1 Ex-Ante Savings Review

Savings estimates for CSO were aligned between data provided by LADWP to the Evaluator and to that filed by LADWP in ESP. Ex-ante savings estimates are summarized in Table 19-2.

Table 19-2 CSO Retrospective Ex-Ante Savings Summary

Fiscal Year	Title 24 Ex-Ante kWh	Cool Roof Ex-Ante kWh	Plumbing Ex-Ante kWh	Title 24 Ex-Ante Peak kW	Cool Roof Ex-Ante Peak kW	Plumbing Ex-Ante Peak kW
15/16	247,660,189	677,552	1,319,760	57,468.39	908.88	22.71
16/17	173,463,937	677,552	1,319,760	42,347.94	908.88	22.71
17/18	128,532,357	677,552	1,319,760	41,730.30	908.88	22.71
18/19	121,712,235	2,031,780	1,319,760	41,868.55	2,725.46	22.71
19/20	197,563,132	0	1,319,760	41,027.25	0	22.71
Total	868,931,850	4,064,436	6,598,800	224,442.43	5,452.10	113.55

19.4 Impact Evaluation

This section presents the findings of the impact evaluation of the CSO Program during the Retrospective Period. Ex-Post gross energy savings and peak demand reduction are presented at the measure level.

19.4.1 Cool Roof Ordinances

The Evaluator reviewed the assumptions developed by LADWP for estimation of savings for cool roofs. Two sets of input parameters were provided:

- One set for FY 15/16-FY 17/18
- One set for FY 18/19-FY 19/20

The 2019 edition of Title 24 incorporated cool roofs. As a result, LADWP claimed zero savings for the Cool Roof Ordinance for FY 19/20.

Table 19-3 summarizes Cool Roof Ordinance savings parameters and adjustments made by the Evaluator.

Table 19-3 CSO Cool Roof Ordinance Savings Parameters

Parameter	Ex-Ante Value: FY 15/16-FY 17/18	Ex-Ante Value: FY 18/19-FY 19/20	Ex-Post Value	Source for Revision
Roof replacements per year	3,500	7,388	3,500 for FY 15/16-FY 17/18, 7,388 for FY 18/19-FY 19/20	
New Homes per Year	1,898	1,898	1,898	
Square Feet of Average Roof of Existing Home	1,500	2,411	1,898	2,411 was a more precise estimate. Evaluator concluded this is applicable to FY 15/16 – FY 17/18

Parameter	Ex-Ante Value: FY 15/16-FY 17/18	Ex-Ante Value: FY 18/19-FY 19/20	Ex-Post Value	Source for Revision
Square feet of Roof New Homes	1,500	2,411	1,648	2,411 was a more precise estimate. Evaluator concluded this is applicable to FY 15/16 – FY 17/18
kWh /sq. ft.^{2} / year	.28 for CZ9	.28	.28	
Adjustment factor for multiple climate zones	.70	.70	.70	
Ratio of new construction / retrofit savings	.20	.20	.20	
Percent of existing homes with AC	55%	55%	58%	2019 RASS
Percent of new homes with AC	100%		100%	

Table 19-4 summarizes the savings estimates and realization rates for the Cool Roof Ordinance. Key factors that resulted in adjustments to savings include:

- Updating of roof square footage for FY 15/16-FY 17/18. LADWP used an estimate of 1,500 square feet as the average roof size for FY 15/16-FY 17/18. Research by LADWP subsequent to this identified average roof square footage of 2,411, which was used for FY 18/19. The Evaluator concluded this to be a more accurate estimate and since it encompassed existing housing, applied it to FY 18/19.
- LADWP savings calculations assumed 55% saturation of central air conditioning, based on the 2009 Residential Appliance Saturation Survey (RASS). The Evaluator updated this to 58%, based on the 2019 RASS.
- LADWP claimed no savings from the Cool Roof Ordinance for FY 19/20, due to this measure being incorporated into Title 24. The Evaluator assigned savings scaled by 50%, as the 2019 edition of Title 24 took effect January 1, 2020 – halfway through LADWP FY 19/20. Essentially, this credits the Cool Roof Ordinance for projects completed from 7/1/2019 – 1/1/2020.

Table 19-4 CSO Cool Roof Ordinance Retrospective Evaluation Results by Fiscal Year

Fiscal Year	Housing Type	kWh			kW		
		Ex-Ante	Ex-Post	Realization	Ex-Ante	Ex-Post	Realization
15/16	Retrofit	565,950	959,289	169.5%	765.53	1297.58	169.5%
	NC	111,602	179,382	160.7%	143.35	230.41	160.7%
16/17	Retrofit	565,950	959,289	169.5%	765.53	1297.58	169.5%
	NC	111,602	179,382	160.7%	143.35	230.41	160.7%
17/18	Retrofit	565,950	959,289	169.5%	765.53	1297.58	169.5%
	NC	111,602	179,382	160.7%	143.35	230.41	160.7%
18/19	Retrofit	1,920,180	2,024,921	105.5%	2,575.76	2716.26	105.5%
	NC	111,600	111,602	100.0%	149.70	149.70	100.0%
19/20	Retrofit	0	1,012,461	N/A	0.00	1,358.13	N/A
	NC	0	55,801	N/A	0	74.85	N/A
Total		4,064,436	6,620,798	162.9%	5,452.10	8,882.91	162.9%

19.4.2 Plumbing Ordinances

The Plumbing Ordinance applied a simplified estimation of impacts based on:

1. USEPA WaterSense estimates of a 12-15 year cycle of fixtures
2. Energy intensity of water taken from the Urban Water Management Plan (1.60 MWH/Acre Foot), derived for the period of 2003-2010.

The resulting estimate is 2,160 acre-feet per year (AFY). The Evaluator did not adjust the water savings estimates as these are a long-term, longitudinal estimate for a 20 year horizon of code compliance and thus mid-cycle adjustments run the risk of adversely affecting accuracy on this longer horizon examined by the City of Los Angeles. However, the water intensity estimate was an older value and does not reflect current conditions (such as ongoing drought conditions after 2010). In an updated study of regional water intensity performed for the CPUC, the South Coast region was found to have an aggregate water intensity of 2.206 MWH per foot acre. The resulting impacts are summarized in Table 19-5.

Table 19-5 CSO Plumbing Ordinance Retrospective Evaluation Results by Fiscal Year

Fiscal Year	Plumbing Ex-Ante kWh	Plumbing Ex-Post kWh	Realization Rate	Plumbing Ex-Ante kW	Plumbing Ex-Post kW	Realization Rate
15/16	1,319,760	1,819,619	137.9%	22.71	31.31	137.9%
16/17	1,319,760	1,819,619	137.9%	22.71	31.31	137.9%
17/18	1,319,760	1,819,619	137.9%	22.71	31.31	137.9%
18/19	1,319,760	1,819,619	137.9%	22.71	31.31	137.9%
19/20	1,319,760	1,819,619	137.9%	22.71	31.31	137.9%
Total	6,598,800	9,098,096	137.9%	113.55	156.56	137.9%

19.4.3 Title 20/24

LADWP assigns savings for Title 20/24 on a pro-rated basis, comparing total sales to Southern California Edison. In LADWP's prior evaluation, savings for code attribution were adjusted upwards due to an adjustment to how LADWP pro-rated impacts; formerly, LADWP compared impacts to statewide totals, but this was changed in the last evaluation to align with SCE sector-level values. The Evaluator concurred with this revision, and thus concluded that LADWP correctly pro-rated SCE codes and standards values to scale for the LADWP service territory; see Table 19-6.

Table 19-6 CSO Title 20/24 Retrospective Evaluation Results by Fiscal Year

Fiscal Year	Title20/24 Ex-Ante kWh	Title20/24 Ex-Post kWh	Realization Rate	Title 20/24 Ex-Ante Peak kW	Title 20/24 Ex-Post Peak kW	Realization Rate
15/16	247,660,189	247,660,189	100%	57,468.39	57,468.39	100%
16/17	173,463,937	173,463,937	100%	42,347.94	42,347.94	100%
17/18	128,532,357	128,532,357	100%	41,730.30	41,730.30	100%
18/19	121,712,235	121,712,235	100%	41,868.55	41,868.55	100%
19/20	197,563,132	197,563,132	100%	41,027.25	41,027.25	100%
Total	868,931,850	868,931,850	100%	224,442.43	224,442.43	100%

19.4.4 Ex-Post Gross Results and Findings

This section presents program-level Ex-Post gross energy savings and demand reduction by fiscal year for the CSO Program.

Table 19-7 CSO Retrospective Evaluation Energy Savings Results by Fiscal Year

Fiscal Year	Title20/24 Ex-Ante kWh	Title20/24 Ex-Post kWh	Cool Roof Ex-Ante kWh	Cool Roof Ex-Post kWh	Plumbing Ex-Ante kWh	Plumbing Ex-Post kWh
15/16	247,660,189	247,660,189	677,552	1,138,671	1,319,760	1,819,619
16/17	173,463,937	173,463,937	677,552	1,138,671	1,319,760	1,819,619
17/18	128,532,357	128,532,357	677,552	1,138,671	1,319,760	1,819,619
18/19	121,712,235	121,712,235	2,031,780	2,136,523	1,319,760	1,819,619
19/20	197,563,132	197,563,132	-	1,068,262	1,319,760	1,819,619
Total	868,931,850	868,931,850	4,064,436	6,620,798	6,598,800	9,098,096

Table 19-8 CSO Retrospective Evaluation Demand Reduction Results by Fiscal Year

Fiscal Year	Title20/24 Ex-Ante kW	Title20/24 Ex-Post kW	Cool Roof Ex-Ante kW	Cool Roof Ex-Post kW	Plumbing Ex-Ante kW	Plumbing Ex-Post kW
15/16	57,468.39	57,468.39	908.88	1527.99	22.71	31.31
16/17	42,347.94	42,347.94	908.88	1527.99	22.71	31.31
17/18	41,730.30	41,730.30	908.88	1527.99	22.71	31.31
18/19	41,868.55	41,868.55	2725.46	2865.96	22.71	31.31
19/20	41,027.25	41,027.25	0.00	1432.98	22.71	31.31
Total	224,442.43	224,442.43	5,452.10	8,882.91	113.55	156.56

Table 19-9 CSO Retrospective Evaluation Results by Fiscal Year

Fiscal Year	Ex-Ante kWh	Ex-Post kWh	Realization Rate	Ex-Ante kW	Ex-Post kW	Realization Rate
15/16	249,657,501	250,618,479	100%	58,399.98	59,027.69	101%
16/17	175,461,249	176,422,227	101%	43,279.53	43,907.24	101%
17/18	130,529,669	131,490,647	101%	42,661.89	43,289.60	101%
18/19	125,063,775	125,668,377	100%	44,616.72	44,765.82	100%
19/20	198,882,892	200,451,013	101%	41,049.96	42,491.54	104%
Total	855,777,139	884,650,743	103%	230,008.08	233,481.89	102%

Table 19-10 CSO Retrospective Evaluation Results by Measure

Measure	Ex-Ante kWh	Ex-Post kWh	kWh Realization	Ex-Ante kW	Ex-Post kW	kW Realization
Title 20/24	868,931,850	868,931,850	100%	224,442.43	224,442.43	100%
Cool Roof	4,064,436	6,620,798	163%	5,452.10	8,882.91	163%
Plumbing	6,598,800	9,098,095	138%	113.55	156.55	138%
Total	879,595,086	884,650,743	103%	230,008.08	233,481.89	102%

19.4.4.1 COVID-19 Impacts on Energy Use

Impact estimates for CSO are based on long-term average projections under business-as-normal conditions. Without revisions to code impact estimates from the CA IOUs and the CPUC, estimation of COVID impacts for LADWP is not feasible.

19.5 Program Recommendations

The Evaluator's recommendations are as follows:

- When LADWP local ordinances are subsumed by Title 20/24, include a half year of savings during the fiscal year affected by the Title 20/24 effective date. Title 20/24 editions take effect on a calendar-year basis (January 1). LADWP program years align with a 7/1 – 6/30 fiscal year. Thus, when an LADWP code is subsumed by Title 20/24, there are still six months of the affected fiscal year that can be attributed to the LADWP CSO Program.
- Revisit energy intensity estimates on an ongoing basis to obtain new estimates that may be updated in a manner accounting for drought conditions. The energy intensity estimates used by LADWP were developed prior to 2010. The Evaluator has updated this with a South Coast Hydrological Region energy intensity estimate developed in 2014. This updated value better reflects current energy intensity conditions.
- Incorporate the 2019 RASS into savings estimates that rely on territory-wide market conditions/assumptions. The saturation rate of central cooling increased from 55% to 58% from the 2009 to the 2019 RASS. LADWP should research existing Ex-Ante estimates that use territory-wide market parameters to identify other relevant updates that may be completed with the new RASS.

20 Cost Effectiveness Evaluation

This chapter provides an overview of cost effectiveness for the LADWP energy efficiency portfolio, along with total program costs and benefits, as well as a summary of the cost effectiveness analysis. Costs include program costs incurred in the implementation of the LADWP energy efficiency portfolio during the Retrospective Period. Cost effectiveness results by program are available in Section 20.2.

20.1 Cost Effectiveness Summary

The cost-effectiveness of LADWP's programs was calculated based on reported total spending and verified energy savings for each of the energy efficiency programs. All spending estimates and incentive costs were provided by LADWP. The methods used to calculate cost-effectiveness are informed by the California Standard Practice Manual.

To calculate the cost-effectiveness of each program, measure lives were assigned on a measure-by-measure basis. When available, measure life values were obtained from DEER workpapers. Additionally, assumptions regarding incremental/full measure costs were necessary. Avoided energy, capacity, and transmission/distribution costs used to calculate cost-effectiveness were provided by LADWP.

Table 20-1 lists benefits and costs along with cost effectiveness results for each fiscal year during the Retrospective Period. Cost effectiveness results are shown for the Total Resources Cost (TRC) Test, Program Administrator Cost (PAC) Test, the Rate-payer Impact Measure (RIM) Test, Participant Cost Test (PCT), and Modified Total Resources Cost (MTRC) Test.

Table 20-1 Retrospective Portfolio Level Cost Effectiveness Results

Fiscal Year	PAC		TRC		PCT		RIM		MTRC	
	Benefits/ Costs*	Ratio	Benefits/ Costs*	Ratio	Benefits/ Costs*	Ratio	Benefits/ Costs*	Ratio	Benefits/ Costs*	Ratio
15/16	$265,179	4.02	$265,179	17.02	$640,716	NA.	$265,179	0.38	$265,179	17.02
	$66,005		$15,582		$0		$691,997		$15,582	
16/17	$278,109	2.33	$278,109	10.75	$771,682	>1.00	$278,109	0.32	$278,109	10.75
	$119,575		$25,860		$18		$875,594		$25,860	
17/18	$240,204	1.89	$240,204	2.19	$625,473	36.48	$240,204	0.33	$240,204	2.19
	$127,014		$109,630		$17,145		$723,356		$109,630	
18/19	$293,796	1.74	$293,796	3.59	$874,098	26.49	$293,796	0.32	$293,796	3.59
	$169,161		$81,743		$33,000		$922,841		$81,743	
19/20	$248,192	1.26	$248,192	2.87	$901,756	67.23	$248,192	0.25	$248,192	2.87
	$196,981		$86,435		$13,413		$974,785		$86,435	
Grand Total	$1,325,480	1.95	$1,325,480	4.15	$3,813,725	59.99	$1,325,480	0.32	$1,325,480	4.15
	$678,736		$319,250		$63,575		$4,188,573		$319,250	
*Dollar amounts in thousands of dollars										

20.2 Cost Effectiveness Program Results

The LADWP portfolio consisted of nineteen programs with verified gross kWh savings of 1,049,617,004. Total spending in the Retrospective Period equaled $678,735,980. Table 20-2 through Table 20-6 provides a summary of program cost effectiveness results for PAC, TRC, PCT, RIM, and MTRC. Measure-level cost effectiveness program results are presented in Appendix B .

Table 20-2 FY 15/16 Program Level Cost Effectiveness Results

Program	PAC	TRC	PCT	RIM	MTRC
	Ratio				
CDI	1.12	36.22	0.00	0.31	36.22
CLIP	1.95	3.52	0.00	0.37	3.52
CPP	2.69	8.46	0.00	0.35	8.46
FSP Comprehensive	3.39	5.99	0.00	0.35	5.99
LADWP Facilities	0.12	36.22	0.00	0.09	36.22
SBD	0.48	0.48	0.00	0.22	0.48
CRP	1.13	3.52	0.00	0.32	3.52
ESAP	5.25	36.22	0.00	0.40	36.22
HEIP	0.38	36.22	0.00	0.19	36.22
LIREP	0.83	36.22	0.00	0.28	36.22
RETIRE	2.58	36.22	0.00	0.47	36.22

Program	PAC	TRC	PCT	RIM	MTRC
	Ratio				
CSO	33.99	33.99	0.00	0.42	33.99
Portfolio Total	4.02	17.02	0.00	0.38	17.02

Table 20-3 FY 16/17 Program Level Cost Effectiveness Results

Program	PAC	TRC	PCT	RIM	MTRC
	Ratio				
CDI	0.93	28.80	0.00	0.27	28.80
CLIP	2.37	5.20	0.00	0.32	5.20
CPP	2.45	6.48	0.00	0.31	6.48
FSP Comprehensive	1.02	1.27	0.00	0.29	1.27
LADWP Facilities	0.11	0.32	0.00	0.08	0.32
LAUSD DI	0.33	13.50	53.69	0.17	13.50
SBD	1.86	33.85	0.00	0.31	33.85
UHVAC	3.04	16.26	0.00	0.42	16.26
CRP	1.02	4.97	0.00	0.30	4.97
EPM	0.56	0.72	0.00	0.32	0.72
ESAP	1.25	46.07	0.00	0.28	46.07
HEIP	0.53	0.95	0.00	0.21	0.95
LIREP	0.78	8.41	0.00	0.25	8.41
RETIRE	2.43	7.09	0.00	0.36	7.09
RLEP	1.91	24.51	0.00	0.28	24.51
ACOP	0.64	0.74	0.00	0.37	0.74
CSO	37.20	37.21	0.00	0.37	37.21
Portfolio Total	2.33	10.75	44,063.11	0.32	10.75

Table 20-4 FY 17/18 Program Level Cost Effectiveness Results

Program	PAC	TRC	PCT	RIM	MTRC
	Ratio				
CDI	0.77	0.77	217.35	0.26	0.77
CLIP	5.07	3.55	35.07	0.38	3.55
CPP	5.79	5.79	0.00	0.37	5.79
FSP Comprehensive	1.23	1.26	11.47	0.24	1.26
LADWP Facilities	0.34	0.39	15.72	0.19	0.39
LAUSD DI	0.25	3.93	47.33	0.15	3.93
SBD	1.25	2.90	8.69	0.31	2.90
UHVAC	2.47	11.45	0.00	0.44	11.45
CRP	4.29	2.01	11.32	0.41	2.01
EPM	1.93	1.17	3.46	0.69	1.17

Program	PAC	TRC	PCT	RIM	MTRC
	Ratio				
ESAP	1.03	1.03	0.00	0.27	1.03
HEIP	0.44	0.85	12.12	0.19	0.85
LIREP	0.70	0.68	54.67	0.25	0.68
RETIRE	0.69	0.89	2.73	0.29	0.89
RLEP	1.93	17.15	0.00	0.29	17.15
MFWB	1.84	2.13	9.05	0.25	2.13
ACOP	0.49	0.54	0.52	0.36	0.54
CSO	20.63	20.63	0.00	0.38	20.63
Portfolio Total	1.89	2.19	36.48	0.33	2.19

Table 20-5 FY 18/19 Program Level Cost Effectiveness Results

Program	PAC	TRC	PCT	RIM	MTRC
	Ratio				
CDI	0.74	3.36	347.27	0.22	3.36
CLIP	1.80	4.65	51.79	0.29	4.65
CPP	3.12	1.91	5.49	0.40	1.91
FSP Comprehensive	0.30	0.30	15.51	0.16	0.30
LADWP Facilities	0.00	0.00	214.30	0.00	0.00
LAUSD DI	0.38	0.61	70.37	0.18	0.61
SBD	1.55	1.93	11.10	0.30	1.93
UHVAC	2.58	1.50	4.27	0.42	1.50
CRP	0.92	2.65	16.50	0.32	2.65
EPM	1.11	1.43	5.90	0.53	1.43
ESAP	0.64	0.64	4.60	0.20	0.64
HEIP	0.57	0.64	29.37	0.25	0.64
LIREP	0.92	3.23	128.06	0.31	3.23
RETIRE	1.51	2.31	0.00	0.36	2.31
RLEP	0.40	0.53	0.00	0.17	0.53
ACOP	0.70	2.47	7.48	0.45	2.47
CSO	165.36	165.36	0.00	0.37	165.36
Portfolio Total	1.74	3.59	26.49	0.32	3.59

Table 20-6 FY 19/20 Program Level Cost Effectiveness Results

Program	PAC	TRC	PCT	RIM	MTRC
	Ratio				
CDI	0.46	1.65	384.40	0.16	1.65
CLIP	1.23	2.80	55.34	0.20	2.80
CPP	1.96	2.52	20.62	0.27	2.52

Program	PAC	TRC	PCT	RIM	MTRC
	Ratio				
FSP Comprehensive	0.19	0.21	168.17	0.11	0.21
FSP POS	0.20	0.23	23.60	0.11	0.23
LADWP Facilities	0.08	0.10	42.15	0.06	0.10
LAUSD DI	0.19	0.76	103.28	0.10	0.76
SBD	1.22	1.38	9.89	0.25	1.38
UHVAC	1.52	3.61	0.00	0.37	3.61
CRP	0.48	2.05	17.13	0.28	2.05
EPM	1.23	1.17	4.71	0.55	1.17
ESAP	0.69	0.69	4.30	0.20	0.69
HEIP	0.28	0.30	102.20	0.16	0.30
LIREP	0.40	0.66	127.62	0.19	0.66
RETIRE	0.93	1.19	0.00	0.29	1.19
RLEP	0.47	0.48	0.00	0.17	0.48
MFWB	1.27	1.50	9.73	0.21	1.50
ACOP	0.68	2.42	0.00	0.37	2.42
CSO	14.79	14.79	0.00	0.32	14.79
Portfolio Total	1.26	2.87	67.23	0.25	2.87

Appendix A Program-Level Evaluation Methodology & Impact/Process Evaluation

This appendix presents detailed evaluation methodology descriptions, as well as the work performed to complete impact evaluations for the LADWP Energy Efficiency Programs offered during the Retrospective Period.

A.1. CDI Program

This section details the impact evaluation for the Commercial Direct Install (CDI) program that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation was to calculate energy savings and peak demand impacts attributable to the CDI Program.

A.1.1. Evaluation Methodology

This section presents the findings of the tracking data review and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program.

As part of the impact evaluation, the Evaluator performed the following data collection activities outlined in Table A-1:

Table A-1 CDI Data Sources for Impact Evaluation

Data	Source
Program Tracking Data	Data requested to LADWP for all data tracking program participation
Desk Review	Reviews of project documentation (Proposed Activity Report, Post Installation Report, Ex-Ante project spreadsheet) of a sample of customers who have participated in the program
Virtual Verification	Virtual site visits of a sample of customers to collect data for savings calculation, to verify installation, and determine operating parameters

A.1.1.1. Tracking Data Review

LADWP provided the Evaluator with the available program tracking data for rebated measures. The database review process started with a tracking data review to ensure that the data provided sufficient information to calculate energy and peak demand impacts. The Evaluator identified 30,794 unique projects, totaling 343,683,154 kWh for the Retrospective Period.

A.1.1.2. M&V Sample Design

A stratified sampling plan was developed using aggregated CDI program data for FY 15/16 through FY 19/20 provided by LADWP.

The sample projects were selected for further exploration, and full project documentation was requested by the Evaluator. Estimation of total program savings was based on a ratio estimation procedure, which allowed precision and confidence requirements to be met with a smaller sample size. The Evaluator selected a sample with enough projects to estimate the total achieved savings with ±10% precision at the 90% confidence interval. To apply the ratio estimation procedure, the Evaluator produced two estimates of gross savings for each project sampled: an expected (Ex-Ante) gross savings estimates as reported in the program tracking system, and the verified (Ex-Post) gross savings estimate developed through the M&V procedures. Program-level gross savings were then developed by applying Ex-Post savings realization rates calculated for sample projects to the program level Ex-Ante savings.

To further improve the precision, projects were selected for the sample through systematic random sampling. That is, a sample of sites is selected by ordering them according to the magnitude of their savings and using systematic random sampling. Sampling systematically from a list that is ordered according to the magnitude of energy savings ensures that any sample selected will have some units with high savings, some with moderate savings, and some with low savings.

Table A-2 presents the number of projects and tracking Ex-Ante kWh savings for the population of projects by stratum.

Table A-2 CDI Population Statistics used for Sample Design

	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5	Stratum 6	Total
Strata boundaries (Ex-Ante kWh)	<2,200	2,200-7,000	7,000-20,000	20,000-59,988	59,988-199,325	>199,325	
Population Size	9,588	10,810	6,273	3,082	973	68	30,794
Total Ex-Post kWh Savings	6,452,326	37,633,683	91,778,605	86,223,375	70,543,467	20,969,038	313,600,495
Average Ex-Post kWh Savings	673	3,481	14,631	27,976	72,501	308,368	
Standard Deviation of Ex-Post kWh Savings	464	1,137	4,534	8,971	26,780	115,583	
Coefficient of Variation	0.69	0.33	0.31	0.32	0.37	0.37	
Final Design Sample	4	4	6	9	10	3	36

The resulting sample of 36 projects consisted of 6 categories, or strata. The Ex-Post gross annual energy savings (kWh) precision was ±9.8%.

A.1.1.3. Baseline Assumptions Review

Generally, for projects involving lighting measures, savings were determined as follows:

$$kWh_{Savings} = \frac{Watt_{Baseline} * HOU_{Baseline} * Qty_{Baseline} - Watt_{Installed} * HOU_{Installed} * Qty_{Installed}}{1000} * IEFe \qquad \textit{Equation A-1}$$

$$kWh_{Code} = \frac{Watt_{Code} * HOU_{Baseline} * Qty_{Baseline} - Watt_{Installed} * HOU_{Installed} * Qty_{Installed}}{1000} * IEFe \qquad \textit{Equation A-2}$$

$$\Delta kW = (\mathrm{Watt}_{\mathrm{Baseline}} - Watt_{Installed}) * CF * IEFd/1000 \qquad \textit{Equation A-3}$$

$$Dual\ Baseline\ Lifetime\ Savings = kWh_{Savings} * \frac{EUL}{3} + kWh_{Code} * (EUL - \frac{EUL}{3}) \qquad \textit{Equation A-4}$$

Equation A-1 and Equation A-3 detail the equations used to determine energy savings and peak demand reduction for lighting measures. Dual baseline lifetime savings were calculated as a part of the program analysis, detailed in Equation A-4. Calculation of dual baseline lifetime savings required the use of savings using code standards found using Equation A-2. The baseline assumptions made for energy savings and peak demand reduction calculations are detailed below.

Baseline Wattage: For the Ex-Post savings analysis, the baseline wattage was considered as the wattage of the pre-retrofit lighting fixture. However, for the purpose of calculating dual baseline lifetime savings, savings were also calculated using a code-specified baseline wattage. For Tube LEDs, High Bay LEDs, and LED Troffer Kits, the code baseline wattage was calculated using a code efficacy value taken from DEER workpapers along with the lumens of the installed fixture. For Screw-In LEDs, the code baseline wattage was determined using a wattage reduction ratio taken from DEER workpapers applied to the installed fixture wattage.

Hours of Use (HOU): The hours of operation used were the hours confirmed during the virtual verification process or hours from DEER workpapers dependent upon space type and climate zone.

Summer Peak Coincidence Factor (CF): The summer peak coincidence factor was a ratio determined by light utilization during the peak demand period of 1pm-5pm on weekdays from July to September.

Interactive Effects, Energy Savings (IEFe): The values for energy interactive effects were sourced from tables taken from DEER. The values were dependent upon space type, climate zone, and installed fixture type.

Interactive Effects, Demand Reduction (IEFd): The values for energy interactive effects were sourced from tables taken from DEER. The values were dependent upon space type, climate zone, and installed fixture type.

A.1.1.4. Ex-Ante Savings Review

Table A-3 summarizes the discrepancies the Evaluator found comparing the reported ESP Ex-Ante kWh and Peak kW savings with the Ex-Ante kWh and Peak kW savings presented in the tracking data delivered by LADWP.

Table A-3 CDI Ex-Ante Savings Source Comparison

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Ante kWh Savings	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW Savings	Program Data Ex-Ante Peak kW Savings	Ex-Ante Peak kW Percent Change
15/16	26,663,441	25,900,550	-2.9%	883.35	5,860.59	563.5%
16/17	70,840,095	74,513,576	5.2%	2,532.00	14,027.56	454.0%
17/18	87,972,111	88,248,732	0.3%	16,239.00	15,787.34	-2.8%
18/19	102,130,238	102,190,012	0.1%	12,859.72	18,043.08	40.3%
19/20	59,764,622	52,830,284	-11.6%	8,500.29	10,199.81	20.0%
Total	347,370,507	343,683,154	-1.1%	41,014.36	63,918.38	55.8%

Generally, the tracking Ex-Ante kWh is less than the ESP Ex-Ante savings. The largest discrepancy was FY 19/20 where the tracking Ex-Ante kWh was 11.6% less than the ESP Ex-Ante kWh. There were significant deviations between ESP and tracking data for peak kW impacts, aggregating to a 55.8% discrepancy for the Retrospective Period.

A.1.1.5. M&V Approach

On site visits were not possible due to health and safety concerns with COVID-19; the Evaluator obtained the primary data needed to calculate electric and water savings impacts with a combination of project desk reviews and virtual site visits, for a sample of sites. The virtual site visits were used to accomplish two major tasks:

- Verification of installation and work quality; and
- Collection of data from site contacts regarding operating hours, building type, HVAC systems, and other parameters that affect savings calculations.

Available documentation (Proposed Activity Report, Post Installation Report, etc.) was reviewed for a sample of projects, with attention given to the building type, fixture counts, location, and other parameters.

A.1.1.6. Virtual Data Collection Activities

The Evaluator substituted on-site fieldwork with virtual site verification, which was performed for a sample of projects to provide the information needed for calculating energy savings. Site interviews were performed by phone call, email, or video walk-through The sample project documentation review was supported with the following activities: Requesting geo-tagged photos from program participants and performing virtual walkthrough verifications. In a virtual verification, customers were guided through a walkthrough inspection while taking video with their cellular phone that was shared in a recorded Streem meeting.

When projects were selected for the M&V sample, the Evaluator notified LADWP by providing LADWP EM&V staff with a list of projects for which the Evaluator planned to schedule M&V activities. This list included the company name, project ID, site address or other premise identification, and the respective contact information for the customer representative the Evaluator intended to contact to schedule an appointment.

Typically, notification was provided at least one week prior to the Evaluator contacting customers to schedule virtual verifications visits. Upon request, the Evaluator coordinated its scheduling and M&V activities with an LADWP Service Representative.

Virtual site visits consisted of several different approaches depending on the project type, facility type, location, and site contact. Virtual site visits included one or more of the following activities:

- A video walk-through to verify installed measures were functioning. Several different methods of video were used including Microsoft Teams, Apple's Facetime, and Streem;
- Email communication with a site contact asking specific questions pertaining to the project involved, and collecting any data or applicable trend data, along with requesting photos of the newly installed equipment; and
- Verbal communication (if no video), to review project details and collect additional information to support analysis through an interview.

A.1.2. Impact Evaluation

Ex-Post kWh savings and peak kW reduction were calculated using the appropriate DEER workpapers and other proven industry techniques. Key input parameters were based on information collected during virtual site verification or from available project documentation.

A.1.2.1. Engineering Review Procedures

Available project documentation was reviewed for a sample of projects, with attention given to system wattage, fixture type, building type, HVAC configuration, and space type. Analysis of lighting savings was accomplished using the Evaluator's custom-designed lighting evaluation model with system parameters (fixture wattage, operating characteristics, etc.) based on information either collected virtually, referenced in project documentation or DEER workpapers and, if appropriate, referencing industry standards.

A.1.2.2. Description of Factors Affecting Gross Realized Savings

The Evaluator determined two main factors that contributed to discrepancies in the realized savings of the sampled projects. Explanations of how each factor affected realized savings are detailed below, along with frequency of occurrence as illustrated in Figure A-1. Figure A-2 quantifies the impact of these identified factors on the gross realized savings of the project sample.

Difference in Interactive Effects: The baseline assumptions made for the Ex-Post savings calculations are detailed in A.1.1.3. This factor was selected for any projects in which the baseline values used in the Ex-Ante savings estimate differed from the Ex-Post savings calculations. The most common occurrence in the analysis was a difference in interactive effects. The Ex-Ante savings estimates were found to use an average value of 1.12, whereas the Ex-Post savings calculations used an average value of 1.10 dependent upon various project-specific factors, such as building type, fixture type, climate zone, and whether the space is conditioned.

Differing Hours of Operation: Sites where the Evaluator used deemed hours sourced from DEER workpapers were generally less than Ex-Ante values. The DEER workpaper hours were a function of the building type, fixture type, and clime zone. In some instances, annual hours of use had a positive effect on Ex-Post savings. For specific projects, the Evaluator used custom-calculated hours of operation sourced from virtual data collection, and these values were generally greater than Ex-Ante annual hours of use.

Figure A-1 Factors Affecting Gross Realized Savings of Sampled Projects

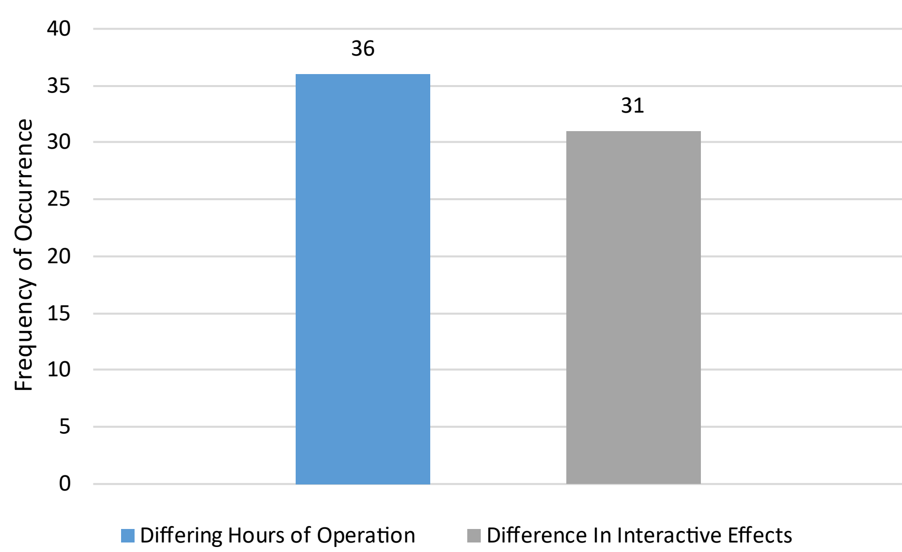
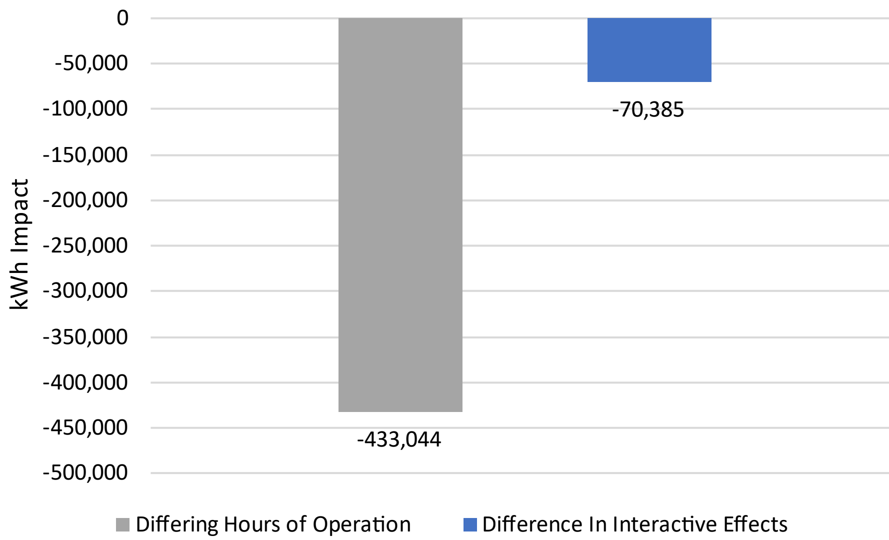


Figure A-2 Retrospective Period Ex-Post kWh Impact Factors



A.2. CLIP

This section details the impact evaluation for the Commercial Lighting Incentive Program (CLIP) program that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation was to calculate energy savings and peak demand reduction attributable to the CLIP program.

A.2.1. Evaluation Methodology

This section presents the findings of the tracking data review, the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program, and the results of the analysis.

A.2.1.1. Tracking Data Review

LADWP provided the Evaluator with the available program tracking data for measures installed as a part of CLIP between June 30, 2015, and August 14, 2020. Review of the tracking data was performed to ensure that the provided data was sufficient to calculate energy savings and peak demand reduction, and to verify that projects listed were completed and had dates matching the fiscal year to which they were attributed.

A.2.1.2. M&V Sample Design

Based on the tracking data provided by LADWP, a sample design was developed for site-level analysis. Samples were drawn that provided savings estimation with ±10% statistical precision at the 90% confidence level. To represent the population of projects, the Evaluator selected a stratified sample (known as ratio estimation) with enough projects to estimate the total achieved savings with 10% precision at a 90% confidence. Projects were categorized by Ex-Ante kWh savings. The boundaries of each stratum were developed to ensure the extrapolation of impacts was appropriately distributed. Realization rates (the ratio of Ex-Post kWh savings to Ex-Ante kWh savings) for projects sampled in each stratum were only extrapolated to other projects within that stratum.

Table A-4 CLIP Population/Sample Statistics

Stratum	Strata boundaries (Ex-Ante kWh)	Population Size	Total Ex-Ante kWh savings	Average Ex-Ante kWh Savings	Standard Deviation of Ex-Ante kWh savings	Final Design Sample
1	<15,000	2,046	14,800,233	7,237	3,679	5
2	15,000 – 50,000	1,165	31,468,295	26,965	9,523	9
3	50,000 – 130,000	536	43,349,496	81,027	22,601	6
4	130,000 – 280,000	300	56,935,101	189,784	41,554	5
5	280,000 – 700,000	151	62,345,098	412,881	113,477	6
6	700,000 – 1,500,000	28	28,172,443	1,006,159	237,827	6
7	1,500,000 – 5,000,000	9	21,989,887	2,443,321	1,044,309	2
Total		4,235	259,060,553			39

A.2.1.3. Billing Analysis

The Evaluator requested and reviewed billing data for sampled measures to ascertain the applicability of performing a billing data regression analysis for the determination of Ex-Post energy savings. Applicability of billing data was tested for:

- Completeness (review of missing readings)
- Reasonableness (review of outliers, fluctuations, and meter arrangements)
- Duration (review of sufficient pre-installation and post-installation readings)
- Magnitude (was the magnitude Ex-Ante savings estimates discernable from total consumption)

Reliance on a commercial billing data regression analysis is dependent on adherence to the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE), Guide 14 stipulations and IMPVP protocols.

A.2.1.4. Baseline Assumptions Review

Generally, for projects involving lighting measures, savings were determined as follows:

$$kWh_{Savings} = \frac{Watt_{Baseline} * HOU_{Baseline} * Qty_{Baseline} - Watt_{Installed} * HOU_{Installed} * Qty_{Installed}}{1000} * IEFe \qquad \textit{Equation A-5}$$

$$kWh_{Code} = \frac{Watt_{Code} * HOU_{Baseline} * Qty_{Baseline} - Watt_{Installed} * HOU_{Installed} * Qty_{Installed}}{1000} * IEFe \qquad \textit{Equation A-6}$$

$$\Delta kW = (\mathrm{Watt}_{\mathrm{Baseline}} - Watt_{Installed}) * CF * IEFd/1000 \qquad \textit{Equation A-7}$$

$$Dual\ Baseline\ Lifetime\ Savings = kWh_{Savings} * \frac{EUL}{3} + kWh_{Code} * (EUL - \frac{EUL}{3}) \qquad \textit{Equation A-8}$$

Equation A-5 and Equation A-7 detail the equations used to determine energy savings and peak demand reduction for lighting measures. Dual baseline lifetime savings were calculated as a part of the program analysis, detailed in Equation A-8. Calculation of dual baseline lifetime savings required the use of savings using code standards calculated using Equation A-6. Baseline assumptions made for energy savings and demand reduction are detailed below:

Baseline Wattage: For the Ex-Post savings analysis, the baseline wattage was considered as the wattage of the pre-retrofit lighting fixture. However, for the purpose of calculating dual baseline lifetime savings, savings were also calculated using a code-specified baseline wattage. For Tube LEDs, High Bay LEDs, and LED Troffer Kits, the code baseline wattage was calculated using a code efficacy value taken from the SWLG009-02, SWLG011-03, and SWLG012-01 workpapers along with the lumens of the installed fixture. For Screw-In LEDs, the code baseline wattage was determined using a wattage reduction ratio taken from DEER workpapers applied to the installed fixture wattage.

Hours of Use (HOU): The lighting hours of use utilized were the hours confirmed during the virtual or on-site verification process. Deemed values from DEER workpapers were also used, which were dependent upon space type and climate zone.

Summer Peak Coincidence Factor (CF): The summer peak coincidence factor was a ratio determined by light usage during the peak demand period of 1 pm - 5 pm on weekdays from July to September.

Interactive Effects, Energy Savings (IEFe): The value utilized for energy interactive effects came from tables in DEER. The values were dependent upon space type, climate zone, and installed fixture type.

Interactive Effects, Demand Reduction (IEFd): The value utilized for energy interactive effects comes from tables in DEER. The values were dependent upon space type, climate zone, and installed fixture type.

A.2.1.5. Ex-Ante Savings Review

Table A-5 summarizes the discrepancy found in comparing the reported ESP Ex-Ante kWh savings and Peak kW reduction with the Ex-Ante kWh savings and Peak kW reduction presented in the program tracking data provided by LADWP.

Table A-5 CLIP Ex-Ante Savings by Fiscal Year

Fiscal Year	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
15/16	18,498,102	15,189,717	-17.9%	4,058.00	2,513.29	-38.1%
16/17	31,735,271	31,735,271	0.0%	4,915.00	4,916.07	0.0%
17/18	71,029,568	71,029,568	0.0%	11,926.00	11,926.77	0.0%
18/19	79,863,767	79,863,767	0.0%	13,630.20	13,798.80	1.2%
19/20	61,242,231	61,242,231	0.0%	8,939.26	10,374.39	16.1%
Total	262,368,939	259,060,553	-1.3%	43,468.46	43,529.31	0.1%

The Ex-Ante kWh reported in the tracking data was less than the ESP Ex-Ante savings for FY 15/16 only. The tracking Ex-Ante kWh was 18% less than what was reported for the ESP Ex-Ante savings in FY 15/16. The Ex-Ante kWh savings for the remaining fiscal years matched exactly across the two datasets. For Peak kW, the data was similar except for FY 15/16 and FY 19/20 which had differences of -38% and 16%, respectively, when comparing the ESP Ex-Ante and program tracking Ex-Ante.

A.2.1.6. M&V Approach

Virtual site visits were used to gather information utilized to calculate project savings estimates. In addition to the virtual site visits, the project documentation provided by LADWP (invoices, cut sheets, applications, etc.) supplemented the information gathered during the virtual verification process to determine associated project savings.

A.2.1.7. Virtual Data Collection Activities

Due to the COVID-19 pandemic, virtual site visits were implemented as a modification to the typical on-site visit procedure to ensure the safety of all parties involved. Virtual site visit/verification involved the utilization of video calls and/or email or phone interviews of site contacts to verify the installation of equipment and gather information pertinent to the operation of the installed measures (hours of use, heating/cooling conditions, controls, etc.)

The Evaluator notified LADWP of all sample projects for which the Evaluator planned to schedule M&V activities. The information included for all projects were the company name, project ID, site address, and contact information of the customer representative for which the Evaluator would contact to schedule a virtual verification appointment.

Once LADWP granted approval of M&V activities for the sampled projects, the Evaluator contacted and scheduled virtual verification activities with the customer representative.

Virtual verification consisted of several communication methods which were dependent upon the project, facility type, location, and customer representative availability. These methods were as follows:

- **Video Call:** During video calls, the Evaluator would verify the installation of claimed project measures while also conducting an interview of the contact to gather information regarding operation of the project measure. Multiple methods of video were employed to accommodate site contacts for various projects. The methods of video communication used were Streem, Microsoft Teams, and FaceTime.
- **Email:** Email correspondence was established with the site contact where the Evaluator would then ask questions pertaining to the installed project measures and their operation. In addition to asking questions, the Evaluator requested photos of the installed equipment.
- **Phone:** In instances where the site contact was unable to perform a video call, a phone call interview was performed, where the Evaluator asked the site contact pertinent questions used in calculating savings. The Evaluator also requested photos of the installed equipment to be sent after the call.

A.2.2. Impact Evaluation

Ex-Post kWh savings and peak kW reduction were estimated using the applicable DEER workpapers and other proven industry techniques. Key input parameters were based on information collected during virtual site verification or from available project documentation.

A.2.2.1. Engineering Review Procedures

Documentation provided by LADWP was reviewed for the projects within the program sample. The CLIP measure summary and incentive calculator along with invoices and specification sheets of installed fixtures were reviewed. Analysis of project savings were performed using typical lighting savings algorithms with information obtained from the project documentation and information gathered during the virtual verification process.

A.2.2.2. Data Collection

Additional projects were added to the evaluation sample to account for an expected reduction in response rate due to COVID-19 and to reduce uncertainty related to the extended period for some projects between equipment installation and M&V activities. All projects selected underwent M&V Plan development which included a desk review. The extent of the desk review was dependent on evaluation approach as well as available information from project documentation. A summary of the data collection progression of the randomly sampled projects is shown in Table A-6.

Table A-6 CLIP Evaluation Data Collection Progression

Stratum	M&V Plans	Contact Attempted	Virtual Verification	Evaluated
1	6	6	5	5
2	14	14	9	9
3	11	11	6	6
4	11	11	5	5
5	12	23	6	6
6	8	8	6	6
7	4	4	2	2
Total	66	66	39	39

The Evaluator did not conduct any power monitoring due to the ongoing pandemic and due to the necessity of completing data collection virtually.

To recruit sites for virtual verification during this time, the Evaluator performed the following actions when the provided site contact could not provide evaluation support:

- If the initial contact responded but was not the correct contact, then the Evaluator would request appropriate contact information and continue in this manner through all available contacts.
- If the initial contact responded but was not aware of who was the correct contact, then a request was submitted for additional contact information from LADWP, as well as performing internet searches.
- If the initial contact responded but refused a site visit (store closed, refused, no one on-site) then the site was dropped from the evaluation sample.
- The Evaluator attempted to reach the initial contact and all additional contacts a minimum of 5 times using both phone calls and emails at different times of the day and different days of the week.

A.2.2.3. Sample Results

Project-level and measure-level results can be found in site-level reports, which can be viewed in Appendix D. For confidential and privacy considerations of participants, Appendix D was not published with the public version of the report. Appendix D was provided only to LADWP as reference to supplement this EM&V report.

A full evaluation analysis was conducted on 39 of the 66 randomly sampled projects from FY 15/16 to FY 19/20. Project-level and measure-level results can be found in project site-level reports. Energy savings for sampled projects within each stratum were aggregated to determine a strata level realization rate used for extrapolation to the population. Sample savings impacts by strata are shown in Table A-7.

Table A-7 CLIP Evaluation Sample Savings Summary

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	40,564	39,668	98%	9.94	11.10	112%
2	233,496	219,669	94%	40.82	36.66	90%
3	562,289	547,858	97%	88.14	79.44	90%
4	930,651	864,316	93%	137.72	140.68	102%
5	2,706,909	2,872,793	106%	364.54	372.91	102%
6	6,494,882	6,701,803	103%	1,026.09	1128.30	110%
7	3,881,152	3,914,923	101%	580.90	329.50	57%
Total	14,849,942	15,161,029	102%	2,248.15	2098.59	93%

The overall realization rates for all strata were relatively similar. The most common cause of discrepancy in the sampled projects were the hours of use utilized in Ex-Ante savings calculations. The largest discrepancy occurred with peak kW savings in Stratum 7 with a realization rate of 57%. Stratum 7 was the main driver of the kW savings realization rate, being the second largest strata by kW savings. Generally, discrepancies in peak kW savings occurred due to a difference in calculation methodology, as detailed in Section A.2.1.4.

A.2.2.4. Description of Factors Affecting Gross Realized Savings

The Evaluator determined four main factors that contributed to discrepancies in the realized savings of the sampled projects. The frequency in which these factors were relevant is skewed, with the most common factors being “Incorrect Baseline Assumptions” and “Differing Hours of Operation”. Explanations of how each factor impacted realized savings are found below, along with frequency of occurrence as illustrated in Figure A-3. Figure A-4 quantifies the impact of identified factors on the gross realized savings of the project sample.

Incorrect Baseline Assumptions: The baseline assumptions made for the Ex-Post savings calculations are detailed in A.2.1.4. This factor was chosen for any projects in which the baseline values utilized in the Ex-Ante savings calculations differed from the Ex-Post savings calculations. The most common occurrence in the CLIP analysis was a difference in interactive effects. The Ex-Ante savings calculations were found to use a value of 1.08 for both energy savings and demand reduction, whereas the Ex-Post savings calculations used values dependent upon various project-specific factors, as explained in 2.1.4.

Differing Hours of Operation: Hours of operation used in the Ex-Post savings calculations were determined during the virtual verification process. This factor had an impact on savings in any instance where the hours of operation differed from the hours claimed in the Ex-Ante calculations.

Clerical Errors: Clerical errors as it pertains to the analysis of CLIP were determined to be a difference in the installed fixture wattage used in the Ex-Ante and Ex-Post savings calculations. The fixture wattages used in the Ex-Post savings calculations were obtained from specification sheets provided in the project documentation.

Errors in Analytical Approach: This factor was the most common reason for discrepancy. For these projects, it was due to a difference in how demand reduction savings were calculated. The Ex-Ante estimates determined peak demand reduction as the difference in the connected load of the project facility pre- and post-retrofit. The Ex-Post demand reduction was determined using the difference in connected load during the summer peak period as noted in 2.1.4 along with interactive effects taken from DEER workpapers, which were dependent on project-specific factors.

Figure A-3 Factors Affecting Gross Realized Savings for Sampled Projects

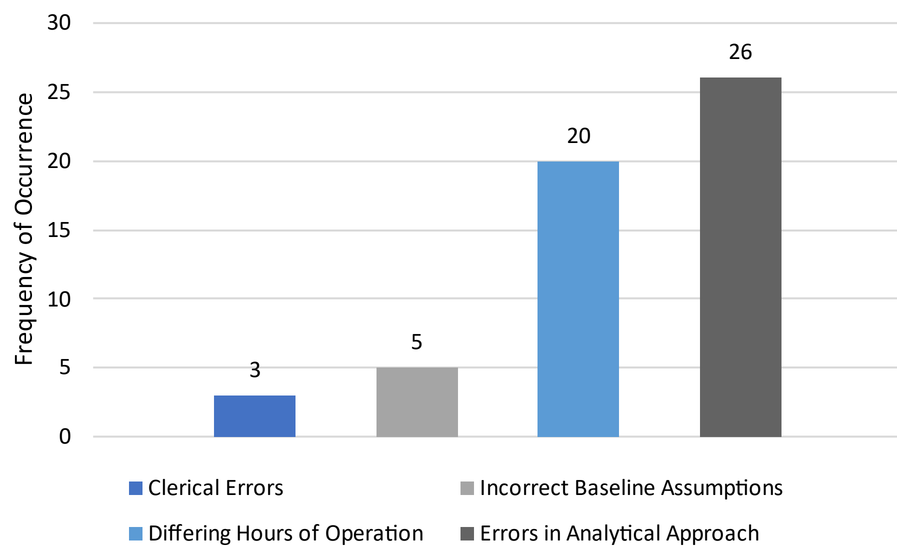
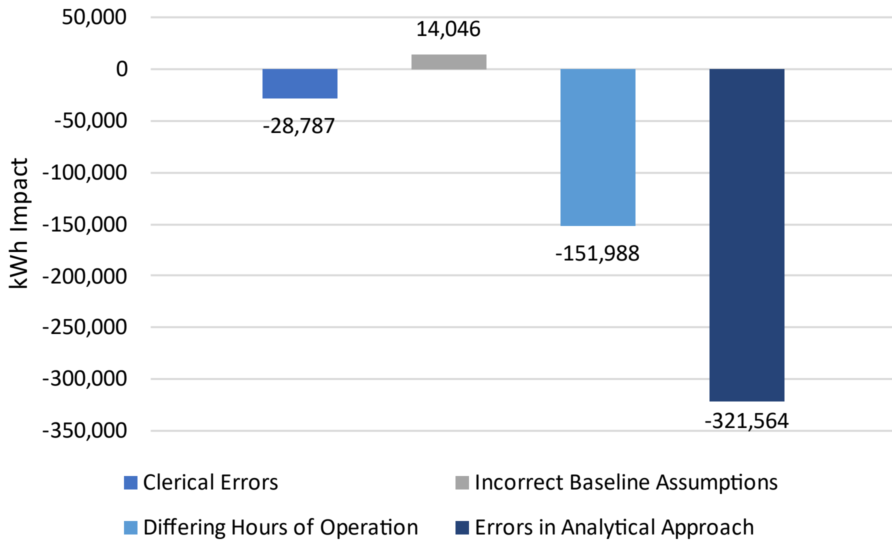


Figure A-4 Retrospective Period Ex-Post kWh Impact Factors



A.3. CPP

This section details the impact evaluation for the Custom Performance Program (CPP) program that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation was to calculate energy savings and peak demand reduction attributable to the CPP program.

A.3.1. Evaluation Methodology

This section presents the methodology used to evaluate the CPP. Ex-Post annual energy savings, lifetime energy savings, and peak demand reduction were determined using the methodologies described. A site-specific approach was used to determine Ex-Post site level impacts with extrapolation to the population based on the design of the CPP. The methods employed included:

- Review of program tracking data for completeness and for project sampling;
- Project documentation review;
- Site-specific Measurement and Verification Plans (M&V Plans);
- Primary data collection from site contacts;
- Engineering analysis for each sampled project; and
- Extrapolation of sample level results to determine program level impact estimates.

A.3.1.1. Tracking Data Review

To begin the impact evaluation, the Evaluator reviewed program documentation and examined data on the performance of the program in previous years. Program tracking data was reviewed for completeness and for identification of outliers and issues. Projects were checked for installation and incentive dates for program year applicability.

Program tracking data (both at the measure level and the project level) was then analyzed to determine the most appropriate sampling approach. Data was reviewed for the range of measure types as well as the range of annual energy savings (kWh). While a random evaluation sample was determined, it was important to ensure that various measure types were represented for extrapolation.

Measure type categories were chosen based on the measures listed in the program tracking data which include Building Envelope, Controls, HVAC, Lighting, Process, VFD, and Other. A summary of measures by measure type category is shown in Table A-8.

Table A-8 CPP Measure Categories

Measure Type	Total Program Measures	Total Ex-Ante Annual kWh	Percent of Population
Process	219	79,321,253	42.0%
VFD	115	31,638,443	16.8%
Lighting	82	30,427,934	16.1%
Controls	54	19,930,048	10.6%
HVAC	172	19,755,349	10.5%
Building Envelope	38	6,378,071	3.4%
Other	20	1,356,796	0.7%
Total	700	188,807,893	100.0%

A.3.1.2. M&V Sample Design

Based on a review of the program tracking data, a stratified random sampling approach was employed based on project level Ex-Ante annual energy savings (kWh) across all fiscal years. Sample design ensured that the combined strata represented the population within ±10% precision at the 90% confidence interval. The number of strata, the boundaries within each stratum, and the number of sample points for each stratum were determined through an iterative process. The sample resulted in a program level precision of ±9.65% at the 90% confidence interval. A summary of the sample is shown in Table A-9.

Table A-9 CPP Evaluation Sample

Stratum	Strata Boundaries (Ex-Ante kWh)	Projects	Sampled Projects	Standard Deviation of Ex-Ante kWh Savings	Total Ex-Ante Annual kWh	Sample Ex-Ante Annual kWh
1	< 109,815	365	7	194,779	12,615,179	287,679
2	109,815 - 299,239	134	6	149,074	24,944,338	893,970

Stratum	Strata Boundaries (Ex-Ante kWh)	Projects	Sampled Projects	Standard Deviation of Ex-Ante kWh Savings	Total Ex-Ante Annual kWh	Sample Ex-Ante Annual kWh
3	299,240 - 847,931	89	7	511,395	42,761,494	15,091,181
4	847,932 - 2,461,604	34	9	1,093,957	52,809,417	16,790,906
5	2,461,605 - 6,346,606	9	4	30,188	35,687,870	9,857,068
6	6,346,607 - 10,132,527	2	2	56,574	19,989,595	3,382,440
Total	NA	633	35	808,963	188,807,893	46,303,245

A.3.1.3. Project Documentation Review

Documentation representing the sampled projects was requested and received from LADWP. Project documentation included a mix of energy savings calculations, invoices, specification sheets, and application materials. Further data requests were provided for projects in which insufficient documentation was available for evaluation. In addition to project documentation, billing data was requested for all electric meters associated with all sampled projects.

Every sampled project underwent a detailed documentation review which was used to develop site-specific M&V Plans. The Evaluator’s review of energy savings calculations focused on the key factors and assumptions used to determine energy use, including operating hours, usage patterns, and load factors. The review included the following:

- Review of energy efficiency improvements;
- Review of energy analysis input assumptions; and
- Review of methods used to calculate energy savings.

When applicable and feasible, a desk-review of the provided calculations was completed to prepare for primary data collection. Regenerating energy savings estimates ensured that all issues and concerns were identified prior to communicating with the site contact. Available billing data was reviewed and analyzed to identify the potential for use in either a billing regression analysis or calibration of an energy simulation.

A.3.1.4. Site-Specific Measurement and Verification Plans (M&V Plans)

After a full review of program documentation, project documentation, and billing data, the Evaluator developed M&V Plans which described the project and initial impact estimation methods, identified the major sources of uncertainty in the impact estimation methods, proposes a methodology for assessing the project’s energy impacts, and specified the exact steps by which data would be collected and analyzed to remove or mitigate uncertainties in energy savings calculations.

M&V Plans were developed and distributed for each project. The plans describe the evaluation approach and data collection activities specific to each measure type within the project.

A.3.1.5. Virtual Data Collection Activities

Adhering to current conditions regarding COVID-19, the Evaluator utilized virtual data collection practices for the retrospective evaluation. The first step was to ensure the M&V Plans provided defensible methodologies to facilitate data collection through a site contact. This included an exploration of a billing regression analysis, review of data collected through implementation, and exploration of available building automation system (BAS) data. To effectively collect information virtually, the Evaluator made sure to work collaboratively with the participant to ensure the data collection procedure was feasible and acceptable.

Data was collected virtually using software platforms that allowed for ease of verification. The Evaluator used the Streem virtual video platform, when possible, to reduce the burden on the site contact. If Streem was not feasible then evaluation staff relied on Microsoft Teams, email, phone, and occasionally another platform of preference by the site contact.

Prior to virtual data collection, the Evaluator underwent a recruitment process that consisted of:

- Sharing with LADWP a list of sampled projects with site contact information, M&V Plans, and data collection approaches;
- Requesting support from LADWP large account managers;
- Initiating contact with the site contact (using both email and phone);
- Scheduling a virtual data collection event with the site contact;
- Performing data collection through feasible virtual means;

As response rate was uncertain due to pandemic conditions, M&V Plans were developed for 56 projects to ensure statistical significance of the sample could be achieved.

A.3.1.6. Engineering Analysis

Energy savings calculation methodologies were selected based on industry standard practices adhering to IPMVP Options. Industry references included DEER, ASHRAE, and DOE UMP. DEER workpapers were reviewed by measure and checked for applicability for each sampled site. Many custom projects were analyzed through energy simulation software.

Energy impacts of annual energy savings (kWh), lifetime energy savings (kWh) and peak demand reduction (kW) were determined for each measure of each sampled project. Each analysis underwent a quality control process to ensure proper methodologies were employed and no calculation errors were present. Measure level energy impacts were aggregated to the project level. A site level report was developed for each project for individual review.

Lifetime energy savings were determined based on the methodologies provided in DEER workpapers or based on industry standards when necessary. Lifetime energy savings by measure were dependent on the type of replacement such that a portion of lifetime energy savings may be reliant on the remaining useful life of the baseline condition and/or the code compliant savings beyond the remaining useful life.

Peak demand reduction was determined based on the methodologies provided in DEER workpapers. For custom projects, the peak demand reduction was defined as the average hourly consumption across the peak demand window of 2 PM to 5 PM on non-holiday weekdays from June through September.

A.3.1.7. Program Analysis

Upon completion of the project-level analyses, the results were aggregated by strata for extrapolation. Sample results within strata were then extrapolated to projects in the population that fell within the same strata criteria. Each project was then provided with Ex-Post energy savings results that were summed to the program level.

A.3.1.8. COVID-19 Impacts

In addition to the determination of annual energy savings, the Evaluator explored the impact of COVID-19 on energy impacts from the installed measures. Through verification efforts the Evaluator explored the effects on operating schedules, mechanical systems, and any other consumption effects presented by site contacts.

A.3.2. Impact Evaluation

This section presents findings from the determination of Ex-Post gross annual energy savings, lifetimes energy savings, and peak demand reduction through M&V evaluation efforts.

A.3.2.1. Program Data Review

Measure level descriptions in program tracking data indicated 31 different measure types as well as 20 line-items with missing project descriptions. Additional information was used to determine measure types to classify all line items. For reporting purposes, measure types were categorized into Building Envelope, Controls, HVAC, Lighting, Process, VFD’s, and Other. The provided measure level tracking data was complete for the purposes of reviewing gross impacts and developing a stratified random sample.

Project documentation was provided by LADWP for each sampled project. The amount of project documentation varied depending on the project. Not all projects included clearly identified final documentation to match program tracking data. Billing data was requested for each sampled site. Comprehensive billing data by project was difficult to obtain as project sites included multiple meters. In addition, billing data must have spanned a significant time to be useful. In most cases the provided billing data could not be used for analysis purposes.

A.3.2.2. Data Collection

Additional projects were added to the evaluation sample to account for an expected reduction in response rate due to COVID-19 and to reduce uncertainty due to the extended period of time for some projects between when measure installation and evaluation occurred. All projects selected underwent M&V Plan development which included a desk review. The extent of the desk review was dependent on evaluation approach as well as available information from project documentation. Table A-10 presents a summary of the data collection progression of the randomly sampled projects.

Table A-10 CPP Evaluation Data Collection by Project

Stratum	M&V Plans	Desk Reviews	Virtual Verification	Evaluated
1	9	9	7	7
2	8	8	6	6
3	12	12	7	7
4	18	18	9	9
5	7	7	4	4
6	2	2	1	2
Total	56	56	34	35

During the evaluation process, a Strata 6 project was identified as having been evaluated under the previous evaluation period. The provided documentation for this project was thoroughly reviewed. Virtual verification of the 34 projects was conducted through Streem, Microsoft Teams, in-depth phone interview, and/or email correspondence. Scheduled virtual verifications were conducted from late March until the beginning of June. Ongoing communication with site contacts extended into July for complete data collection.

The Evaluator did not conduct any power monitoring due to the ongoing pandemic and necessity of completing data collection virtually. The Evaluator explored all other avenues of data collection through building management systems, sub-meter configurations, billing data, prior monitoring, provided recordings, virtual observations, and interviews.

To recruit sites for virtual verification during this difficult time, the Evaluator performed the following actions when the site contact could not provide evaluation support:

- If the initial contact responded but was not the correct contact, then the Evaluator would request appropriate contact information and continue in this manner through all available contacts.

- If the initial contact responded but was not aware of who was the correct contact, then a request was submitted for additional contact information from LADWP, as well as conducting internet searches.
- If the initial contact responded but refused a site visit (store closed, refused, no one on-site) then the site was dropped from the evaluation sample.
- The Evaluator attempted to reach the initial contact and all additional contacts a minimum of 5 times using both phone calls and emails at different times of the day and different days of the week.

The result was a full evaluation of 44 measures incentivized during the Retrospective Period. As site recruitment success was somewhat out of the Evaluator's control, the distribution of projects was skewed. A summary of measures evaluated by calendar year is shown in Table A-11.

Table A-11 CPP Evaluated Measures by Year

Stratum	2015	2016	2017	2018	2019	Total
1	0	2	2	1	2	7
2	1	3	1	1	0	6
3	1	0	1	1	4	7
4	1	5	5	0	1	12
5	7	0	0	4	0	11
6	0	0	0	1	0	1
Total	10	10	9	8	7	44

The 44 measures that were verified consisted of 17 different measure descriptions. A summary of the measure descriptions and which measure category they were placed into is shown in Table A-12.

Table A-12 CPP Evaluated Measures by Measure Category

Measure	Bldg. Env.	Controls	HVAC	Lighting	Process	VFD	Total
A/C Economizer	0	0	2	0	0	0	2
BSL - LED Retrofit	0	0	0	3	0	0	3
CO Sensors in Parking Garage	0	4	0	0	0	0	4
Data Center Measures	0	0	0	0	1	0	1
EMS	0	2	0	0	0	0	2
High Eff. A/C >63tons	0	0	1	0	0	0	1
High Eff. A/C ≤ 63tons	0	0	2	0	0	0	2
High Eff. Chiller, Early Ret.	0	0	1	0	0	0	1
High Eff. Motors	0	0	0	0	7	0	7

Measure	Bldg. Env.	Controls	HVAC	Lighting	Process	VFD	Total
LED Lighting	0	0	0	3	0	0	3
Other - Special Process/Installation	0	0	0	0	6	0	6
Replace non-operational VFD Supply/Return Fan	0	0	0	0	0	1	1
VFD for Process Applications	0	0	0	0	0	2	2
VFD on Cooling Tower Fan Motor	0	0	0	0	0	1	1
VFD on Existing Chiller	0	0	0	0	0	2	2
VFD on HVAC Fan Motor	0	0	0	0	0	4	4
Window Film	2	0	0	0	0	0	2
Total	2	6	6	6	14	10	44

A.3.2.3. Sample Results

A full evaluation analysis was conducted on 35 of the 56 randomly sampled projects. Of these projects, 44 measures were evaluated. Evaluation protocols were classified using the IPMVP Options. A summary of the protocols used is shown in Table A-13.

Table A-13 CPP Evaluation Protocols by Measure

IPMVP Option	2015	2016	2017	2018	2019	Total
Option A: Spreadsheet or Basic Bin Analysis	3	3	2	5	2	15
Option A-: TRM (Or other Deemed) Analysis	0	1	2	1	3	7
Option B: Partial Retrofit Isolation	1	0	0	0	0	1
Option C: Whole Building Retrofit	6	6	3	1	2	18
Option D: Calibrated Simulation	0	0	2	1	0	3
Total	10	10	9	8	7	44

Measure classifications were grouped into seven classifications for reporting purposes. These classifications are Building Envelope, Controls, HVAC, Lighting, Process, VFD, and Other. A summary of evaluated measures by measure type is shown in Table A-14. The measure category “Other” included project descriptions of refrigerator doors, refrigerated cases with doors, refrigeration controls, and two unknown measures. None of these 20 measures were included in the evaluation sample. These measures accounted for 0.72% of annual energy savings.

Table A-14 CPP Evaluated Measures by Category and Protocol

Measure Type	Option A	Option B	Option C	Option D	Total
Building Envelope	1	0	1	0	2
Controls	5	0	0	1	6
HVAC	2	0	2	2	6
Lighting	5	0	1	0	6
Process	5	0	9	0	14
VFD	4	1	5	0	10
Total	22	1	18	3	44

Project-level and measure-level results can be found in site-level reports, which can be viewed in Appendix D. For confidential and privacy considerations of participants, Appendix D was not published with the public version of the report. Appendix D was provided only to LADWP as reference to supplement this EM&V report.

Sampled measures represented 25% of the reported annual energy savings. The evaluation sample was grouped by strata based on the magnitude of annual energy savings. Energy savings for projects within each stratum were aggregated to determine a strata level realization rate for extrapolation to the population. Sample savings impacts by strata are shown in Table A-15.

Table A-15 CPP Evaluation Sample Savings Summary

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	287,679	249,102	87%	51.24	47.61	93%
2	893,970	806,344	90%	230.43	208.07	90%
3	3,382,440	2,839,250	84%	648.25	630.23	97%
4	15,091,181	14,721,876	98%	3,309.62	1,743.21	53%
5	16,790,906	16,942,574	101%	3,300.94	2,339.37	71%
6	9,857,068	11,776,103	119%	2,270.30	1,264.39	56%
Total	46,303,245	47,335,249	102%	9,810.78	6,232.88	64%

Sampled projects from strata 1 and 3 demonstrated the largest discrepancies between Ex-Ante savings estimates and Ex-Post savings estimates. Strata 1 sampled projects included seven projects with Ex-Ante annual energy savings below 103,000 kWh. These projects consisted of HVAC VFD's, Rooftop HVAC units, Parking Garage CO_2 Sensors, an Energy Management System, Refrigeration Controls, and Lighting. Ex-Ante energy savings estimates for strata 3 projects ranged from 352,000 kWh to just over 713,000 kWh. These six projects consisted of Efficient Motors, Lighting, Chillers, process VFD's, and Parking Garage CO_2 Sensors. These strata combined represent 454 of the 633 projects in the population and were equivalent to 29% of the Ex-Ante estimated annual energy savings.

Verification efforts through evaluation determined similar energy impacts as Ex-Ante estimates. Differences that were found can be attributed to differing hours of operation, differing load profiles, errors in analytical approaches, incorrect baseline assumptions, algorithm input assumptions and rounding errors, and savings discrepancies between provided project documentation and program tracking data. These differences will be referred to as realization rate factors. The magnitude of these differences across the 44 samples measures is shown in Table *A-16*.

Table A-16 CPP Sample Realization Rate Factors

Realization Rate Factor	Sample Difference Net Change Value (kWh)
Differing Hours of Operation	326,210
Differing Load Profiles	(350,242)
Errors In Analytical Approach	1,742,020
Incorrect Baseline Assumptions	(510,729)
Savings Discrepancy	(178,119)
Algorithm Assumptions/Rounding	2,865
Total	1,032,005

Realization rate factors as a function of measure type indicates that while verification found differences at the measure and project level, the entirety of the sample was well balanced. Table A-17 provides a summary of realization rate factors by measure type.

Table A-17 CPP Evaluation Sample Impact from Realization Rate Factors

Realization Rate Factor	Bldg. Env.	Controls	HVAC	Lighting	Process	VFD	Total
Algorithm Assumptions/Rounding	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.01%
Differing Hours of Operation	0.00%	0.00%	-1.96%	-3.81%	0.00%	0.06%	-0.51%
Differing Hours of Operation, Differing Load Profiles	0.00%	0.91%	0.00%	0.00%	0.00%	1.95%	0.56%
Differing Hours of Operation, Errors in Analytical Approach	0.00%	-0.18%	0.00%	0.00%	0.01%	0.44%	-0.12%
Differing Load Profiles	-14.95%	-0.01%	0.00%	0.00%	-0.20%	0.00%	-0.82%
Differing Load Profiles, Savings Discrepancy	0.00%	0.00%	0.00%	0.00%	0.47%	0.00%	0.19%
Errors In Analytical Approach	0.00%	0.00%	0.00%	0.00%	9.90%	0.00%	3.42%

Realization Rate Factor	Bldg. Env.	Controls	HVAC	Lighting	Process	VFD	Total
Errors In Analytical Approach, Differing Load Profiles	0.00%	0.00%	0.00%	0.00%	0.00%	2.96%	-0.63%
Incorrect Baseline Assumptions	0.00%	0.00%	0.00%	0.00%	-1.59%	2.07%	-1.10%
Savings Discrepancy	0.00%	0.00%	-1.29%	0.06%	-0.98%	0.00%	-0.47%
Savings Discrepancy, Errors in Analytical Approach	0.00%	-0.13%	0.00%	0.00%	0.00%	0.00%	-0.02%
Savings Discrepancy, Differing Hours of Operation	20.22%	0.00%	0.00%	0.00%	0.00%	0.00%	0.99%
Total	5.27%	0.63%	-3.25%	-3.75%	7.61%	3.46%	1.50%

Evaluation efforts at the measure level did not find any significant systemic issues with analytical approaches or calculation errors. Post-implementation evaluation has the advantage of identifying operating conditions in the post-installation period. Factors such as operating schedules and consumption patterns influenced the realization rates for a few measure types. In addition, savings discrepancies between project documentation and program tracking data were present for several projects.

A.3.2.4. EETAP Projects

Three EETAP projects were verified in the evaluation. Project documentation for each EETAP project included an energy audit report generated to provide the site with guidance on the potential for energy savings. Ex-Ante energy savings estimates were typically developed through energy simulation in which iterations of model runs consecutively accounted for proposed energy savings measures. Measures which impacted each other were grouped into the same parametric run. Ex-Post savings estimates were calculated in a similar manner based on installed energy efficiency measures. A summary of the energy audit recommendations is shown in Table A-18. If energy savings for the measure were found to be claimed in the Retrospective Period, it was listed as a claimed measure. If a proposed energy efficiency measure was not found to be claimed but evaluation data collection determined the measure was installed at a later date, then the measure was considered to be non-claimed. Energy savings for non-claimed measures were not evaluated as reported savings were not available and the scope of work could have updated from the time of the energy audit. None of the non-claimed measures were found to be in more recent program tracking data.

Evaluation findings thus indicate that out of the three evaluated projects, measures representing 63% of the proposed annual energy savings (from the energy audit reports) were implemented during the Retrospective Period. Evaluation data collection indicated that measures representing an additional 19% of proposed annual energy savings were installed or implemented later. These measures could not be found in recent program tracking data. From these three projects, the Evaluator determined that measures representing 82% of the proposed annual energy savings for EETAP projects were installed by program participants.

Table A-18 CPP Evaluated EETAP Projects

Proposed Measure	Proposed Annual Savings (kWh)	Ex-Post Annual Savings (kWh)	Claimed Measure	Non-Claimed Measure
Replace Chillers and Install Waterside Economizer	1,549,377	741,572	Y	N
Optimize Chiller Sequencing	21,174	102,438	Y	N
Implement CHW setpoint reset	(72,833)	27,272	Y	N
RCx CT Fan VFD	129,955	293,479	Y	N
Implement CW Setpoint reset	23,279	0	Y	N
VFD on CHEW primary pump	(1,175)	5,160	Y	N
VFD on CW pump	(6,169)	265,033	Y	N
Replace 2way valves with 3-way valves	5	NA	N	N
Install VFDs on HHW Pumps	57,436	NA	N	N
SAT setpoint reset on all AHUs	81,998	39,971	Y	N
Install Low DP Filters and UV Reactors AHUs	18,582	NA	N	N
Replace all motors with ECMs	111,780	NA	N	N
Replace boilers with HE non-condensing boilers	-	NA	N	N
All interior lighting	424,598	NA	N	N
Bathroom OCC Sensors	13,571	NA	N	N
OCC based t-stats in guest rooms	23,752	NA	N	N
Interior Lighting Upgrade	1,085,184	950,458	Y	N
Exterior Lighting Upgrade	171,405	182,100	Y	N
Phase 1 Central Plant Upgrade	801,353	667,472	Y	N
New Direct Digital Controls	270,253	478,494	Y	N
Control LSS Water Loops VFDs	35,573	59,864	Y	N
Interior LEDs	165,090	166,766	Y	N
Interior Lighting Controls	109,860	111,319	Y	N
Strip Heats to HHW	2,084,910	2,018,076	Y	N
High Efficiency Chiller Upgrade	1,179,410	NA	N	Y
Water Side Economizer	11,580	NA	N	Y
HHW Pumps VFDs	21,440	NA	N	Y
CW Pumps VFDs	80,920	NA	N	Y
CW Temperature Reset	29,820	NA	N	Y
CHW Temperature Reset	122,520	NA	N	Y
Static Pressure Reset	179,130	NA	N	Y
Supply Air Temp Reset	143,120	NA	N	Y

Proposed Measure	Proposed Annual Savings (kWh)	Ex-Post Annual Savings (kWh)	Claimed Measure	Non-Claimed Measure
Heating Hot Water Lockout	126,640	NA	N	Y
Window film	1,299,010	NA	N	N

A.4. FSP Comprehensive

This chapter details the impact evaluation for the Food Service Program – Comprehensive (FSPC) that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation is to estimate energy and peak demand impacts attributable to the FSPC.

A.4.1. Evaluation Methodology

This section presents the findings of the tracking data review and the methodology used to calculate verified Ex-Post energy and peak demand impacts for the program.

As part of the impact evaluation, the Evaluator performed the following data collection activities:

Table A-19 FSPC Data Sources for Impact Evaluation

Data	Source
Program Tracking Data	Data requested to LADWP for all data tracking program participation and rebate applications
Desk Review	Reviews of project documentation (invoices, model numbers, application, etc.) of a sample of customers who have participated in the program
Virtual Verification	Virtual site visits of a sample of customers to collect data for savings calculation, to verify installation, and determine operating parameters

A.4.1.1. Tracking Data Review

LADWP provided the Evaluator with the available program tracking data for measures incentivized between June 14, 2016, through June 30, 2020. The database review process started with a review of tracking data to ensure that the data provided sufficient information to the calculated energy and peak demand impacts. Additionally, the data was reviewed for duplicate entries and errors. Some duplicate entries were identified and removed after confirming with LADWP program staff.

A.4.1.2. M&V Sample Design

Based on the tracking data provided by LADWP, a sample design was developed for site-level analysis. To represent the population of projects, the Evaluator selected a stratified sample of projects (known as ratio estimation), with enough projects to estimate the total achieved savings with ±10% precision at a 90% confidence interval. Projects were categorized to each stratum by Ex-Ante kWh savings. The boundaries of each stratum were developed to ensure the extrapolation of impacts was appropriately distributed. Realization rates (the ratio of Ex-Post kWh savings to Ex-Ante kWh savings) for projects sampled in each stratum were only extrapolated to other projects within that stratum.

Occasionally, the energy savings for a given project were impacted by circumstances that were not consistent with similar projects. In these situations, the verified energy savings were assigned to the project but were not extrapolated to any other projects ("certainty projects"). The statistical reason for including a certainty stratum is to capture and isolate the outliers so that their extreme values do not influence sampling variability. One project in this program was determined to be a certainty project. This project was held from extrapolating to the population due to the nature of the measure installed. It was not extrapolated to a population as the project was a test kitchen and the unit was for display and had never been used, resulting in an estimation of energy savings of zero; therefore, the realization rate applied to this project was not representative of similar projects.

Table A-20 presents the number of projects and tracking Ex-Ante kWh savings for the sampled projects by stratum.

Table A-20 FSPC Population Statistics used for Sample Design

	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Certainty	Totals
Strata boundaries (Ex-Ante kWh)	<2,138	2,138 – 8,000	8,000 – 84,000	>84,000	Certainty Strata	
Population Size	52	31	32	4	1	120
Total Ex-Ante kWh Savings	65,269	119,096	680,590	445,281	21,109	1,331,345
Average Ex-Ante kWh Savings	1,255	3,842	21,268	111,320	21,109	
Standard Deviation of Ex-Ante kWh Savings	597	1,074	9,577	32,052	N/A	
Coefficient of Variation	0.51	0.28	0.44	0.17	N/A	
Final Design Sample	8	3	14	2	1	28

The resulting sample of 28 projects consisted of 4 categories, or strata, and one certainty project. The Ex-Post gross annual energy savings (kWh) precision was ±9.5%.

A.4.1.3. Baseline Assumptions Review

The Evaluator utilized DEER workpaper baseline assumptions for all measures. Workpapers approval dates were cross-checked with the sampled projects' installation dates in order to ensure the appropriate DEER workpaper was used.

A.4.1.4. Ex-Ante Savings Review

The following table summarizes the discrepancy the Evaluator found comparing the reported ESP Ex-Ante kWh and peak kW savings with the Ex-Ante kWh and peak kW savings presented in the tracking data delivered by LADWP.

Table A-21 FSPC Ex-Ante Savings Source Comparison

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Ante kWh Savings	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW Savings	Program Data Ex-Ante Peak kW Savings	Ex-Ante Peak kW Percent Change
15/16	231,379	223,003	-3.6%	10.00	8.66	-13.4%
16/17	451,068	430,238	-4.6%	9,661.50	59.94	-99.4%
17/18	204,024	189,482	-7.1%	34.44	33.87	-1.7%
18/19	234,054	234,054	0.0%	31.43	46.72	48.6%
19/20	254,568	254,568	0.0%	32.83	45.62	39.0%
Total	1,375,093	1,331,345	-3.2%	9,770.20	194.81	-98.0%

In general, the tracking Ex-Ante kWh and peak kW impacts were less than the ESP Ex-Ante savings. The FY 16/17 peak kW reduction in the tracking data was significantly less than the ESP value; this was the likely the result of a clerical error, as it included a 9,661 peak kW reduction from a Refrigerator/Freezer line item with a claimed kWh of only 15,088.

A.4.1.5. M&V Approach

A combination of project desk reviews and virtual site visits were implemented to calculate sample savings. Available documentation (invoices, applications, cut sheets, etc.) was reviewed for a sample of projects, with attention given to the model numbers and unit parameters. Due to COVID-19, virtual site visits were performed in lieu of on-site visits to collect data for savings calculation, to verify measure installation, and to determine measure operating parameters. Of the 28 sampled sites, the Evaluator completed 19 virtual visits, and the remaining 9 sites were completed with a desk review.

A.4.1.6. Virtual Data Collection Activities

Due to COVID-19, the primary data collection was conducted virtually for a sample of projects to collect the information needed for calculating savings. Interviews were performed by means of phone call, email, and or video walk-through for non-contact project verification.

When projects were selected for the M&V sample, the Evaluator notified LADWP by providing staff with a list of projects for which the Evaluator planned to schedule M&V activities. This list included the company name, the project ID, the site address or other premise identification, and the respective contact information for the customer representative the Evaluator intended to contact to schedule an appointment.

Typically, notification was provided at least one week prior to the Evaluator contacting customers to schedule M&V virtual verifications. Upon request, the Evaluator coordinated its scheduling and M&V activities with an LADWP Service Representative.

Virtual site visits consisted of several different approaches depending on the project type, facility type, location, and site contact. Virtual visits included one or more of the following.

- A video walk-through to verify installed measures are functioning. Several different methods of video were used including Microsoft Teams, Apple's Facetime, and Streem.
- Email communication with a site contact asking specific questions pertaining to the project, and collecting any applicable data or trend data, along with requesting photos of the newly installed equipment.
- Verbal communication (if no video) through an interview, to review project details and collect additional information to support analysis.

A.4.2. Impact Evaluation

Ex-Post kWh savings were estimated using the appropriate DEER workpapers and industry standards. Key input parameters were based on information collected during virtual verification or reviewing equipment specification sheets.

A.4.2.1. Engineering Review Procedures

Available documentation was reviewed for a sample of projects, with attention given to model numbers, ENERGY STAR ratings, invoice dates, and unit specifications. Analysis of FSPC measures was accomplished using algorithms from DEER workpapers and input parameters (unit operating hours, unit efficiencies, unit size/capacity, etc.) based on information either collected virtually, taken from specification sheets and if appropriate, using default values from DEER workpaper.

A.4.2.2. Description of Factors Affecting Gross Realized Savings

There were several factors affecting gross realized savings. Explanations of how each factor affected realized savings are provided below, along with frequency of occurrence as illustrated in Figure A-5. Figure A-6 quantifies the impact of these identified factors on the gross realized savings of the project sample.

Differing Efficient Assumptions: Ex-Post calculation utilized project-specific unit specifications such as idle energy rates, production capacities, and cooking efficiencies in lieu of the default DEER workpaper values the utilized in the Ex-Ante. For example, for a steamer unit, the following efficient case assumptions were used:

The Ex-Ante used efficient case DEER workpaper values for the following parameters.

Idle Energy Rate (kW) = 0.26, Cooking Efficiency = 68%, Production Cap (lb./hr.) = 88

The Ex-Post used the installed unit's parameters from the LADWP qualifying list.

Idle Energy Rate (kW) = 0.10, Cooking Efficiency = 70%, Production Cap (lb./hr.) = 127

Differing Hours of Operation: There were instances where the verified measure hours of use were greater than the default DEER workpapers values used in the Ex-Ante estimate. Additionally, there was equipment installed at a test/display kitchen, in which it was verified during the virtual site visit that the unit has never been used.

Differing Measure Parameter, Volume (cu. ft.): There were incorrect measure parameters used. For example, a Hot Food Cabinet was verified to have a volume of 5.83 cu. ft., while the Ex-Ante estimate assumed a default DEER workpaper value of 10 cu. ft.

Incorrect DEER Workpaper: There were instances of Incorrect DEER workpapers values used in the Ex-Ante estimate. For example, a unit purchased in 2018 using pre-2018 DEER workpaper values. Additionally, a kitchen hood DVC project with Ex-Ante values that were greater than the DEER workpapers values. The DEER workpaper values for this measure had not changed since 2014, and the Evaluator was unsure what the source of the Ex-Ante values was. In this case, the Ex-post analysis used the DEER workpaper savings values.

Figure A-5 Factors Affecting Gross Realized Savings of Sampled Projects

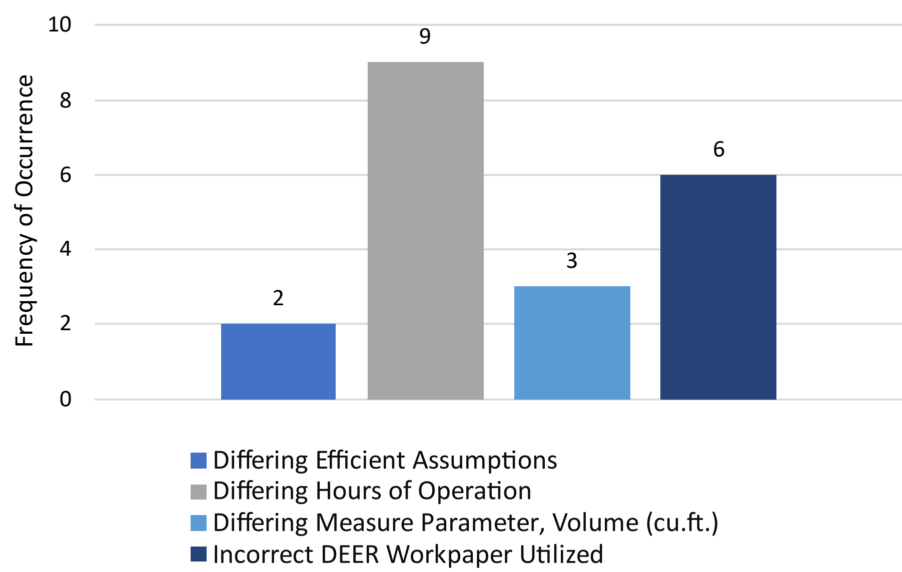
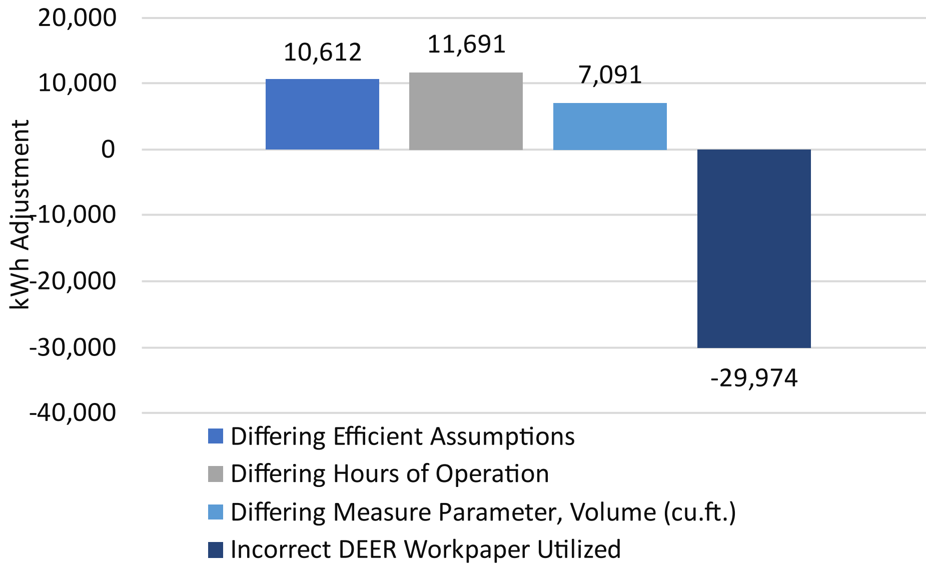


Figure A-6 Retrospective Period Ex-Post kWh Impact Factors



A.5. FSP POS

This chapter details the impact evaluation for the Food Service Program – Point of Sale (FSP POS) that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation was to estimate energy and peak demand impacts attributable to the FSP POS.

A.5.1. Evaluation Methodology

This section presents the findings of the tracking data review, the methodology used to calculate verified Ex-Post energy and demand impacts for the program, and the results for the analysis.

The Evaluator performed the following data collection activities as part of the impact evaluation:

Table A-22 FSP POS Data Sources for Impact Evaluation

Data	Source
Program Tracking Data	Data requested to LADWP for all data tracking program participation and rebate applications
Desk Review	Reviews of project documentation (invoices, model numbers, application, etc.) of a sample of customers who have participated in the program
Virtual Verification	Virtual site visits of a sample of customers to collect data for savings calculation, to verify installation, and determine operating parameters

A.5.1.1. Tracking Data Review

LADWP provided the Evaluator with the available program tracking data for rebated measures. The database review process started with a tracking data review to ensure that the data provided sufficient information to the calculated energy and demand impacts. Additionally, the data was reviewed for duplicates and errors. The data showed 25 projects with a total of 48 rebated units.

A.5.1.2. M&V Sample Design

Based on the tracking data provided by LADWP, a sample design was developed for site-level analysis. Samples were drawn that provide savings estimation with ±10% statistical precision at the 90% confidence level. To represent the population of projects, the Evaluator selected a stratified sample (known as ratio estimation) with enough projects to estimate the total achieved savings with 10% precision at a 90% confidence. Projects were categorized by Ex-Ante kWh savings. The boundaries of each stratum were developed to ensure the extrapolation of impacts was appropriately distributed. Realization rates (the ratio of Ex-Post kWh savings to Ex-Ante kWh savings) for projects sampled in each stratum were only extrapolated to other projects within that stratum.

The selected projects were identified for further exploration and full documentation was requested. To further improve the precision, projects were selected for the sample through systematic random sampling. That is, a sample of sites was selected by ordering them according to the magnitude of their savings and using systematic random sampling. This ensures that any sample selected will have some units with high savings, some with moderate savings, and some with low savings.

Table A-23 presents the number of projects and tracking Ex-Ante kWh savings for the sampled projects by stratum.

Table A-23 FSP POS Population Statistics used for Sample Design

	Stratum 1	Stratum 2	Stratum 3	Totals
Strata boundaries (Ex-Ante kWh)	<893	893 – 7,665	>7,665	
Population Size	16	6	3	25
Total Ex-Ante kWh Savings	8,159	23,123	38,814	70,096
Average Ex-Ante kWh Savings	510	3,854	12,938	
Standard Deviation of Ex-Ante kWh Savings	194	2,093	7,408	
Coefficient of Variation	0.38	0.54	0.57	
Final Design Sample	2	6	3	11

The resulting sample of eleven projects consisted of 3 categories, or strata. The Ex-Post gross annual energy savings (kWh) precision was ±6.2%.

A.5.1.3. Baseline Assumptions Review

The Evaluator utilized DEER workpaper baseline assumptions for all measures. Workpapers approval dates were cross-checked with the sampled projects' installation dates in order to ensure the appropriate DEER workpaper was referenced.

A.5.1.4. Ex-Ante Savings Review

The following table summarizes the discrepancy the Evaluator found comparing the reported ESP Ex-Ante kWh and peak kW savings with the Ex-Ante kWh savings and peak kW reduction presented in the tracking data delivered by LADWP.

Table A-24 FSP POS Ex-Ante Savings Source Comparison

Fiscal Year	ESP Data Ex-Ante kWh Savings	Program Data Ex-Ante kWh Savings	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW Savings	Program Data Ex-Ante Peak kW Savings	Ex-Ante Peak kW Percent Change
19/20	59,607	70,096	17.6%	7.69	11.47	49.2%

In general, the tracking Ex-Ante kWh and peak kW were greater than the ESP Ex-Ante savings. The Evaluator was unable to recreate the reported ESP Portfolio Ex-Ante kWh and kW impact values with the provided program tracking data.

A.5.1.5. M&V Approach

Project desk reviews and virtual site visits were performed to collect data for the Ex-Post savings evaluation. Available documentation (invoices, applications, cut sheets, etc.) was reviewed for a sample of projects, with attention given to the model numbers and unit parameters. Due to COVID-19, virtual site visits were performed in lieu of on-site visits to collect data for energy savings calculations, to verify measure installation, and to determine equipment operating parameters. Of the 11 sampled sites, the Evaluator completed 7 virtual visits, and the remaining 4 sites were completed with desk reviews.

A.5.1.6. Virtual Data Collection Activities

Due to COVID-19, primary data collection was conducted virtually for a sample of projects to provide the information needed for estimating savings. Interviews were conducted by means of phone call, email, or video walk-through for non-contact project verification.

When projects were selected for the M&V sample, the Evaluator notified LADWP by providing staff with a list of projects for which the Evaluator planned to schedule M&V activities. This list included the company name, the project ID, the site address or other premise identification, and the respective contact information for the customer representative the Evaluator intended to contact to schedule an appointment.

Typically, notification was given at least one week prior to the Evaluator contacting customers to schedule M&V virtual verifications. Upon request, the Evaluator coordinated its scheduling and M&V activities with an LADWP Service Representative.

Virtual site visits consisted of several different approaches depending on the project type, facility type, location, and site contact. Virtual visits included one or more of the following.

- A video walk-through to verify installed measures were functioning. Several different methods of video were used including Microsoft Teams, Apple's Facetime, and Streem.
- Email communication with a site contact asking specific questions pertaining to the project involved, and collecting any applicable data or trend data, along with requesting photos of the newly installed equipment.
- Verbal communication (if no video) through an interview, to review project details and collect additional information to support the analysis.

A.5.2. Impact Evaluation

Ex-Post kWh savings were estimated using the appropriate DEER workpapers and industry standards. Key input parameters were based on information collected during virtual verification or review of equipment specification sheets.

A.5.2.1. Engineering Review Procedures

Available documentation was reviewed for a sample of projects, with attention given to model numbers, ENERGY STAR ratings, invoice dates, and unit specifications. Analysis of FSP- POS measures was accomplished using algorithms from DEER workpapers and input parameters (unit operating hours, unit efficiencies, unit size/capacity, etc.) based on information either collected virtually, taken from specification sheets, and if appropriate, using default values from the DEER workpaper.

A.5.2.2. Description of Factors Affecting Gross Realized Savings

There were several factors that affected gross realized savings. Explanations of how each factor affected realized savings are provided below, along with the frequency of occurrence as illustrated in Figure A-7. Figure A-8 quantifies the impact of these identified factors on the gross realized savings of the M&V sample.

Differing Efficient Assumptions: The Ex-Post analysis utilized project-specific unit specifications such as idle energy rates, production capacities, and cooking efficiencies in lieu of default DEER workpaper values the used in the Ex-Ante estimate. Additionally, there were incorrect savings applied to types of measures. For example, the Ex-Ante estimate applied deemed savings values for a glass door refrigerator, while in reality the unit was a solid door refrigerator.

Differing Hours of Operation: There were instances where the verified hours of use were less than the default DEER workpapers' hours of operation used in the Ex-Ante estimate.

Differing Measure Parameter, Volume (cu. ft.): Incorrect measure parameters were used. For example, a Hot Food Cabinet was verified to have a volume of 3.9 cu. ft., while the Ex-Ante utilized the default DEER workpaper value of 10 cu. ft.

Figure A-7 Factors Affecting Gross Realized Savings of Sampled Projects

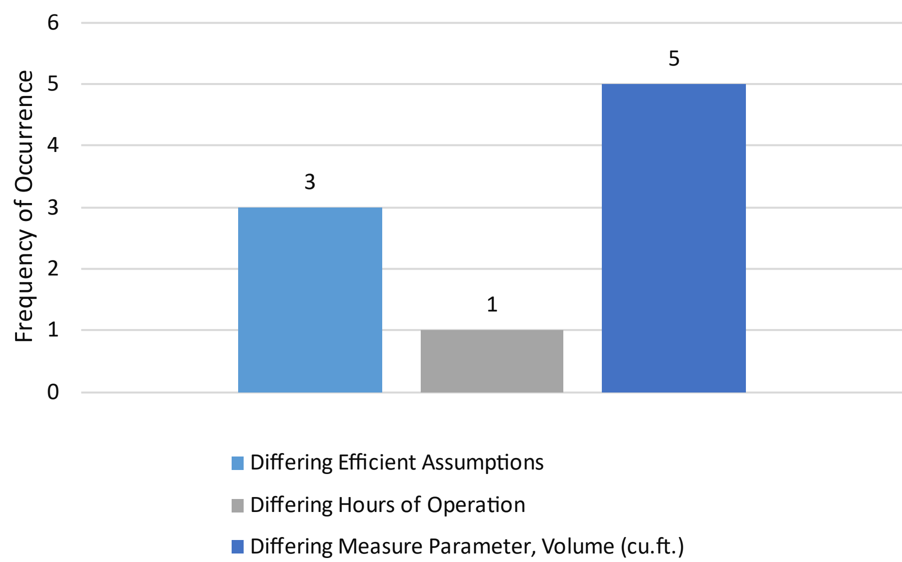
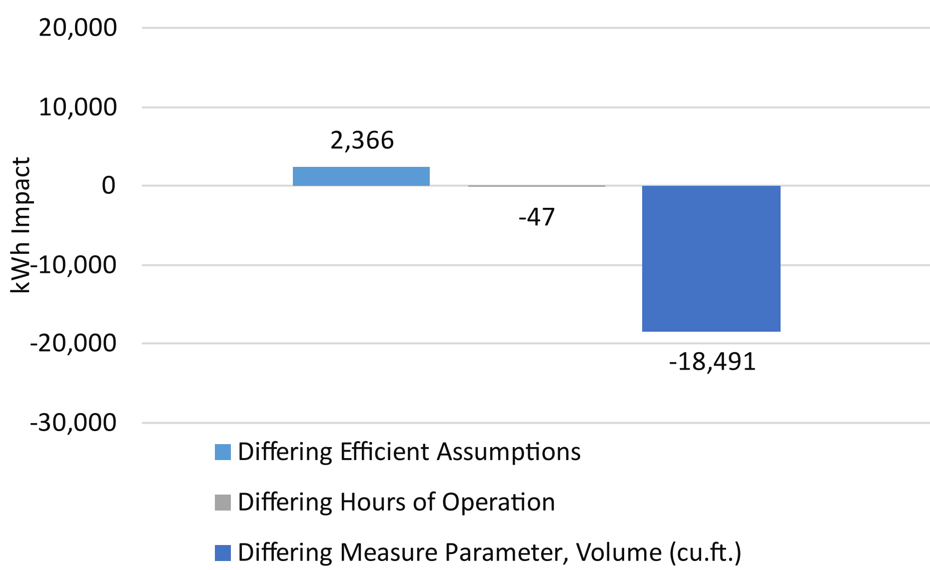


Figure A-8 Retrospective Period Ex-Post kWh Impact Factors



A.6. LADWP Facilities Program

This section details the impact evaluation for the LADWP Facilities Program that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation is to calculate energy savings and peak demand impacts attributable to the Program.

A.6.1. Evaluation Methodology

This section presents the findings of the tracking data review, the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program, and the results of the analysis.

A.6.1.1. Tracking Data Review

LADWP provided the Evaluator with the available program tracking data for measures installed as a part of LADWP Facilities Upgrades between July 01, 2015, and June 30, 2020. Review of the tracking data was performed to ensure that the provided data was sufficient to calculate energy savings and peak demand reduction, and to verify that projects listed were completed and had dates matching the fiscal year to which they were attributed.

A.6.1.2. M&V Sample Design

Based on the tracking data provided by LADWP, a sample design was developed for site-level analysis. Samples were drawn that provided savings estimation with ±10% statistical precision at the 90% confidence level. To represent the population of projects, the Evaluator selected a stratified sample (known as ratio estimation) with enough projects to estimate the total achieved savings with 10% precision at a 90% confidence. Projects were categorized by Ex-Ante kWh savings. The boundaries of each stratum were developed to ensure the extrapolation of impacts was appropriately distributed. Realization rates (the ratio of Ex-Post kWh savings to Ex-Ante kWh savings) for projects sampled in each stratum were only extrapolated to other projects within that stratum.

Table A-25 LADWP Facilities program Population/Sample Statistics

	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Totals
Strata boundaries (Ex-Ante kWh)	<35,000	35,000 – 100,000	100,000 – 300,000	>300,000	
Population Size	17	15	4	2	38
Total Ex-Ante kWh savings	373,252	882,888	587,021	886,489	2,729,650
Average Ex-Ante kWh Savings	21,956	58,859	146,755	443,245	
Standard deviation of Ex-Ante kWh savings	8,622	18,646	20,467	76,780	
Coefficient of variation	0.39	0.32	0.14	0.17	

	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Totals
Final design sample	3	4	2	2	11

A.6.1.3. Baseline Assumptions Review

The projects completed under the LADWP Facilities program during the Retrospective Period consisted of only lighting measures. Generally, for projects involving lighting measures, savings were determined as follows:

$$kWh_{Savings} = \frac{Watt_{Baseline} * HOU_{Baseline} * Qty_{Baseline} - Watt_{Installed} * HOU_{Installed} * Qty_{Installed}}{1000} * IEFe \qquad \textit{Equation A-9}$$

$$kWh_{Code} = \frac{Watt_{Code} * HOU_{Baseline} * Qty_{Baseline} - Watt_{Installed} * HOU_{Installed} * Qty_{Installed}}{1000} * IEFe \qquad \textit{Equation A-10}$$

$$\Delta kW = (\mathrm{Watt}_{\mathrm{Baseline}} - Watt_{Installed}) * CF * IEFd/1000 \qquad \textit{Equation A-11}$$

$$Dual\ Baseline\ Lifetime\ Savings = kWh_{Savings} * \frac{EUL}{3} + kWh_{Code} * (EUL - \frac{EUL}{3}) \qquad \textit{Equation A-12}$$

Equation A-9 and Equation A-11 detail the equations used to determine energy savings and demand reduction for lighting measures. Dual baseline lifetime savings were calculated as a part of the program analysis, detailed in Equation A-12. Calculation of dual baseline lifetime savings required the use of savings using code standards which was calculated using Equation *A-10*. Baseline assumptions made for energy savings and demand reduction are detailed below:

Baseline Wattage: For the Ex-Post savings analysis, the baseline wattage is considered as the wattage of the pre-retrofit lighting fixture. However, for the purpose of calculating dual baseline lifetime savings, savings were also calculated using a code-specified baseline wattage. For Tube LEDs, High Bay LEDs, and LED Troffer Kits, the code baseline wattage was calculated using a code efficacy value taken from the DEER workpaper along with the lumens of the installed fixture. For Screw-In LEDs, the code baseline wattage was determined using a wattage reduction ratio taken from DEER workpapers applied to the installed fixture wattage.

Hours of Use (HOU): The hours of use utilized in the savings calculation were the hours confirmed during the virtual or on-site verification process. Deemed values from DEER workpapers dependent upon space type and climate zone were also used.

Summer Peak Coincidence Factor (CF): The summer peak coincidence factor is a ratio determined by light usage during the peak demand period from 1pm-6pm on weekdays from June to September.

Interactive Effects, Energy Savings (IEFe): The utilized value for energy interactive effects comes from tables taken from DEER. The values are dependent upon space type, climate zone, and installed fixture type.

A.6.1.4. Ex-Ante Savings Review

The following table summarizes the discrepancy the Evaluator found comparing the reported ESP Ex-Ante kWh savings and peak kW reduction with the Ex-Ante kWh savings and peak kW reduction presented in the tracking data delivered by LADWP. Generally, Ex-Ante kWh and Peak kW were lower in the tracking data compared to the ESP database.

Table A-26 LADWP Facilities Ex-Ante Savings by Fiscal Year

Fiscal Year	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
15/16	1,395,552	544,493	-61.0%	192.00	185.00	-3.6%
16/17	1,104,281	483,964	-56.2%	113.00	104.00	-8.0%
17/18	1,383,033	1,060,360	-23.3%	152.00	146.00	-3.9%
18/19	250,597	36,244	-85.5%	43.00	11.00	-74.4%
19/20	466,175	604,589	29.7%	1.00	71.00	>100%
Total	4,599,638	2,729,650	-40.7%	501.00	517.00	3.2%

A.6.1.5. M&V Approach

Virtual and in-person site visits were performed to gather information used in project savings estimates. In addition to the site visits, provided project documentation (invoices, cut sheets, applications, etc.) supplemented the information gathered during the virtual and on-site verification process to determine associated project savings.

A.6.1.6. Virtual Data Collection Activities

Due to the COVID-19 pandemic, virtual site visits were implemented in the beginning of the verification process, as a modification to the typical on-site visit procedure to ensure the safety of all parties involved. Virtual site visit/verification involved the use of video calls and/or email or phone interviews of site contacts to verify the installation of equipment and gather information pertinent to the operation of the installed measures (hours of use, heating/cooling conditions, controls, etc.). However, the Evaluator was only able to conduct virtual data collection on a few sites due to issues pertaining to scheduling and availability of site personnel.

The Evaluator notified LADWP of all sample projects for which the Evaluator planned to schedule M&V activities. Information for all projects included the company name, project ID, site address, and contact information of the customer representative for which the Evaluator would contact to schedule a virtual verification appointment.

Once approval of M&V activities for the sampled projects was given by LADWP, the Evaluator contacted and scheduled virtual verification activities with the customer representative.

Virtual verification consisted of several implementation methods which were dependent upon the project, facility type, location, and customer representative availability. These methods were as follows:

- Video Call: During video calls, the Evaluator would verify the installation of claimed project measures while also conducting an interview of the contact to gather information regarding operation of the project measure. Multiple methods of video were employed to accommodate site contacts for the various projects. The methods of video communication employed were Streem, Microsoft Teams, and Apple's FaceTime.
- Email: Email correspondence was established with the site contact where the Evaluator would then ask questions pertaining to the installed project measures and their operation. In addition to obtaining responses to questions, the Evaluator requested photos of the installed project measures.
- Phone: In instances where the site contact was unable to perform a video call, a phone call interview was performed, and in which the Evaluator would ask the site contact pertinent questions to gather information. The Evaluator would also request photos of the installed project measures.

A.6.1.7. In-Person Data Collection Activities

After COVID-19 restrictions were lifted, the Evaluator revisited the data collection strategy in order to arrange for on-site visits. After some discussions with LADWP on safety procedures and providing the essential safety compliance documentation, LADWP approved in-person site visits, which were subsequently implemented. The on-site visit involved the visual inspection and obtaining photos of the installed equipment. An interview with the site contact was conducted to gather information pertinent to the installed measures and their operation, and to obtain answers to some specific questions listed in the M&V plan for each site. Data collection for most LADWP Facilities projects was completed via in-person visits.

A.6.2. Impact Evaluation

This section describes various procedures undertaken to conduct the impact evaluation of the LADWP Facilities program. These activities include engineering review procedures, data analysis, extrapolation of results, and description of factors affecting gross realized savings.

A.6.2.1. Engineering Review Procedures

The documentation provided by LADWP was reviewed for the projects within the program sample. The LADWP Facilities program measure summary and incentive calculator along with invoices and specification sheets of installed fixtures were reviewed. Analysis of project savings were done using typical lighting savings algorithms using information gathered from the project documentation and information gathered during the virtual verification process.

A.6.2.2. Data Collection

All projects selected underwent M&V Plan development, which included a desk review. The extent of the desk review was dependent on evaluation approach as well as available information from project documentation. A summary of the progression of the randomly sampled projects is shown in Table A-27.

Table A-27 LADWP Facilities program Evaluation Data Collection Progression

Stratum	M&V Plans	Contact Attempted	Virtual Verification	On-Site Verification	Evaluated
1	3	3	1	1	2
2	4	4	0	4	4
3	2	2	0	2	2
4	2	2	1	1	2
Total	11	11	2	8	10

Due to the ongoing pandemic, the Evaluator was not able to conduct any on-site power monitoring. To recruit sites for virtual or on-site verification, the Evaluator performed the following actions:

- If the initial contact responded but was not the correct contact, then the evaluator would request appropriate contact information and continue in this manner through all available contacts.
- If the initial contact responded but was not aware of who the correct contact was, the Evaluator would then request additional contact information from LADWP as well as conduct internet searches to obtain more information.
- The Evaluator would attempt to reach the initial contact and all additional contacts a minimum of 5 times using both phone calls and emails at different times of the day and different days of the week.

A.6.2.3. Sample Results

Project-level and measure-level results can be found in site-level reports, which can be viewed in Appendix D. For confidential and privacy considerations of participants,

Appendix D was not published with the public version of the report. Appendix D was provided only to LADWP as reference to supplement this EM&V report.

A full evaluation analysis was conducted on 11 of the 42 randomly sampled projects from the FY 15/16 to FY 19/20. Energy savings for sampled projects within each stratum were aggregated to determine a strata level realization rate used for extrapolation to the population. Sample savings impacts by strata are shown in Table A-28.

Table A-28 LADWP Facilities program Evaluation Sample Savings Summary

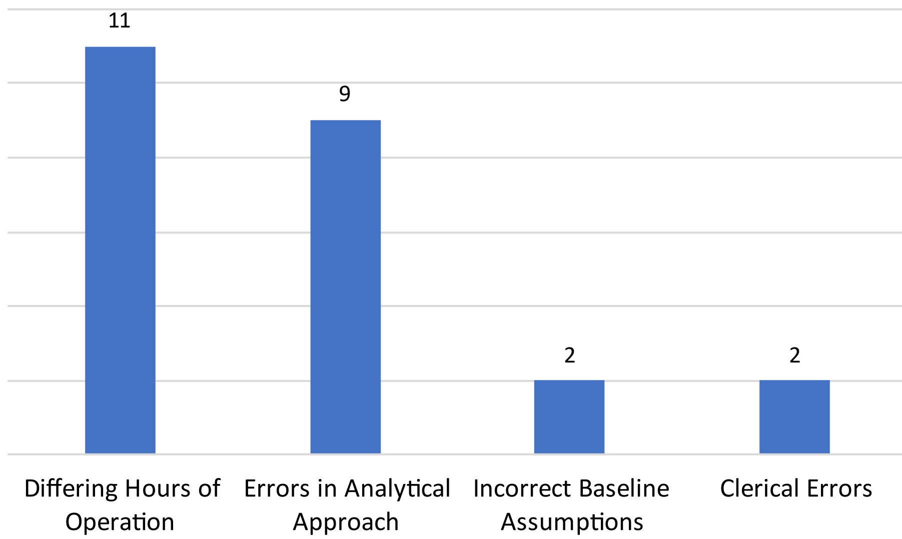
Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	53,605	24,546	46%	17.00	2.20	13%
2	277,633	405,515	146%	79.00	68.86	87%
3	291,261	171,599	59%	53.00	21.98	41%
4	886,489	602,333	68%	104.00	87.48	84%
Total	1,508,988	1,203,993	80%	253.00	180.52	71%

The overall realization rates for all stratum varied. The most common cause of discrepancy in the sampled projects were the hours of use employed in energy savings calculations. The largest discrepancy occurred with peak kW savings in Stratum 1. Generally, discrepancies in peak kW savings occurred due to a difference in calculation methodology mentioned in section A.6.1.3.

A.6.2.4. Description of Factors Affecting Gross Realized Savings

The Evaluator determined four main factors that contributed to discrepancies in realized savings. The frequency in which these factors are relevant is skewed, with the most common factors being “Errors in Analytical Approach” & “Differing Hours of Operation”. Explanations of how each factor affected realized savings are found below, along with frequency of occurrence as illustrated in Figure A-9.

Figure A-9 Factors Affecting Gross Realized Savings for Sampled Projects



Incorrect Baseline Assumptions: The baseline assumptions made for the Ex-Post savings calculations are detailed in section A.6.1.3. This factor was chosen for any projects in which the baseline values utilized in the Ex-Ante savings calculations differed from the values in the Ex-Post savings calculations. The most common occurrence in the LADWP Facilities projects analysis was a difference in interactive effects. The Ex-Ante savings calculations used a value of 1.08 for both energy savings and demand reduction, whereas the Ex-Post savings calculations used values dependent upon various project-specific factors, as explained in section A.6.1.3.

Differing Hours of Operation: Hours of use employed in the Ex-Post savings calculations were determined during the virtual verification process. This factor was listed as having an effect on realized savings in any instance where the verified hours of use differed from the hours claimed in the Ex-Ante calculations.

Clerical Errors: Clerical errors pertaining to the analyses of the LADWP Facilities projects were determined to be differences in the installed fixture wattage used in the Ex-Ante and Ex-Post savings calculations. The fixture wattages used in the Ex-Post savings calculations were obtained from specification sheets and applied to fixtures specified in the project documentation.

Errors in Analytical Approach: This factor affected only one project. For that project it was due to a difference in how demand reduction was calculated. The Ex-Ante calculations determined demand reduction as the difference in the connected load of the project facility, pre- and post-retrofit. The Ex-Post demand reduction was determined using the difference in connected load during the summer peak period as noted in A.6.1.3.

The following are a few examples the factors affecting gross realized savings:

- Example-1: The calculated Ex-Post savings were different than expected due to differences in the number of fixtures, controls factors, and hours of use. The Ex-Ante calculations used 251 fixtures and occupancy sensors, whereas the Ex-Post calculations used 240 fixtures, which were confirmed during site visit and supported by construction drawings provided as part of the project documentation. The Ex-Ante used control reduction of 25%, 55%, and 60%, whereas the drawings provided a reduction of 30%, 50%, and photocell controlled. Lastly, the hours of use employed in the Ex-Ante calculations were 8,750 hours per year, whereas the Ex-Post calculations used 8,760 hours per year for the fixtures that remain on year-round.
- Example-2: Savings were different than expected due to a difference in fixture wattages, quantity of efficient lamps in operation, and methods of savings calculations. The Ex-Ante used lamp wattages and added ballast wattage, whereas the Ex-Post used a fixture wattage that accounted for the ballast. The M&V site visit found 1,431 lamps in use in the parking garage, compared to the 1,544 used in the Ex-Ante calculation. The Ex-Ante estimate calculated hours of use by dividing lamp lifetime savings by estimated EUL. The Ex-Post calculation used actual hours of use per year for the facility.
- Example-3: The Ex-Ante annual energy saving calculations were performed by dividing 100,000 hours by an 11 year EUL. This calculation yielded 9,090 hours of use per year, which is greater than the total number of hours in a year. The Ex-Post calculations used 8,760 hours of operation for lighting fixtures.
- Example-4: Savings were different than expected due to differences in hours of use, controls savings factor, efficient fixture wattages, and quantities of confirmed fixtures. The Ex-Ante used 8,571 annual hours of use per year, whereas the Ex-Post used 3,250 for confirmed baseline hours of use. The Ex-Ante calculations employed a control factor of 0.8 for fixtures with occupancy sensors whereas the Ex-Post calculations employed 0.5 per the area description. The Evaluator’s site visit confirmed 429 of 445 expected 4-foot 1-lamp fixtures and 247 of 237 expected 3-foot 1-lamp fixtures.

A.7. LAUSD DI Program

This section details the impact evaluation for the LAUSD DI Program that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation was to calculate energy savings and peak demand impacts attributable to the Program.

A.7.1. Evaluation Methodology

This section presents the findings of the tracking data review, the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program, and the results of the analysis.

A.7.1.1. Tracking Data Review

LADWP provided the Evaluator with the available program tracking data for measures installed as a part of LAUSD DI Upgrades between July 01, 2015, and June 30, 2020.

Review of the tracking data was performed to ensure that the provided data was sufficient to calculate energy savings and peak demand reduction, and to verify that projects listed were completed and had dates matching the fiscal year to which they were attributed.

A.7.1.2. M&V Sample Design

Based on the tracking data provided by LADWP, a sample design was developed for site-level analysis. Samples were drawn that provided savings estimation with ±10% statistical precision at the 90% confidence level. To represent the population of projects, the Evaluator selected a stratified sample (known as ratio estimation) with enough projects to estimate the total achieved savings with 10% precision at a 90% confidence. Projects were categorized by Ex-Ante kWh savings. The boundaries of each stratum were developed to ensure the extrapolation of impacts was appropriately distributed. Realization rates (the ratio of Ex-Post kWh savings to Ex-Ante kWh savings) for projects sampled in each stratum were only extrapolated to other projects within that stratum.

Table A-29 LAUSD DI Program Population/Sample Statistics

	Stratum 1	Stratum 2	Stratum 3	Total
Strata boundaries (Ex-Ante kWh)	<35,000	200,000 – 500,000	>500,000	
Population Size	25	18	7	50
Total Ex-Ante kWh savings	3,699,764	5,486,928	4,318,564	13,505,256
Average Ex-Ante kWh Savings	147,991	304,829	616,938	
Standard deviation of Ex-Ante kWh savings	46,231	101,545	107,868	
Coefficient of variation	0.33	0.17	0.45	
Final design sample	5	6	7	18

A.7.1.3. Baseline Assumptions Review

The projects completed under the LADWP Facilities program during the Retrospective Period consisted of lighting measures only. Generally, for projects involving lighting measures, savings were determined as follows:

$$kWh_{Savings} = \frac{Watt_{Baseline} * HOU_{Baseline} * Qty_{Baseline} - Watt_{Installed} * HOU_{Installed} * Qty_{Installed}}{1000} * IEFe \qquad \text{Equation A-13}$$

$$kWh_{Code} = \frac{Watt_{Code} * HOU_{Baseline} * Qty_{Baseline} - Watt_{Installed} * HOU_{Installed} * Qty_{Installed}}{1000} * IEFe \qquad \text{Equation A-14}$$

$$\Delta kW = (\mathrm{Watt}_{\mathrm{Baseline}} - Watt_{Installed}) * CF * IEFd/1000 \qquad \text{Equation A-15}$$

$$Dual\ Baseline\ Lifetime\ Savings = kWh_{Savings} * \frac{EUL}{3} + kWh_{Code} * (EUL - \frac{EUL}{3}) \qquad \text{Equation A-16}$$

Equation A-13 and Equation A-15 detail the equations used to determine energy savings and demand reduction for lighting measures. Dual baseline lifetime savings were calculated as a part of the program analysis, detailed in Equation A-16. Calculation of dual baseline lifetime savings required the use of savings using code standards calculated using Equation A-14. Baseline assumptions made for calculation of energy savings and demand reduction are detailed below:

Baseline Wattage: For the Ex-Post savings analysis, the baseline wattage was considered as the wattage of the pre-retrofit lighting fixture. However, for the purpose of calculating dual baseline lifetime savings, savings were also calculated using a code-specified baseline wattage. For Tube LEDs, High Bay LEDs, and LED Troffer Kits, the code baseline wattage was calculated using a code efficacy value taken from DEER workpaper along with the lumens of the installed fixture. For Screw-In LEDs, the code baseline wattage was determined using a wattage reduction ratio taken from DEER workpapers applied to the installed fixture wattage.

Hours of Use (HOU): The hours of use employed for the analysis were the hours confirmed during the virtual or on-site verification process. Deemed values from DEER workpapers dependent upon space type and climate zone were also used.

Summer Peak Coincidence Factor (CF): The summer peak coincidence factor was a ratio determined by light usage during the peak demand period from 1pm-6pm on weekdays from June to September.

Interactive Effects, Energy Savings (IEFe): The value used for energy interactive effects were obtained from DEER. The values were dependent upon space type, climate zone, and installed fixture type.

A.7.1.4. Ex-Ante Savings Review

The following table summarizes the discrepancy the Evaluator found comparing the reported ESP Ex-Ante kWh savings and peak kW reduction with the Ex-Ante kWh savings and peak kW reduction presented in the tracking data delivered by LADWP.

Table A-30 LAUSD DI Ex-Ante Savings by Fiscal Year

Fiscal Year	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
16/17	376,228	376,228	0.0%	149.00	148.52	-0.3%
17/18	2,286,462	1,937,625	-15.3%	971.00	756.10	-22.1%
18/19	364,407	364,407	0.0%	42.00	143.86	242.5%
19/20	10,717,685	10,826,996	1.0%	1,764.00	3,017.42	71.1%
Total	13,744,782	13,505,256	-1.7%	2,926.00	4,065.90	39.0%

A.7.1.5. M&V Approach

In-person site visits were conducted to gather information utilized in project savings calculations. In addition to the site visits, LADWP provided project documentation (measure level project tracking data), supplementing the information gathered during the on-site verification process to determine associated project savings. The on-site visit/verification involved the visual inspection and photographing of the installed equipment, an interview with the site contact to gather information pertinent to the installed measures and their operation, and to obtain answers to some specific questions listed in the M&V plan for each site. No virtual data collection activities were performed for the LAUSD DI program.

A.7.2. Impact Evaluation

This section describes various procedures undertaken to conduct the impact evaluation of the LAUSD DI program. These included engineering review procedures, data analysis, extrapolation of results, and description of factors affecting gross realized savings.

A.7.2.1. Engineering Review Procedures

The provided documentation was reviewed for the projects within the M&V sample. Analysis of project savings were performed using typical lighting savings algorithms and the information gathered from the project documentation and the on-site verification process.

A.7.2.2. Data Collection

All projects selected underwent M&V Plan development, which included a desk review. The extent of the desk review was dependent on evaluation approach as well as available information from project documentation. A summary of the progression of the randomly sampled projects is shown in Table A-31.

Table A-31 LAUSD DI program Evaluation Data Collection Progression

Stratum	M&V Plans	Contact Attempted	Virtual Verification	On-Site Verification	Evaluated
1	5	5	0	5	5
2	6	6	0	6	6
3	7	7	0	7	7
Total	18	18	0	18	18

Due to the ongoing COVID-19 pandemic at that time, the Evaluator was not able to conduct any on-site power monitoring on LAUSD DI projects.

A.7.2.3. Data Analysis

Project-level and measure-level results can be found in site-level reports, which can be viewed in Appendix D. For confidential and privacy considerations of participants, Appendix D was not published with the public version of the report. Appendix D was provided only to LADWP as reference to supplement this EM&V report.

A full evaluation analysis was conducted on 18 of the 50 randomly sampled projects from FY 15/16 to FY 19/20. Energy savings for sampled projects within each stratum were aggregated to determine a strata level realization rate used for extrapolation to the population. Sample savings impacts by strata are shown in Table A-32.

Table A-32 LAUSD DI program Evaluation Sample Savings Summary

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	750,079	844,263	113%	273.44	184.76	68%
2	1,872,051	1,901,970	102%	538.19	300.18	56%
3	4,318,564	4,119,348	95%	1,081.18	580.95	54%
Total	6,940,694	6,865,582	99%	1,892.82	1,065.90	56%

The overall realization rates for all strata varied. The most common cause of discrepancy in the sampled projects were the hours of use employed in the savings calculations. Generally, discrepancies in peak kW reduction occurred due to a difference in calculation methodology mentioned in Section A.7.1.3.

A.7.2.4. Description of Factors Affecting Gross Realized Savings

The Evaluator reviewed the main factors that contributed to discrepancies in realized savings and identified two factors. The most common factors being “Differing Hours of Operation” and “Errors in Analytical Approach”. Explanations of how each factor affected realized savings are provided below.

Differing Hours of Operation: Hours of use utilized in the Ex-Post savings calculations were determined based on verified schedule of 6:00am - 10:00pm Monday - Friday, along with eleven federal holidays, and reduced lighting usage for summer, winter, and spring breaks.

Errors in Analytical Approach: This was due to a difference in how peak demand reduction savings were calculated. The Ex-Ante calculations determined peak demand reduction as the difference in the connected load of the project facility pre- and post-retrofit. The Ex-Post demand reduction was determined using the difference in connected load during the summer peak period as noted in Section A.7.1.3.

A.8. SBD Program

This section details the impact evaluation for the Savings by Design (SBD) Program that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation is to calculate energy savings and peak demand impacts attributable to the Program.

A.8.1. Evaluation Methodology

This section presents the methodology used to evaluate the SBD Program. Ex-Post annual energy savings, lifetime energy savings, and peak demand reduction were determined using the methodologies described. A site-specific approach was used to determine Ex-Post site level impacts with extrapolation to the population based on the design of the SBD program. The methods employed included:

- Review of program tracking data for completeness and sampling;
- Project documentation review;
- Site-specific Measurement and Verification Plan (M&V Plans);
- Primary data collection from site contacts;
- Engineering analysis for each sampled project; and
- Extrapolation of sample level results to determine program level impact estimates.

A.8.1.1. Tracking Data Review

To begin the impact evaluation, the Evaluator reviewed program documentation and examined data on the performance of the program in previous years. Program tracking data was reviewed for completeness and identification of outliers and issues. Projects were checked for installation and incentive dates for program year applicability.

Project level tracking data was then analyzed to determine the most appropriate sampling approach. Data was reviewed for the range of annual energy savings and whether projects were categorized as New Construction or Modernization. While a random evaluation sample was determined, it was important to ensure that each type of project was represented for extrapolation. A summary by measure type is shown in Table A-33.

Table A-33 SBD Project Categories

Stratum	Measures	Program Data Ex-Ante Annual kWh	Percent of Population
New Construction	55	17,742,424	72.6%
Modernization	35	6,690,972	27.4%
Total	90	24,433,396	100.0%

A.8.1.2. M&V Sample Design

Based on a review of the program tracking data, a stratified random sampling approach was employed based on project level Ex-Ante annual energy savings (kWh) across all program years. Sample design ensured that the combined strata represented the population within +/- 10% precision at the 90% confidence interval. The number of strata, the boundaries within each stratum, and the number of sample points for each stratum were determined through an iterative process. The sample resulted in a program level precision of +/- 9.08% at the 90% confidence interval. A summary of the sample is shown in Table A-34.

Table A-34 SBD Evaluation Sample

Stratum	Projects	Sampled Projects	Maximum kWh	Program Data Ex-Ante Annual kWh	Sample Ex-Ante Annual kWh
1	44	5	135,000	2,192,648	259,015
2	28	5	400,000	6,406,898	1,317,086
3	14	5	900,000	7,940,521	3,056,441
4	4	4	4,000,000	7,893,329	7,893,329
Total	90	19	5,435,000	24,433,396	12,525,871

A.8.1.3. Project Documentation Review

Documentation representing the sampled projects was requested and received from LADWP. Project documentation included design team and owner incentive agreements, design team and owner letters of interest, utility incentive worksheets (UTIL-1), and energy simulation models. Energy simulation models used a variety of energy simulation software including EnergyPro 5, EnergyPro 6, EnergyPro 7, CBECC, IES-VE, eQUEST, and TRACE 700. Upon request, site verification reports were subsequently provided. In addition to project documentation, billing data was requested for all electric meters associated with sampled projects.

Every sampled project underwent a detailed documentation review which was used to develop site-specific M&V plans. Our review of energy savings calculations focused on the verification of installed equipment and specification comparing with inputs to the energy simulation models used to determine Ex-Ante energy savings. The review included the following:

- Review of energy savings by end-use;
- Review of energy simulation model inputs; and
- Review of project scope and equipment based on verification reports.

A.8.1.4. Site-Specific Measurement and Verification Plans (M&V Plans)

After a full review of program documentation, project documentation, and billing data, the Evaluator developed M&V Plans which described the project and initial impact estimation methods, identified the major sources of uncertainty in the impact estimation methods, proposed a methodology for assessing the project’s energy impacts, and specified the exact steps by which data was collected and analyzed to remove or mitigate uncertainties in energy savings estimations.

M&V Plans were developed and distributed for each project. The plans described the evaluation approach and data collection activities specific to each measure type within the project.

A.8.1.5. Virtual Data Collection Activities

Adhering to current conditions regarding COVID-19, the Evaluator utilized virtual data collection practices for this evaluation. The first step was to ensure the M&V Plans provided defensible methodologies to facilitate data collection through a site contact. This included an exploration of available or provided billing data, review of data collected through implementation, and review of the energy simulation models. To effectively collect information virtually, the Evaluator made sure to work collaboratively with the participant to ensure the data collection procedure was feasible and acceptable.

Data was collected virtually using software platforms that allowed for ease of verification. The Evaluator used the Streem virtual video platform, when possible, to reduce the burden on the site contact. If Streem was not feasible then evaluation staff relied on Microsoft Teams, email, phone, and occasionally another platform of preference by the site contact.

Prior to virtual data collection, the Evaluator underwent a recruitment process that consisted of:

- Sharing with LADWP a list of sampled projects with site contact information, M&V Plans, and data collection approach;
- Requesting support from LADWP large account managers;
- Initiating contact with the site contact (using both email and phone);
- Scheduling a virtual data collection event with the site contact; and
- Performing data collection through feasible virtual means.

As response rate was uncertain due to pandemic conditions, M&V Plans were developed for 28 projects to ensure statistical significance of the sample could be achieved.

A.8.1.6. Engineering Analysis

Energy Savings calculation methodologies were selected based on industry standard practices adhering to IPMVP options. Industry references included DEER, ASHRAE, and California’s Title-24.

Energy impacts of annual energy savings (kWh), lifetime energy savings (kWh) and peak demand reduction (kW) were determined for each project. Each analysis underwent a quality control process to ensure proper methodologies were employed and no calculation errors were present. A site level report was developed for each project for individual review.

Lifetime energy savings were determined based on the methodologies provided in DEER workpapers or based on industry standards when necessary. Lifetime energy savings by measure were dependent on the type of installed equipment.

Peak demand reduction was determined based on the methodologies provided in DEER workpapers. The peak demand reduction was defined as the average hourly consumption across the peak demand window of 2 PM to 5 PM on non-holiday weekdays from June through September.

A.8.1.7. Program Analysis

Upon completion of the project-level analyses, the results were aggregated by strata for extrapolation. Sample results within strata were then extrapolated to projects in the population that fell within the same strata criteria. Each project was then provided with Ex-Post energy savings results that were summed to the program level.

A.8.1.8. COVID-19 Impacts

In addition to the determination of annual energy savings, the Evaluator explored the impact of COVID-19 on energy impacts from the installed measures. Through verification efforts the Evaluator explored the effects on operating schedules, mechanical systems, and any other consumption effects presented by site contacts.

A.8.2. Impact Evaluation

This section presents findings from the determination of Ex-Post gross annual energy savings, lifetimes energy savings, and peak demand reduction through EM&V efforts.

A.8.2.1. Program Data Review

Project level descriptions in program tracking data indicated that projects were classified as either New Construction or Modernization. For reporting purposes, project types were categorized into these two classifications. The provided project level tracking data was complete for the purpose of reviewing gross impacts and developing a stratified sample.

Project documentation was delivered for each sampled project. The initial documentation provided was mostly consistent, consisting of design team and owner incentive agreements, design team and owner letters of interest, utility incentive worksheets (UTIL-1), and energy simulation models, with various software types used for the energy simulation models. The initial documentation did not provide sufficient information for determining specific measures or for verification of installed equipment, therefore site verification reports were subsequently requested and provided for each sampled project. Site verification reports included a list of measures and a checklist of whether these measures were installed during implementation review. Additional information provided in the site verification reports was variable, with some including mechanical and electrical schedules and drawings and others providing more limited information.

Billing data was requested for each sampled site and additional data was obtained using MV-Web. However, the Evaluator was unable to obtain billing data for every project. Comprehensive billing data by project is difficult to obtain as project sites may include multiple meters or share a meter with other buildings on a campus. In addition, billing data must span a significant time to be useful. In most cases the provided or obtained billing data could not be used for analysis purposes.

A.8.2.2. Data Collection

Additional projects were added to the Evaluator's evaluation sample to account for an expected reduction in response rate due to COVID-19 and the extended period of time for some projects between measure installation and evaluation. All projects selected underwent M&V Plan development. Table A-35 presents the count of projects as they progressed through the data collection process.

Table A-35 SBD Evaluation Data Collection by Project

Stratum	M&V Plans	Desk Reviews	Virtual Verification	Evaluated
1	8	4	3	5
2	9	4	3	7
3	7	3	0	3
4	4	3	1	4
Total	28	14	7	19

Virtual verification of the 7 projects was conducted through Streem, Microsoft teams, in-depth phone interview, and/or email correspondence. Scheduled virtual verifications were conducted from late March until July. On-going communication with site contacts extended into August 2020 for completing data collection.

Due to the ongoing pandemic and necessity of completing data collection virtually, the Evaluator did not conduct any power monitoring. The Evaluator explored all other avenues of data collection through building management systems, sub-meter configurations, billing data, virtual observations, and interviews.

To recruit sites for virtual verification during this challenging time, the Evaluator performed the following actions when the provided site contact could not provide evaluation support:

- If the initial contact responded but was not the correct contact, then the Evaluator would request appropriate contact information and continue in this manner through all available contacts.
- If the initial contact responded but was not aware of who was the correct contact, then the Evaluator would request additional contact information from LADWP as well as perform internet searches for more information.

- If the initial contact responded but refused a site visit (store closed, refused, no one on-site) then the Evaluator would drop the site from the evaluation sample.
- The Evaluator would attempt to reach the initial contact and all additional contacts a minimum of 5 times using both phone calls and emails at different times of the day and different days of the week.

The result was a full evaluation of 19 projects incentivized during the Retrospective Period. As site recruitment success was somewhat out of the Evaluator's control, the distribution of projects was skewed. A summary of projects evaluated by program year is shown in Table A-36.

Table A-36 SBD Evaluated Projects by Year

Stratum	2015	2016	2017	2018	2019	Total
1	1	2	1	0	1	5
2	1	2	1	0	1	5
3	0	1	1	1	2	5
4	0	1	0	1	2	4
Total	2	6	3	2	6	19

A.8.2.3. Sample Results

Project-level and measure-level results can be found in site-level reports, which can be viewed in Appendix D. For confidential and privacy considerations of participants, Appendix D was not published with the public version of the report. Appendix D was provided only to LADWP as reference to supplement this EM&V report.

A full evaluation analysis was conducted on 19 of the 28 randomly sampled projects. All evaluated projects consisted of either New Construction or Modernization project types, and all were evaluated using IPMVP Option D: Calibrated Simulation.

Sampled projects represented 51% of the reported annual energy savings. The evaluation sample was grouped by strata based on the magnitude of annual energy savings. Energy savings for projects within each stratum were aggregated to determine a strata level realization rate for extrapolation to the population. Sample savings impacts by strata are shown in Table A-37.

Table A-37 SBD Evaluation Sample Savings Summary

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
1	259,015	255,584	99%	31.90	33.10	104%
2	1,317,086	932,850	71%	228.90	198.40	87%

Stratum	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
3	3,056,441	2,692,472	88%	476.32	881.22	185%
4	7,893,329	8,819,697	112%	1,854.80	2,455.79	132%
Total	12,525,871	12,700,603	101%	2,592	3,569	138%

Sample projects from Strata 2 demonstrated the largest discrepancies between Ex-Ante savings estimates and Ex-Post savings estimates. Strata 2 sampled projects included five projects with Ex-Ante annual energy savings below 400,000 kWh. These projects consisted of four New Construction projects and one Modernization project. This stratum represents 28 of the 90 projects in the population and is equivalent to 26% of the Ex-Ante estimated annual energy savings.

Verification efforts through evaluation determined similar energy impacts as Ex-Ante estimates. Differences that were found can be attributed to billing data calibration, incorrect model inputs, simulation anomalies, and savings discrepancies between the provided documentation and the program tracking data. The magnitude of these differences across the 19 sampled measures is shown in Table A-38. Note that the differences between Ex-Ante and Ex-Post may be positive or negative. Net value is the overall difference by realization rate factor.

Table A-38 SBD Sample Realization Rate Factors

Realization Rate Factor	Sample Difference Net Change Value (kWh)
Billing Data Calibration	(105,390)
Incorrect Model Inputs	101,889
Savings Discrepancies	(349,908)
Simulation Anomalies	528,143
Total	174,734

Realization rate factors as a function of project type indicated that while verification found differences, the entirety of the sample was well balanced. Table A-39 provides a summary of realization rate factors by project type.

Table A-39 SBD Evaluation Sample Impact from RR Factors

Realization Rate Factor	New Construction	Modernization
Billing Data Calibration, Savings Discrepancies	-1%	0%
Billing Data Calibration, Simulation Anomalies	-66%	0%
Incorrect Model Inputs	-16%	2%

Realization Rate Factor	New Construction	Modernization
Incorrect Model Inputs, Savings Discrepancies	-44%	0%
Incorrect Model Inputs, Simulation Anomalies	28%	-4%
Savings Discrepancies	0%	-38%
Savings Discrepancies, Simulation Anomalies	0%	-23%
Simulation Anomalies	17%	0%
Total	6%	-12%

Evaluation efforts at the project level found some significant systematic issue. It was determined for several projects, prior to making any changes to the simulation models, that the results did not match the provided UTIL-1 sheet savings. Additionally, for several projects, the UTIL-1 sheet savings did not match the program tracking data. However, these simulation anomalies more often had a positive impact on savings while the inconsistencies in UTIL-1 savings and program tracking data more often had a negative impact on savings, causing their individual impacts to partially offset the overall impact on program savings. In other words, when the model did not produce the same results as the UTIL-1 sheet, the UTIL-1 sheet typically represented higher savings than the re-produced energy model results.

A.9. Upstream HVAC Program

This section details the impact evaluation for the Upstream HVAC (UHVAC) Program that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation was to calculate energy savings and peak demand impacts attributable to the Program.

A.9.1. Evaluation Methodology

The Retrospective evaluation consisted of a deemed savings approach with a thorough review of all available project documentation and customer data followed by an analysis of energy savings methodologies that included applicable equivalent full load hours (EFLH). The approach can be summarized as:

- Tracking data review;
- Sample project database review;
- Sample customer and specification review;
- Database for Energy Efficient Resources (DEER) Workpaper review and analysis;
- Industry standard analysis; and
- EFLH study.

The methodologies described in the chapter were used to estimate Ex-Post impact evaluation results for annual energy savings, peak demand reduction, and lifetime energy savings. The evaluation steps are described in this section.

A.9.1.1. Tracking Data Review

The Evaluator used the provided program tracking data for each fiscal year to then identify and develop an understanding of expected savings, base savings estimates, and the methods used to develop these estimates. The provided program tracking data, which included equipment information, end-user information, and service provider information, allowed for a review of evaluation impacts based on end-user business types, service provider, and equipment type. Availability of end-user contact information allowed for the development of a survey effort to collect additional end-user information.

A.9.1.2. M&V Sample Design

The Evaluator selected a sample of line items to estimate evaluated energy savings of the program's retrospective years with the number of sampled line items meeting 90/10 confidence/precision requirements. Precision requirements were met through stratification of projects based on annual energy savings. The Evaluator had planned to develop the sample through end-user surveys; however, this was not possible due to the structure of program implementation and available program data. A sample was instead developed randomly using stratification by equipment type (AC, HP, VRF) and aggregated annual energy savings by line item. Additional line items were added in situations where multiple line items were part of the same project. A summary of sample statistics is shown in Table A-40. Strata identification is based on equipment category (AC, HP, VRF), individual unit capacity (in tons), and numerical by tracking data line item total Ex-Ante annual energy savings.

Table A-40 UHVAC Retrospective Sample

Strata	Strata Boundaries	Population Size	Ex-Ante kWh	Sample Size	Sample kWh
AC <20	169-8,993	862	3,508,573	6	26,933
AC <20 2	9,007-68,248	283	4,997,653	4	92,339
AC >20	2,157-49,294	138	2,984,077	3	64,547
AC >20 2	53,058-358,697	21	2,663,602	4	748,902
HP	500-14,360	275	1,158,256	2	16,134
HP 2	15,244-169,455	38	1,399,127	3	51,964
VRF <20	2,575-34,931	223	4,244,585	29	516,975
VRF <20 2	35,093-99,854	91	5,168,774	13	674,444
VRF <20 3	103,110-242,033	39	6,443,633	8	1,334,623
VRF <20 4	261,551-420,219	7	2,288,524	1	261,551
VRF <20 5	1,068,977-1,130,051	3	3,279,592	1	1,130,051

Strata	Strata Boundaries	Population Size	Ex-Ante kWh	Sample Size	Sample kWh
Total	169-1,130,051	1980*	38,136,394	74	4,918,464

*Nineteen line-items in the program tracking data had unidentified measure types. A program level realization was applied to these projects. These projects account for 300,128 of reported Ex-Ante annual energy savings to make a Total Ex-Ante kWh of 38,436,522.

The evaluation sample design resulted in a precision of 9.96% at the 90% confidence interval based on Ex-Ante annual energy savings. Ex-Post results were based on Ex-Post annual energy savings meeting precision requirements better than ±10% at the 90% confidence interval.

Applicable program documentation was reviewed for these measures that included application information, invoices, specification sheets, billing data, and analysis assumptions. Documentation was collected from the implementation team to support program documentation and provide an understanding of Ex-Ante energy impact estimates.

Annual energy savings extrapolation was achieved by projecting a realization rate by stratum to population measure level line items that fall within each strata's criteria. The annual energy savings, or kWh, realization rate was determined by dividing the aggregated Ex-Post kWh by the aggregated Ex-Ante kWh for each stratum. The same function is performed to extrapolate peak demand reduction results.

Lifetime energy savings extrapolation was achieved by projecting a stratum level effective useful life from the evaluation sample to the population. Lifetime energy savings were determined for each sampled measure line item. Ex-Post stratum level aggregated lifetime energy savings were divided by stratum level aggregated Ex-Post annual energy savings to determine a strata effective useful life to be applied to measure line items in the population.

A.9.1.3. Sample Customer and Specification Review

Additional research was conducted for impact verification on sampled measures. Facility information was collected through an online review using the provided site address. Measure specifications were verified through a review of available manufacturer and Air Conditioning, Heating and Refrigeration Institute (AHRI) data.

A.9.1.4. DEER Workpaper Review

As the program included various mechanical system types, the Evaluator considered various methodologies to calculate Ex-Post energy savings. Where content was available from DEER workpapers, the Evaluator reviewed and incorporated Ex-Post savings impact estimates based on the associated workpaper. Many DEER workpapers provide savings rates of kWh/ton and kW/ton based on a measures facility type, location, and efficient specifications. When available, the Evaluator performed a review of the DEER workpaper algorithms as provided in embedded documentation within the workpaper. In some instances, this involved the collection and review of energy simulations.

A.9.1.5. Industry Standard Analysis

In support of the DEER workpaper assumptions, the Evaluator determined Ex-Post savings estimates using industry standard guidelines following the methodologies from the International Performance Measurement and Verification Protocol (IPMVP) and Uniform Methods Project (UMP). A Major Measure Database (MMDB) from the implementation team was included as part of the provided documentation. The Evaluator calculated energy savings based on a desk review of the provided energy savings algorithm inputs.

$$Annual\ kWh = CAP * EFLH * \left(\left(\frac{1}{Effbase}\right) - \left(\frac{1}{Effinstall}\right)\right) \qquad \textit{Equation A-17}$$

Where:

- CAP = Full Load capacity (kBTU/hr.) of all equipment (heating or cooling)
- EFLH = Equivalent Full Load Hours (heating or cooling)
- Eff = Energy Efficiency Ratio or Seasonal Energy Efficiency Ratio (baseline from Title 24, efficient from as found installed).

Operating hours of mechanical equipment was a driver of energy savings and therefore an EFLH study was conducted based on the equipment type, facility type, and climate zone of the sampled measures.

A.9.1.6. Equivalent Full Load Hours Study

In support of verification efforts, the Evaluator developed a set of EFLH's applicable to sampled measures. To determine EFLH, the Evaluator reviewed prototypical energy models for different building types. These prototypical models were developed by the California Public Utilities Commission and are contained in DEER[2]. The energy models were developed to represent typical conditions within each facility type including; facility

[2] Detailed energy model descriptions can be found in Chapter 6 of the 2004-2005 DEER Update Study.
http://deeresources.com/files/deer2005/downloads/DEER2005UpdateFinalReport_ItronVersion.pdf

size, exterior wall and glazing construction, lighting systems, HVAC systems, operating hours, and individual space types within the building.

The energy models were run using the eQUEST energy simulation software using Typical Meteorological Year (TMY3) weather data for three regional climates in the service territory, Climate Zone 6, Climate Zone 8, and Climate Zone 9.

The energy models were also run with and without airside economizers on the HVAC equipment. Airside economizers use cool outside air to provide air conditioning to the building when ambient and inside air conditions allow. The economizers reduce the runtime on the air conditioning compressors and thus decrease the EFLHc. Additionally, economizers are required by building codes to be installed on certain types and sizes of equipment. The Evaluator evaluated the models with and without economizers to provide a more comprehensive list of appropriate EFLH values.

Using the results of the energy simulations, the EFLH were calculated as shown in Equation A-18

$$EFLH = \frac{kWh_{usage} \times EER_{cooling}}{Cap_{tot}} \qquad \textit{Equation A-18}$$

Where:

- EFLH = Equivalent Full Load Hours (heating or cooling)
- kWh_{usage} = Total annual energy usage of all equipment (heating or cooling)
- Cap_{tot} = Full Load capacity (kBTU/hr.) of all equipment (heating or cooling)
- $EER_{cooling}$ = Energy Efficiency Ratio from eQUEST model.

A.9.1.7. Billing Analysis

The Evaluator requested and reviewed billing data for sampled measures to ascertain the applicability of performing a billing data regression analysis for the determination of Ex-Post energy savings. Applicability of billing data was tested for:

- Completeness (review of missing readings);
- Reasonableness (review of outliers, fluctuations, and meter arrangements);
- Duration (review of sufficient pre-installation and post-installation readings); and
- Magnitude (is the magnitude Ex-Ante savings estimates discernable from total consumption).

Billing data was reviewed for the address associated with each measure line item in the program tracking data. Each address would be reviewed and modeled individually based on a comparison of billing data prior to the equipment installation to billing data after equipment installation. Reliance on a commercial billing data regression analysis is dependent on adherence to the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Guide 14 stipulations and IMPVP protocols.

A.9.1.8. COVID-19 Impacts

The impact of COVID-19 was meant to be assessed based on findings from the billing analysis. The Evaluator was to use the billing analysis results to decipher the influence on set point changes that may have occurred during the COVID-19 pandemic. Commercial facilities were generally encouraged to increase ventilation which could cause an increase in consumption by fans in the system as well as cooling system compressor run-time with ambient temperature above cooling set points.

A.9.2. Impact Evaluation

The Evaluator conducted an impact evaluation to determine Ex-Post annual energy savings, peak demand reduction, and lifetime energy savings for the Retrospective Period including FY 16/17, FY 17/18, FY 18/19, and FY 19/20. The Evaluator incorporated the methodologies described in the previous section. Results are reported by measure type.

A.9.2.1. Ex-Ante Savings Review

The Evaluator acquired program tracking data, implementation documents, and overall results summaries from ESP to perform the Retrospective impact evaluation. The provided program tracking data differed from the provided ESP summary data. A comparison is shown in Table A-41.

Table A-41 UHVAC Retrospective Ex-Ante Savings Comparison

Fiscal Year	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
16/17	10,374,531	10,365,136	-0.1%	4,773.00	7,773.09	62.9%
17/18	9,075,740	9,080,092	0.0%	4,163.00	4,166.30	0.1%
18/19	9,031,524	9,031,523	0.0%	3,149.09	3,620.34	15.0%
19/20	10,570,057	9,982,595	-5.6%	4,990.22	3,969.54	-20.5%
Total	39,051,852	38,459,346	-1.5%	17,075.31	19,529.27	14.4%

The provided program tracking data was mostly complete and sufficient to determine a random stratified sample to represent the population with a precision of +/- 10% at the 90% confidence interval. Project documentation was provided for all sampled measures that included equipment specifications, invoices, energy models (when applicable), and all necessary information to determine energy savings estimates.

Billing data was made available to the Evaluator. Recent meter data (2019 – present) was provided through an online portal (MV-Web) and additional historical meter data (2016-2019) was provided electronically as a database. Billing data was reviewed for all sampled measures. There were no sampled measures in which the provided billing data met all of the requirements as discussed in the Methodology section. Further information on billing data results is presented later in this section.

A.9.2.2. DEER Workpaper Analysis

The Evaluator sourced applicable workpapers by equipment type and revision to perform a desk review analysis adhering to DEER specifications. Energy savings based on DEER workpapers are reliant on a selection of energy savings rates (kWh/ton and kW/ton) from a database for each equipment type. Selection of the energy savings rate is based on installed equipment type, installed equipment specifications, facility type, and climate zone. The majority of measures in the program sample relied on energy savings rates provided in workpapers associated with water source heat pumps, unitary air-cooled AC, air cooled packaged chillers, and VRF commercial HP and heat recovery systems.

Three sampled measures within the same multifamily VRF project fell outside the scope of the available DEER workpapers. These measures were assessed using provided energy simulation models from the implementation team. Model inputs were checked for reasonableness and to ensure the model results were translated into energy savings according to the appropriate DEER workpaper.

Discrepancies were found in energy savings across the three classifications of equipment type (AC, HP, VRF) within the sample. Through verification of efficient equipment, the Evaluator found minor discrepancies in equipment capacity, efficiency ratings, and quantities. This resulted in variances in savings of 0.18% for AC measures, 1.60% for HP measures, and 0.29% for VRF measures in the sample. Some of the equipment specification discrepancies found were negated by other discrepancies. The remainder of variance in energy savings from Ex-Ante to Ex-Post (realization rate) is believed to have been from the selection of the energy savings rates associated with the DEER workpaper tables. Based on the provided program tracking data, the Evaluator treated UHVAC measures as replace on burnout (including units past their useful life). Results are shown in Table A-42.

Table A-42 UHVAC Realization Rate Factors

Equipment Type	Ex-Ante Sample kWh	Ex-Post Sample kWh	Equip. Spec. Savings Variance	Workpaper Selection Savings Variance	Total Savings Variance	Savings Variance Percentage
AC	932,722	538,069	(1,714)	396,366	394,653	42%
HP	68,098	30,273	(1,088)	38,913	37,826	56%
VRF	3,917,645	3,582,472	(11,482)	346,655	335,172	9%
Total	4,918,464	4,150,814	(14,284)	781,934	767,650	16%

The savings discrepancy due to selection of energy savings rate could have been influenced by selection of facility type and replace on burnout versus early retirement. The Evaluator used internet searches and mapping software to determine facility type. Most sampled AC projects were reported as “miscellaneous commercial” whereas the Evaluator identified a particular classification for each measure. Results by sample stratification are shown in Table A-43. Strata classification is defined in the methodology section. The Evaluator selected energy impacts based on replacement on burnout due to the information provided in program tracking data.

Table A-43 UHVAC Retrospective Sample Savings Results

Measure Category	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
AC <20	26,933	3,594	13%	11.63	2.85	25%
AC <20 2	92,339	15,599	17%	45.24	8.33	18%
AC >20	64,547	8,940	14%	27.62	8.74	32%
AC >20 2	748,902	509,935	68%	191.14	57.44	30%
HP	16,134	6,542	41%	7.04	2.88	41%
HP 2	51,964	23,731	46%	22.64	10.46	46%
VRF <20	516,975	446,600	86%	220.85	192.55	87%
VRF <20 2	674,444	522,137	77%	285.42	224.03	78%
VRF <20 3	1,334,623	1,221,851	92%	605.35	561.28	93%
VRF <20 4	261,551	261,551	100%	17.66	17.66	100%
VRF <20 5	1,130,051	1,130,333	100%	562.53	562.67	100%
Total	4,918,464	4,150,814	84%	1,997.10	1,648.89	83%

The implementation team provided the Evaluator with the MMDB used to develop Ex-Ante savings estimates. The Evaluator applied its equipment specification findings to the energy savings rates provided in the MMDB. The results show a lower variance in energy savings for AC equipment, HP equipment, and VRF equipment compared to the variance using the DEER workpapers. Reasons for the differences in energy savings factors between the implementation teams MMDB and the Evaluator acquired DEER workpapers are believed to be caused by selection of efficient condition, facility type, and replacement type. A summary of the variance in findings, by means of realization rate for each equipment type, is shown in Table A-44.

Table A-44 UHVAC Retrospective Sample MMDB Review

Equipment Type	Workpaper Ex-Post kWh	Workpaper Ex-Post RR	MMDB Ex-Post kWh	MMDB Ex-Post RR
AC	538,069	58%	641,200	69%
HP	30,273	44%	76,521	112%
VRF	3,582,472	91%	3,855,044	98%
Total	4,150,814	84%	4,572,765	93%

Results from the deemed savings analysis using the DEER workpapers indicate the largest impact on realization rate for the program is due to the selection of energy savings factors for AC equipment. While VRF equipment consists of 55% of the program's annual energy savings (compared to 37% for AC equipment) in the Retrospective Period, the large discrepancy in AC equipment savings outweighs this distribution.

A.9.2.3. EFLH Study

To support validation of the DEER workpapers, the Evaluator performed a study of 102 energy simulation iterations across various mechanical system equipment, facility types, and weather zones. Energy simulations were run based on conditions presented in the program's evaluation sample. A summary of the count of iterations completed is shown in Table A-45.

Table A-45 UHVAC Energy Simulation Iterations

Building Type	AC with Economizer	AC without Economizer	HP with Economizer	VRF with Economizer	Total
Assembly	4	4	0	0	8
Primary School	4	4	0	0	8
Community College	4	4	0	0	8
University	2	3	0	0	5
Hotel	4	4	0	0	8
Medical Health Clinic	4	4	0	0	8
Multi-family Mid-rise	0	0	0	6	6
Multi-family High-rise	0	0	0	6	6
Large office	0	0	2	0	2
Small Office	4	4	3	0	11
Light Industrial	4	4	0	0	8
Fast-Food Rest.	4	4	0	0	8
Retail	4	4	0	0	8
Warehouse	4	4	0	0	8

Building Type	AC with Economizer	AC without Economizer	HP with Economizer	VRF with Economizer	Total
Total	42	43	5	12	102

Energy simulations were specific to facility type but left at default values for setting outside of mechanical system (including economizing), and weather files. Weather files were explored using CZ9 weather data as well as data from Los Angeles International Airport (LAX), Long Beach, and Santa Ana. Model results were checked using various weather files because of the large difference in cooling degree days (CDD) reported by location within each climate zone. Climate zone 6 for example had locations with CDD ranging from 470 to 1,201. Energy simulations were run in eQUEST or EnergyPlus depending on availability. Most model iterations were run for AC equipment type due to findings during the workpaper review. Mechanical systems varied somewhat based on facility type due to assumptions of typical parameters for each facility type. The methodology to convert model results into equivalent full load hours is presented in the methodology section of this chapter.

The Evaluator was not able to acquire the same energy simulations used to generate EFLH from the DEER workpapers. There were many inputs in energy simulations that may have impacted EFLH. Considerations included the building envelope parameters, interior configuration, mechanical system configuration, building schedule and occupancy as well as lighting systems. In addition, the energy simulation configurations used by the Evaluator were representative of to-code assumptions.

Table A-46 presents findings of EFLH from 85 model iterations to represent packaged, unitary, and chiller-based air cooled air-conditioning system.

Table A-46 UHVAC AC Effective Full Load Hours Cooling

Building Type	Climate Zone 9	Climate Zone 6	Climate Zone 8	Climate Zone 9	Climate Zone 6	Climate Zone 8
	With Economizer			Without Economizer		
Assembly	1,201	1,010	910	1,401	1,219	1,185
Primary School	351	367	339	369	381	355
Community College	1,638	1,522	2,848	3,112	2,458	4,906
Hotel	1,508	1,429	1,374	1,955	1,836	1,847
Medical - Clinic	1,478	1,583	1,587	1,585	1,616	1,605
Office - Small	745	682	633	1,053	935	1,152
Light Industrial	846	713	654	1,020	839	839
Fast-Food Rest.	923	794	722	1,191	998	991
Retail	930	730	629	1,021	802	734
Warehouse	334	176	137	336	176	150

Figure A-10 presents a comparison of findings from EFLH study to DEER workpapers for a range of facilities utilizing AC equipment types in California Climate Zone 9. Zone 9 CDD ranges from 1,273 to 1,558 depending on location. The figure shows reduced hours in the ADM energy simulation iterations. The cause of the variance is unknown.

Figure A-10 Climate Zone 9 AC Equipment EFLH Comparison

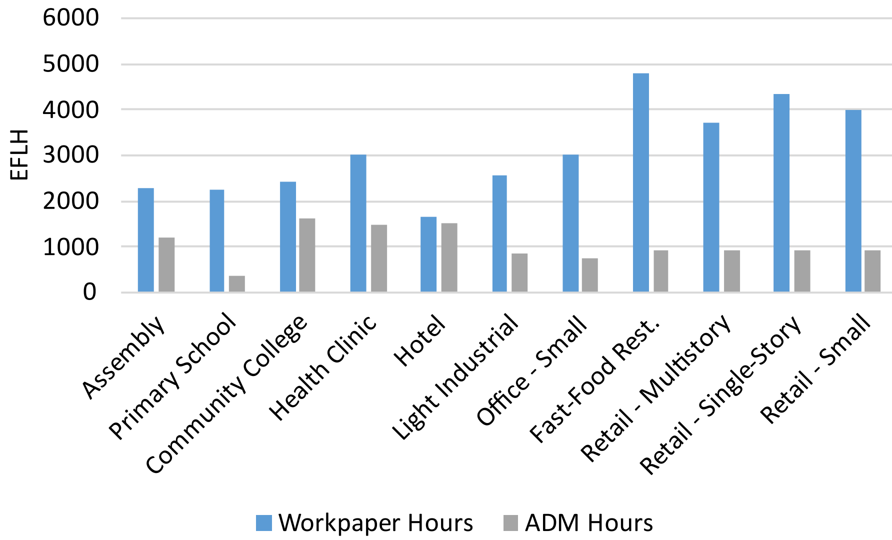
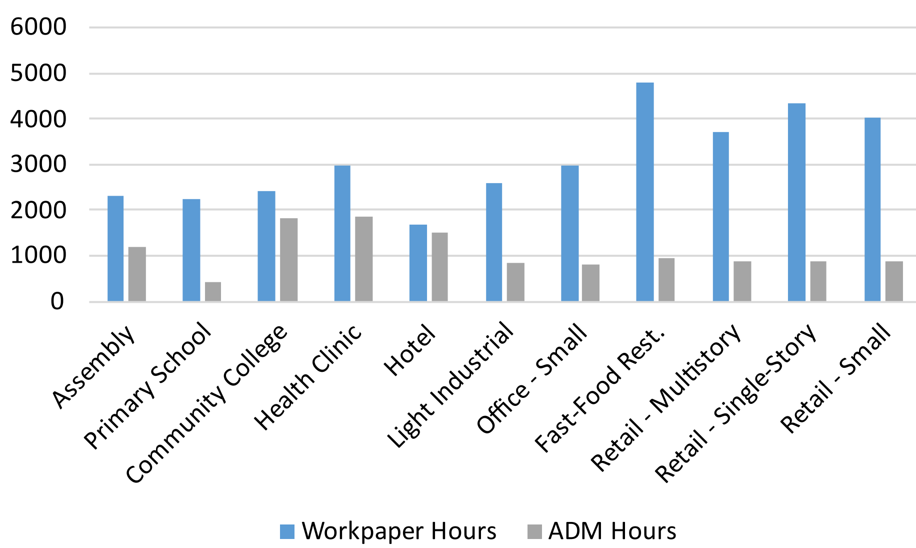


Figure A-11 presents a comparison of findings from EFLH study to DEER workpapers for a range of facilities utilizing AC equipment types in California Climate Zone 6. The figure shows reduced hours in the ADM energy simulation iterations. The cause of variance is unknown. Results for California Climate Zone 8 show similar results.

Figure A-11 Climate Zone 6 AC Equipment EFLH Comparison



Heat pump measures which fell into the Retrospective sample consisted of small and large office facility types within climate zone 9. Variations such as building area had a large impact on energy simulation results. The Evaluator determined EFLH for heat pumps based on a large office being 350,000 square feet and a small office being 20,000 square feet. An average value is presented as conditioned office area is often not known and this value could be representative of office areas between 20,000 square feet and 250,000 square feet.

Table A-47 UHVAC HP Equipment EFLH Comparison

Building Type	Weather Zone	ADM EFLH	Workpaper EFLH
Large Office	CZ9	5,266	2,643
Small Office	CZ9	770	2,664
Average	CZ9	3,018	2,654

The Evaluator inquired about the DEER models used in the workpaper for VRF systems but was unable to obtain the models. EFLH are not presented in the VRF workpaper. The Evaluator was able to determine EFLH based on the provided VRF models representing mid-rise and high-rise multifamily buildings. Results are shown in Table A-48.

Table A-48 UHVAC VRF Equipment EFLH Comparison

Building Type	Weather Zone	ADM EFLH	Workpaper EFLH
Mid-Rise MF	CZ6	405	NA.
High-Rise MF	CZ6	630	NA.
Average	CZ6	518	NA.

In an ideal situation the EFLH developed would be calibrated to a sample of known businesses energy usage. The Evaluator was not able to use the billing data provided that represented the facilities in the evaluation sample.

A.9.2.4. Industry Standard Analysis Results

To further assess the implications of the DEER workpaper based energy savings rates and address the impact from ADM-generated EFLH's, an analysis was performed using industry standard energy savings algorithms. Energy savings were determined for the sampled measures based on the algorithm presented in this chapter's methodology section. For this analysis, capacity and EER ratings were determined through desk review verification efforts. EFLH's were based on the Evaluator's EFLH study results. Heat pump calculations for office facilities used the average value found from the EFLH study as the square footage of conditioned space for each measure could not be determined.

Sample results by strata are shown in Table A-49.

Table A-49 UHVAC Retrospective Industry Standard Analysis Sample Savings Results

Measure Category	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
AC <20	26,933	6,558	24%	11.63	1.89	16%
AC <20 2	92,339	26,423	29%	45.24	5.29	12%
AC >20	64,547	25,090	39%	27.62	7.21	26%
AC >20 2	748,902	679,239	91%	191.14	83.90	44%
HP	16,134	10,207	63%	7.04	2.50	36%
HP 2	51,964	39,739	76%	22.64	9.75	43%
VRF <20	516,975	216,758	42%	220.85	70.86	32%
VRF <20 2	674,444	225,404	33%	285.42	85.72	30%
VRF <20 3	1,334,623	392,666	29%	605.35	136.57	23%
VRF <20 4	261,551	107,902	41%	17.66	15.16	86%
VRF <20 5	1,130,051	33,451	3%	562.53	32.16	6%
Total	4,918,464	1,763,437	36%	1,997.10	451.00	23%

The industry standard approach yielded higher energy savings for AC and HP systems compared to the Ex-Post deemed savings analysis (DEER workpapers). This approach utilized exact equipment specifications as opposed to bins of energy savings rates. The baseline condition was based on the California energy code. Energy savings results for VRF systems showed a large reduction compared to Ex-Post DEER workpaper results. These results may be impacted by the complexity of modeling VRF systems without calibration to specific facilities. The Evaluator was not able to acquire the DEER workpaper VRF models to compare.

It is reasonable to assume the variance in energy savings between the Ex-Post industry standard analysis and Ex-Post deemed savings analysis (DEER workpapers) is the result of applying ADM-derived EFLH. This impact by equipment type is shown in Table A-50. The overall impact on the sample is a reduction in annual energy savings of 42% compared to the DEER workpaper analysis.

Table A-50 UHVAC Ex-Post Sample Result Comparison

Equipment Type	Ex-Post Workpaper kWh	Ex-Post Industry kWh	Impact
AC	538,069	737,310	137%
HP	30,273	49,946	165%
VRF	3,582,472	976,182	27%
Total	4,150,814	1,763,437	42%

A.9.2.5. Billing Analysis Results

All sampled measures were reviewed for the potential of performing a billing regression analysis. Billing data was acquired based on the address presented for each measure line item in the program tracking data. Billing data was reviewed for each address individually to perform a billing regression analysis based on pre/post data.

Billing data was available for ten of the seventeen sampled AC equipment measure line items in the program tracking data. Of these ten sites, seven had sufficient pre-installation and post installation billing data. Of these seven, the Ex-Ante savings estimates were below the threshold to be discernable from overall annual energy consumption for three sites, leaving four sites available for a billing regression analysis.

Regression analysis for these four measures demonstrated that factors outside of weather and the equipment installation were large drivers of energy consumption variance. The Evaluator performed a daily linear regression analysis accounting for day type, pre/post (binary factor), CDD, HDD, CDDx, and HDDx. Additional factors were tested for and removed due to their t-test score statistical significance. A summary of regression results for these line items is shown in Table A-51.

Table A-51 UHVAC Ex-Post Sample Regression Results

Equipment Type	Ex-Post Workpaper kWh	Regression kWh	Statistical Significance (r^2)
AC	869	(13,705)	40%
AC	2,833	(1,038)	45%
AC	52,444	(68,552)	11%
AC	14,136	139,105	29%

Billing data was available for four of the five sampled HP equipment measure line items in the program tracking data. Of these five, only one had sufficient pre-installation billing data and post-installation billing data. The Ex-Ante savings estimate for this line item represented 0.3% of average annual consumption, not meeting the requirements for a billing analysis.

Billing data was available for seventeen of the fifty-two sampled VRF equipment measure line items in the program tracking data. Of these, the amount of pre-installation and post-installation billing data was not sufficient for a billing regression analysis.

A.9.2.6. Extrapolation of Results

The Evaluator determined the extrapolation of sampled Ex-Post gross energy savings based on the use of appropriate DEER workpapers to present program level Ex-Post gross savings results. The evaluation sample was based on meeting precision requirements (90/10) through ratio estimation of a randomly chosen stratified sample. Sample stratification was implemented based on equipment type (divided into AC, HP, and VRF) as well as measure level program tracking data line-item Ex-Ante annual energy savings. Evaluation sample results are presented in Table A-43. A summary of strata classification and boundaries is shown in Table A-40.

Extrapolated annual energy savings and peak demand reduction are presented in Table A-52. Ex-Post evaluation sample results indicate the provided program level results were at 8.04% precision at the 90% confidence interval for annual energy saving. Precision at the 90% confidence interval for peak demand reduction results was at 10.44%.

Table A-52 UHVAC Retrospective Ex-Post Extrapolation Results

Measure Category	Program Data Ex-Ante kWh Savings	Program Data Ex-Post kWh Savings	Gross kWh Realization Rate	Program Data Ex-Ante Peak kW Savings	Program Data Ex-Post Peak kW Savings	Gross Peak kW Realization Rate
AC <20	3,508,573	468,241	13%	1,618	397	25%
AC <20 2	4,997,653	844,282	17%	2,283	421	18%
AC >20	2,984,077	413,298	14%	1,222	387	32%
AC >20 2	2,663,602	1,813,674	68%	796	239	30%
HP	1,158,256	469,640	41%	506	207	41%
HP 2	1,399,127	638,947	46%	612	283	46%
VRF <20	4,244,585	3,666,779	86%	1,843	1,607	87%
VRF <20 2	5,168,774	4,001,525	77%	2,102	1,650	78%
VRF <20 3	6,443,633	5,899,161	92%	2,796	2,593	93%
VRF <20 4	2,288,524	2,288,524	100%	1,010	1,010	100%
VRF <20 5	3,279,592	3,280,412	100%	1,633	1,633	100%
Not Identified	322,951	272,547	84%	109	90	83%
Total	38,459,346	24,057,028	63%	16,529	10,516	64%

A.10. CRP

This section details the impact evaluation for the Consumer Rebate Program (CRP) that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation is to calculate energy savings and peak demand impacts attributable to the Program.

A.10.1. Evaluation Methodology

The Evaluator completed the following types of data collection for the impact evaluation:

Table A-53 CRP Program Data Collection

Data	Source
Program tracking data	Data requests to LADWP for all measure level program tracking data
Program participant surveys	Survey administered to a sample of program participants via email contact information

Data	Source
Recipient and control group billing data	Data requests to LADWP for all relevant billing data in the study period
Participation in other LADWP programs	Data requests to LADWP for all residential program participation in the study period
Recipient and control group customer data	Data requests to LADWP for other customer information (e.g., demographics, contact permissions)

This section presents the methodology used to establish program participation, obtain product data not available in the tracking data, and provide the findings of the tracking data review.

A.10.1.1. Tracking Data Review

Program data aggregated at the measure level was obtained from the ESP database platform, the cloud-based IT platform hosted by the Energy Savings Platform, Inc. (ESP) provider. The ESP data was formatted as aggregated measure level data by program year. Also, program participant tracking data was sourced from spreadsheet data in Excel .xlsx file format provided securely by LADWP. The initial tracking data did not align properly for FY 17/18 and FY 19/20 program years. The field descriptions did not match the measure and were replaced by an updated file for the combined years. The following table lists the final workbooks for spreadsheet participant tracking data and the ESP SB1037 export file.

Table A-54 CRP Program Evaluation Data Collection

Workbook File Name	Participant Records
CRP Equity Metrics FY 18/19.xlsx	7,852
CRP Equity Metrics FY 15/16.xlsx	6,296
CRP Equity Metrics FY 16/17.xlsx	7,525
CRP Equity Metrics FY 17/18 & 19/20.xlsx	29,407
LADWP FY SB1037 Report.export.csv (each year)	0
Total	51,080

Tracking data was reviewed to ensure that the data provided sufficient information to verify program participation and to calculate energy and peak demand impacts. The following is a high level synopsis of the completed review:

- Bin the tracking data category name to an ESP measure;
- Determine if the measure was installed as described; and
- Perform supplementary data collection for the required inputs to energy savings algorithms or billing accounts to perform the impact analysis.

A.10.1.2. M&V Sample Design

Field data collection consisted of collecting participant surveys online. In home data collection did not occur for the Retrospective Period due to the COVID-19 pandemic. Savings were evaluated via billing analysis and engineering desk reviews for the program measures. The approach the Evaluator used to determine Ex-Post kWh savings and Ex-Post peak kW reduction for the CRP program was based on statistical analysis of billing data for the weather sensitive measures of cool roofs, central air conditioners, central heat pumps, and variable speed swimming pool pump with motors. Engineering desk reviews were completed for room air conditioners, refrigerators, whole house fans and dual pane windows.

Participant information from the tracking data was cross referenced to LADWP account data to determine which account holders were willing to be contacted. The email address for those that did not have a “no contact” flag was aggregated by their measure from the CRP program, and by participation year. Table A-55 summarizes the survey sample deployed by an email invitation for the online participant survey. The FY 17/18 and FY 19/20 sample sizes were less than other program years, as there was uncertainty with the initial data as described in the tracking data review. Survey responses were verified to the final data when received after the survey was deployed.

Table A-55 CRP Deployed Participant Surveys

Strata	Deployed Participant Surveys				
	FY 15/16	FY 16/17	FY 17/18	FY 18/19	FY 19/20
Attic Insulation	0	0	0	512	133
Central Air Conditioner	88	171	11	116	3
Central Heat Pump	2	12	1	9	1
Cool Roof	126	224	19	171	18
Dual Panel Windows	51	41	1	25	2
Refrigerator	496	154	0	0	0
Room Air Conditioner	94	20	0	0	0
Pool Pump Replacement	1,646	2,092	50	1,718	19
Whole House Fan	1	1	0	0	1
Total	2,504	2,715	82	2,551	177

The sample design for impact savings was census based. Estimations of the savings for each record (measure) in the verified tracking data were established on the base case conditions, efficient equipment, building style, and climate zone. The measures evaluated in the billing analysis were census based but were adjusted according to qualifying factors detailed in Section A.10.1.5.

Table A-56 CRP Program Data Collection

Strata	Sampling	Sample
Attic Insulation	Billing analysis	Qualified census*
Central Air Conditioner	Billing analysis	Qualified census*
Central Heat Pump	Billing analysis	Qualified census*
Cool Roof	Billing analysis	Qualified census*
Dual Pane Windows	Desk review	Census
Refrigerator	Desk review	Census
Room Air Conditioner	Desk review	Census
Pool Pump Replacement	Billing analysis	Qualified census*
Whole House Fan	Desk review	Census

*Census qualification for billing analysis: Section A.10.1.5.

A.10.1.3. Ex-Ante Savings Review

The ESP database and spreadsheet participant tracking data were sourced for the Ex-Ante savings review.

A.10.1.3.1. ESP Data and Tracking Data Alignment

The Ex-Ante data review had three objectives. The first was to compare the tracking data energy savings to the aggregate measure level energy savings in ESP. Then, to compare the number of units and incentive cost to the ESP data to determine inclusion in the impact analysis. Finally, to review the available measure data fields used by the program to estimate energy savings and peak demand reduction.

Additional data requests were made to LADWP for participant data with more descriptive data fields of the installed measures. Provided data then added manufacturer name, model number, SRI number, AHRI number and other descriptive data for most of the products. The Ex-Ante savings were primarily deemed per-unit savings values, which were factored by the number of units to determine the energy and demand savings.

The following tables summarize the energy and peak demand values from both the ESP database and tracking data provided in spreadsheet format.

The tracking data for the program year FY 15/16 contained 94% of the ESP reported savings for both energy savings and peak demand reduction.

Table A-57 CRP FY 15/16 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Central Air Conditioner	84,832	80,224	-5.4%	88.52	83.71	-5.4%
Central Heat Pump	3,385	2,120	-37.4%	3.19	2.00	-37.3%
Cool Roof	496,830	470,439	-5.3%	903.33	855.34	-5.3%
Dual Pane Skylights & Windows	13,762	12,937	-6.0%	25.02	23.52	-6.0%
CRP Pool Pump	2,851,477	2,671,600	-6.3%	456.24	427.77	-6.2%
Certified Install Pool Pump	4,084,751	3,829,056	-6.3%	1,719.06	1,611.46	-6.3%
Refrigerator	153,477	137,102	-10.7%	21.95	19.60	-10.7%
Room Air Conditioner	37,446	33,390	-10.8%	56.52	50.40	-10.8%
Whole House Fan	2,539	1,696	-33.2%	-	3.12	N/A
Total	7,728,498	7,238,565	-6.3%	3,273.83	3,076.93	-6.0%

The tracking data for the program year FY 16/17 contained 86% of the ESP reported savings for energy savings and 85% of the peak demand reduction.

Table A-58 CRP FY 16/17 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Central Air Conditioner	771,696	171,120	-77.8%	805.25	178.56	-77.8%
Central Heat Pump	48,760	17,808	-63.5%	46.00	16.80	-63.5%
Cool Roof	1,593,306	885,643	-44.4%	1,677.16	1,610.26	-4.0%
Dual Pane Skylights & Windows	15,228	13,754	-9.7%	27.69	25.01	-9.7%
CRP Pool Pump	4,022,200	3,838,250	-4.6%	643.55	614.12	-4.6%
Certified Install Pool Pump	5,890,696	5,634,804	-4.3%	2,479.10	2,371.40	-4.3%
Refrigerator	44,696	40,064	-10.4%	6.39	5.73	-10.3%
Room Air Conditioner	8,162	6,572	-19.5%	12.32	9.92	-19.5%
Whole House Fan	1,272	1,272	0.0%	2.34	2.34	0.0%
Total	12,396,015	10,608,850	-14.4%	5,699.80	4,833.35	-15.2%

The tracking data for the program year FY 17/18 contained 95% of the ESP reported savings for energy savings and 100% of the peak demand reduction.

Table A-59 CRP FY 17/18 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Central Air Conditioner	242,238	242,880	0.3%	253.15	253.44	0.1%
Central Heat Pump	17,808	17,808	0.0%	16.80	16.80	0.0%
Cool Roof	1,952,997	1,250,828	-36.0%	2,274.23	2,274.23	0.0%
Dual Pane Skylights & Windows	16,531	16,529	0.0%	30.06	30.05	0.0%
CRP Pool Pump	4,899,050	4,898,400	0.0%	783.85	783.74	0.0%
Certified Install Pool Pump	7,304,836	7,303,800	0.0%	3,074.24	3,073.80	0.0%
Refrigerator	-	646	N/A	-	0.09	N/A
Room Air Conditioner	-	106	N/A	-	0.16	N/A
Whole House Fan	1,696	1,696	0.0%	3.12	3.12	0.0%
Total	14,435,156	13,732,695	-4.9%	6,435.45	6,435.45	0.0%

The tracking data for the program year FY 18/19 contained 100% of the ESP reported savings for both energy savings and peak demand reduction.

Table A-60 CRP FY 18/19 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Attic Insulation	418,613	412,206	-1.5%	441.74	441.75	0.0%
Central Air Conditioner	133,952	133,952	0.0%	139.78	139.78	0.0%
Central Heat Pump	11,024	11,024	0.0%	10.40	10.40	0.0%
Cool Roof	766,471	766,471	0.0%	1,393.58	1,393.58	0.0%
Dual Pane Skylights & Windows	10,154	10,154	0.0%	18.46	18.46	0.0%
CRP Pool Pump	3,450,200	3,450,200	0.0%	552.03	552.03	0.0%
Certified Install Pool Pump	5,229,728	5,229,728	0.0%	2,200.93	2,200.93	0.0%
Whole House Fan	1,272	1,272	0.0%	2.34	2.34	0.0%
Total	10,021,414	10,016,007	-0.1%	4,759.27	4,760.64	0.0%

The tracking data for the program year FY 19/20 contained 100% of the ESP reported savings for energy savings and 115% of peak demand reduction.

Table A-61 CRP FY 19/20 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Attic Insulation	3,245,185	3,245,185	0.0%	3,894.05	3,263.26	-16.2%

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Central Air Conditioner	139,104	139,104	0.0%	167.26	145.15	-13.2%
Central Heat Pump	19,928	19,928	0.0%	18.24	18.80	3.1%
Cool Roof	1,003,499	1,003,499	0.0%	1,206.64	1,824.54	51.2%
Dual Pane Skylights & Windows	35,415	35,415	0.0%	42.58	64.39	51.2%
CRP Pool Pump	2,132,000	2,133,300	0.1%	293.77	341.33	16.2%
Certified Install Pool Pump	3,172,496	3,171,196	0.0%	437.15	1,334.60	205.3%
Whole House Fan	2,120	2,120	0.0%	0.41	3.90	851.2%
Total	9,749,747	9,749,747	0.0%	6,060.11	6,995.97	15.4%

Continuing with the Ex-Ante review, in order to understand if all the measures were in the tracking data, the rebate and number of units for each measure were compared. The first comparison for the FY 15/16 rebates and installed units are in Table A-62. The incentive alignment indicated more incentives were in the tracking data than the ESP data, but less quantity of units, 106%, and 95%, respectively.

Table A-62 CRP FY 15/16 Units and Incentives Source Comparison

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Match	ESP Data	Program Data	% Match
Central Air Conditioner	923	218	24%	92,111	98,698	107%
Central Heat Pump	8	5	63%	850	1,400	165%
Cool Roof	1,129,159	1,069,180	95%	215,715	230,971	107%
Dual Pane Skylights/Window	31,277	29,043	94%	55,482	55,806	106%
CRP Pool Pump	4,387	4,109	94%	1,945,466	2,053,852	106%
Certified Install Pool Pump	3,943	3,696	94%	1,748,530	1,845,484	106%
Refrigerator	1,425	1,273	89%	82,156	82,630	101%
Room Air Conditioner	353	315	89%	15,666	15,750	101%
Whole House Fan	6	4	67%	1,062	800	75%
Total	1,171,481	1,108,203	95%	4,157,038	4,388,391	106%

The incentives aligned 100% between ESP and tracking data, and the quantity of units was 96% of the ESP units for FY 16/17 in Table A-63.

Table A-63 CRP FY 16/17 Units and Incentives Source Comparison

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Match	ESP Data	Program Data	% Match
Central Air Conditioner	2,097	465	22%	209,700	202,010	96%

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Match	ESP Data	Program Data	% Match
Central Heat Pump	115	42	37%	11,500	11,150	97%
Cool Roof	2,096,455	2,012,825	96%	440,256	421,185	96%
Dual Pane Skylights/Window	34,609	31,260	90%	69,218	60,532	87%
CRP Pool Pump	6,188	5,905	95%	3,093,567	2,952,088	95%
Certified Install Pool Pump	5,686	5,439	96%	2,554,379	2,713,851	106%
Refrigerator	415	372	90%	26,975	24,550	91%
Room Air Conditioner	77	62	81%	3,850	3,100	81%
Whole House Fan	3	3	100%	600	600	100%
Total	2,145,645	2,055,379	96%	6,410,044	6,389,066	100%

The rounded incentives and rounded quantity of units aligned 100% between ESP and tracking data for FY 17/18 as shown in Table A-64.

Table A-64 CRP FY 17/18 Units and Incentives Source Comparison

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Match	ESP Data	Program Data	% Match
Central Air Conditioner	2,584	660	26%	292,020	291,910	100%
Central Heat Pump	119	42	35%	11,900	11,900	100%
Cool Roof	2,842,790	2,842,790	100%	613,805	613,805	100%
Dual Pane Skylight/Window	37,571	37,571	100%	75,142	75,142	100%
CRP Pool Pump	7,537	7,536	100%	3,768,299	3,767,191	100%
Certified Install Pool Pump	7,051	7,050	100%	3,525,500	3,520,076	100%
Refrigerator	-	6	-	-	390	
Room Air Conditioner	-	1	-	-	50	
Whole House Fan	4	4	100%	800	800	100%
Total	2,897,656	2,895,660	100%	8,287,466	8,281,264	100%

The exact quantity of units aligned 100% between ESP and tracking data for FY 18/19, with the incentives at 99%, as shown in Table A-65.

Table A-65 CRP FY 18/19 Units and Incentives Source Comparison

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Match	ESP Data	Program Data	% Match
Attic Insulation	2,208,248	2,10,056	100%	2,208,248	2,156,218	98%
Central Air Conditioner	364	364	100%	164,910	167,490	102%

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Match	ESP Data	Program Data	% Match
Central Heat Pump	26	26	100%	7,750	7,750	100%
Cool Roof	1,741,980	1,741,980	100%	372,076	372,076	100%
Dual Pane Skylight/Window	23,077	23,077	100%	46,154	46,154	100%
CRP Pool Pump	5,308	5,308	100%	2,654,000	2,655,000	100%
Certified Install Pool Pump	5,048	5,048	100%	2,524,000	2,521,874	100%
Whole House Fan	3	3	100%	600	600	100%
Total	3,984,054	3,985,862	100%	7,977,738	7,927,162	99%

Finally, for FY 19/20, the tracking data captured 100% of the units and 98% of the incentive of the ESP data as shown in Table A-66.

Table A-66 CRP FY 19/20 Units and Incentives Source Comparison

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Match	ESP Data	Program Data	% Match
Attic Insulation	21,167,655	21,167,655	100%	21,446,267	21,049,929	98%
Central Air Conditioner	378	378	100%	160,910	160,910	100%
Central Heat Pump	47	47	100%	12,550	12,550	100%
Cool Roof	2,280,680	2,280,680	100%	496,789	496,789	100%
Dual Pane Skylight/Window	80,488	80,488	100%	160,976	160,976	100%
CRP Pool Pump	3,280	3,282	100%	1,640,492	1,641,500	100%
Certified Install Pool Pump	3,063	3,061	100%	1,531,500	1,528,489	100%
Whole House Fan	5	5	100%	1,000	1,000	100%
Total	23,535,596	23,535,596	100%	25,450,484	25,052,143	98%

A.10.1.3.2. Verified Ex-Ante Measure Quantity

The unit quantities for attic insulation, central HVAC, cool roof, dual pane windows, and whole house fans were verified for reasonableness and entered into the Ex-Post impact evaluation to estimate the energy savings and peak demand reduction for each measure unit.

The unit quantities for the CRP pool pump and the Certified Pool Pump Replacement (CPPR) Program were aggregated for the participant billing analysis. Program guidelines indicated that all CPPR Program measures also had an accompanying CRP pool pump measure. The Evaluator confirmed that both measures were received for 48,442 participants summarized by program year in Table A-67. But there were 73 participants that only received the certified install measure and were missing the expected accompanying CRP pool pump measure.

The Ex-Post evaluation method for this measure is detailed in A.10.1.5. The analysis method utilized billing data per home and isolated the pool pump energy usage in the pre and post condition. Two separate billing analysis were completed, one for those in the CPPR Program receiving the certified install pool pump measure, and another for homes only receiving the CRP pool pump measure.

Table A-67 CRP VSD Pool Pump Participants

Measures Received per Participant			Number of Participants by Fiscal Program Year					
CRP Pool Pump	Certified Install	Total Measures	15/16	16/17	17/18	18/19	19/20	Total
N	Y	1	8	21	29	12	3	73
Y	N	1	421	487	513	271	220	1,912
Y	Y	2	7,376	10,836	14,042	10,072	6,116	48,442
Total			7,805	11,344	14,584	10,355	6,339	50,427

The binning of the pool pump measures to the billing analysis groups is summarized in Table A-68. The Ex-Ante and Ex-Post verified quantities are equal for the first two groups that received one of the two measures. The last group that received both measures have the savings from both measures already aggregated in the billing analysis group, certified install. The verified quantity for the CRP pool will be zero for this group, to avoid a double count of the pool pump measure savings.

Table A-68 CRP VSD Pool Pump Verified Ex-Post Measures

Measures per participant			Ex-Post Billing Analysis Groups	
CRP Pool Pump	Certified Install	Total Measures	Billing Analysis Group	Total Groups
N	Y	1	Certified Install	1
Y	N	1	CRP Pool Pump	1
Y	Y	2	Certified Install	1

A.10.1.4. M&V Methods – Algorithm Based Savings

The Evaluator used engineering-based equations to calculate energy savings and peak demand reduction for ENERGY STAR refrigerators, room air conditioners, dual pane skylights and windows, and whole house fans. The following sections provide calculation details for each type of equipment.

A.10.1.4.1. ENERGY STAR Refrigerator

The energy savings for the purchase of a new ENERGY STAR refrigerator was determined by the efficiency of the new unit compared to the same type of unit with the federal standard energy use. This is the same method used by the DEER database and workpapers and is compliant with CA Title 20. The manufacturer and model number from the tracking were cross referenced to the ENERGY STAR online database to obtain the unit energy consumption (UEC).

$$kWh = \left(UEC_{fedbase} - UEC_{efficient}\right) x\ ISR \qquad \textit{Equation A-19}$$

Table A-69 CRP ENERGY STAR Refrigerator Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
kWh, kW	Measure savings per program year	Algorithm	12-131 kWh 0.002-0.014 kW
$UEC_{fedbase}$	Unit Energy Consumption – Federal and CA state baseline	US DOE Federal Refrigerator Standards, CA Title 20	Varies by freezer & refrigerator volume, defrost, door configuration, icemaker
$UEC_{efficient}$	Unit Energy Consumption - efficient	ENERGY STAR Database	265 to 855 kWh
ISR	In Service Rate	Participant Survey, 2021	88% to 100%
IE	Interactive Effects Factor by climate zone	DEER Interior Lighting	1.22 to 1.48

A.10.1.4.2. Room Air Conditioner

The energy savings for the purchase of new room air conditioners were determined by the efficiency of the new unit compared to the same type with the federal standard energy use. This is the same method used by the DEER database and workpapers and is compliant with CA Title 20. The manufacturer and model number from the tracking were cross referenced to the ENERGY STAR online database to obtain the unit combined energy efficiency rating (CEER). The DEER workpapers listed aggregated savings, but sourced savings from the “Residential Retrofit High Impact Measure Evaluation Report (The Cadmus Group)”. From this monitoring study, the evaluation team obtained the effective full load hours (EFLH) for climate zones.

$$kWh = EFLH\ x\ Capacity\ x \frac{\frac{1}{CEER_{base}} - \frac{1}{CEER_{eff}}}{1000}\ x\ ISR \qquad \textit{Equation A-20}$$

Table A-70 CRP Room Air Conditioner Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
kWh, kW	Measure savings per program year	Algorithm	11-121 kWh 0.0078-0.1015 kW
EFLH	Effective Full Load Hours	Residential Retrofit High Impact Measure Evaluation Report (The Cadmus Group, Inc.)	225 to 631 hours
Capacity	Capacity of new unit, BTUh	Tracking Data Model and ENERGY STAR Database	5,000 to 25,000
$CEER_{base}$	CEER – base case efficiency	US DOE Federal Regulations	Varies by capacity, louver, reverse cycle
$CEER_{eff}$	CEER – efficient model	Tracking Data Model and ENERGY STAR Database	10.3 to 12.4
ISR	In Service Rate	Participant Survey, 2021	100%

A.10.1.4.3. Dual Pane Skylights and Dual Pane Windows

For the Ex-Post savings, the Evaluator utilized a deemed per square foot savings value, by climate zone, and the product of the installed square feet of windows and the ISR.

$$\mathrm{kWh} = \frac{kWh_{CZ}}{\mathrm{SF}}\ x\ SF\ x\ ISR$$ *Equation A-21*

Table A-71 CRP Dual Pane Windows & Skylights Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
kWh, kW	Measure savings per program year per square feet of window or skylight	Workpaper table	2.4-5.0 kWh/SF 0.003-0.006 kW/SF
kWh_{CZ}	Energy savings per square feet of double plan replacing single pane	Window Workpaper	4-9781 square feet
ISR	In Service Rate	Participant Survey, 2021	100%

A.10.1.4.4. Whole House Fan

For the Ex-Post savings, the Evaluator utilized a deemed savings per unit value based on the type of efficient motor, the number of air changes by the whole house fan and the climate zone. Public LA Open Data records were sourced for the home square feet and model product data for the type of fan and the maximum CFM per fan.

$$\mathrm{kWh} = kWh_{CFMsfMotorCZ}\ x\ ISR$$ *Equation A-22*

Table A-72 CRP Whole House Fan Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
kWh, kW	Measure savings per program year	Algorithm	145-479 kWh 0.134-0.810 kW
$kWh_{CZ, Area, Motor}$	kWh savings per fan by CFM, home size and climate zone	Manufacturer Spec Sheet-Motor Type & CFM; Climate Zone; LA Open Data Portal-Home SF	0.8-4.2 CFM/SF
ISR	In Service Rate	Participant Survey, 2021	100%

A.10.1.5. M&V Methods Billing Data Based Savings

The Evaluator performed a billing analysis to evaluate the energy savings for the central air conditioner, central heat pump, cool roof, CRP pool pump and motors, and certified-install pool pump and Motor measures. The pool pump and motor measures used a pooled billing data regression while the HVAC-related measures (central air conditioner, central heat pump, and cool roof) were evaluated using a billing data retrofit isolation approach.

A.10.1.5.1. Billing Data Regression

Section 10.1.5.1 describes the pooled billing data regression approach with a propensity score matched (PSM) comparison group used to evaluate the CRP Install pool pump and certified-install pool pump and motor measures.

A.10.1.5.2. Building Data Preparation

LADWP provided both participant and non-participant bi-monthly billing data. Because billing periods varied across participants and did not correspond to the start and end of calendar months, all billing data was calendarized. To accomplish this, the Evaluator first calculated an average daily kWh for each customer bill as represented by Equation A-23.

$$Average\ Daily\ kWh = \frac{Total\ kWh}{Number\ of\ Days} \qquad \text{Equation A-23}$$

The average daily kWh was then multiplied by the number of days in each respective calendar month of the respective bill. For example, for a bill starting on January 15th and ending on March 14th, the average daily kWh would be multiplied by 17 to calculate the bill's January consumption, 28 for February, and 14 to calculate March's consumption. The portions corresponding to each given period in a calendar year would then be summed across for each participant to ascertain that customer's total monthly kWh.

It should be noted that, given billing data is measured at a monthly or lower resolution, there are customer bills which contain both pre and post data. These customer bills and any months that contain calendarized data from these bills were removed from the analysis to prevent savings suppression.

After calendarizing the data set, data was then filtered for the following criteria:

- A simple outlier filter of three times the standard deviation of average daily kWh was applied to both participant and non-participant data.
- To maintain consistency with the preparation of the PSM, participants' installation dates could not fall before the start of the program year.
- Participants and non-participants must have data dating back to 12 months prior to the start of the program year.
- Participants must have 12 months of post-installation data.
- Participants must not have participated in any other energy efficiency programs administered by LADWP during the five-year Retrospective Period.
- Participants must not have participated in the CRP program across multiple program years.
- Participants must not have installed multiple types of CRP program measures.
- Non-participants must have a pool, as reported in the LA County Assessor database.

Because the number of participants in the CRP Pool Pump Program for FY 18/19 and FY 19/20 were not sufficient to perform separate regression analyses, a consolidated regression including customers who participated int the CRP Pool Pump Program from all five fiscal years from FY 15/16 through FY 19/20 was used to estimate savings for these two fiscal years. This consolidated cohort is referred to as FY 15/20 for the remainder of this section.

The number of qualified participants remaining in the data set after filtering for the above criteria are provided in Table A-73 and Table A-74.

Table A-73 CRP Certified-Install Pool Pump and Motor Participant Count

Fiscal Year	All Participants	Qualified Participants	All Non-participants with Billing Data	Qualified Non-participants
15/16	3,508	1,269	441,032	38,427
16/17	5,259	2,229	441,032	38,416
17/18	6,975	2,970	441,032	38,302
18/19	5,023	2,482	441,032	38,182
19/20	3,032	653	441,032	37,167

Table A-74 CRP Pool Pump and Motor Participant Count

Fiscal Year	All Participants	Qualified Participants	All Non-Participants with Billing Data	Qualified Non-Participants
15/16	384	120	441,032	38,427
16/17	438	108	441,032	38,416
17/18	416	113	441,032	38,302
15/20	1,501	750	441,032	37,167

For all remaining participants in the participant and non-participant pool, the zip code for each customer's service address was geolocated to an approximate latitude and longitude and historical weather data was obtained through NOAA for the nearest weather station.

A.10.1.5.3. Propensity Score Matching (PSM)

The Evaluator utilized PSM to develop a comparison group from the non-participant pool. The Evaluator developed five pre-treatment variables for use in the PSM:

- The average daily kWh annually,
- The average daily kWh for winter (December through February),
- The average daily kWh for spring (March through May),
- The average daily kWh for summer (June through September), and
- The average daily kWh for fall (October through November).

Because the non-participant pool does not have established treatment start dates, the Evaluator used the 12-month period prior to the start of the program year as the pre-treatment period for all customers.

Using the five pre-treatment variables, latitude, and longitude; the Evaluator executed a nearest neighbor PSM using the “MatchIt 4.1.0” package in the software “R 3.6.3”. The Evaluator selected a one-to-one participant-to-comparison match due to lack of equivalence when attempting a one-to-multiple matching. After executing the PSM, the Evaluator compared the participant group and the comparison group on several metrics to ensure a good match.

The Evaluator performed a MANOVA in “R 3.6.3” using default settings (Pillai’s trace) on the five pre-treatment variables to ensure similar distributions on all five variables. The results for all five fiscal years are presented in Table A-75 and Table A-76. The distributions did not significantly differ between the participant group and the comparison group, suggesting a good PSM.

Table A-75 CRP Certified-Install Pool Pump and Motor Pre-Treatment MANOVA

Fiscal Year	Pillai's Trace	F-statistic	Num DF	Den DF	P-value
15/16	0.001	0.705	5	2,570	0.619
16/17	0.004	0.341	5	4,552	0.888
17/18	0.001	0.864	5	5,992	0.505
18/19	0.001	0.674	5	4,994	0.643
19/20	0.001	0.661	5	2,762	0.653

Table A-76 CRP Pool Pump and Motor Pre-Treatment MANOVA

Fiscal Year	Pillai's Trace	F-statistic	Num DF	Den DF	P-value
15/16	0.022	1.073	5	238	0.376
16/17	0.016	0.714	5	220	0.613
17/18	0.008	0.374	5	224	0.866
15/20	0.004	1.306	5	1,548	0.259

After reviewing the results of the MANOVA, the Evaluator then performed a series of T-tests on the average daily kWh in the pre-treatment period by month. Because nearest neighbor matching pairs participants with their respective nearest comparison group match, the Evaluator established pseudo-treatment start dates for all comparison group customers based on their participant matches. Thus, the Evaluator used the 12 months prior to the treatment start date as the pre-treatment period for this comparison.

The results of these T-tests are presented in Figure A-12 through Figure A-20. The Evaluator considered matching successful if the number of months that were significantly different between the participant and comparison groups did not exceed two at the 95% confidence level. The Evaluator established a two-month tolerance band to account for the probability that repeated T-testing on panel data may result in any given month resulting in a significant difference-40% for two out of 12 months. The PSM did not exceed this tolerance band for any of the fiscal years.

Figure A-12 Certified-Install Pool Pump and Motor Pre-Treatment Equivalency (FY 15/16)

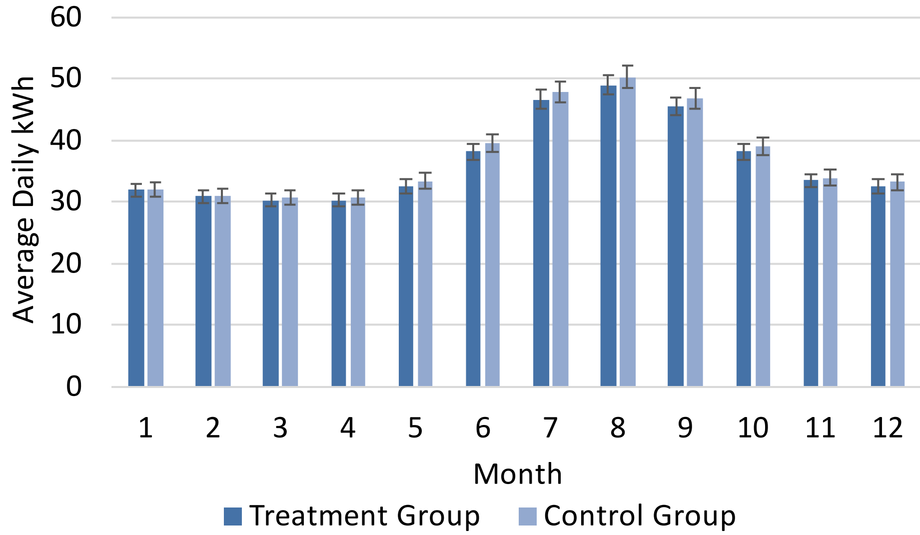


Figure A-13 Certified-Install Pool Pump and Motor Pre-Treatment Equivalency (FY 16/17)

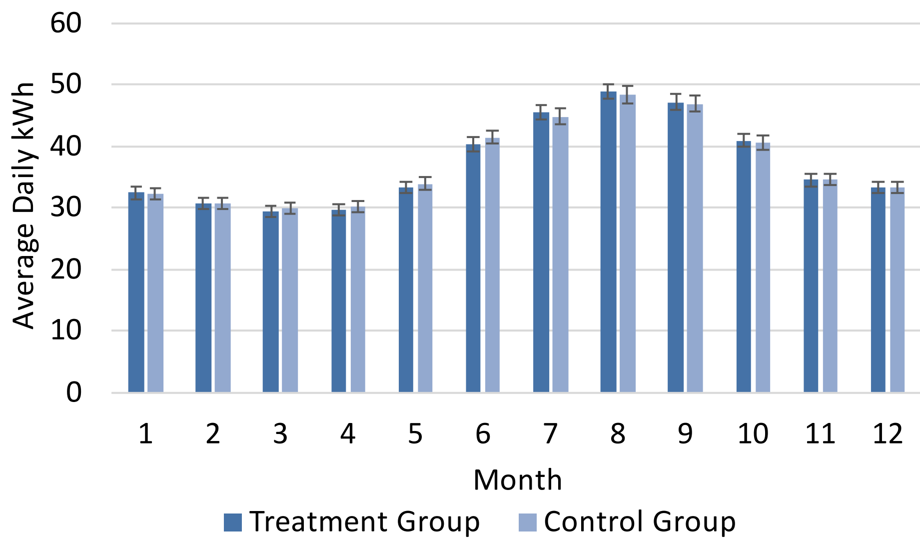


Figure A-14 Certified-Install Pool Pump and Motor Pre-Treatment Equivalency (FY 17/18)

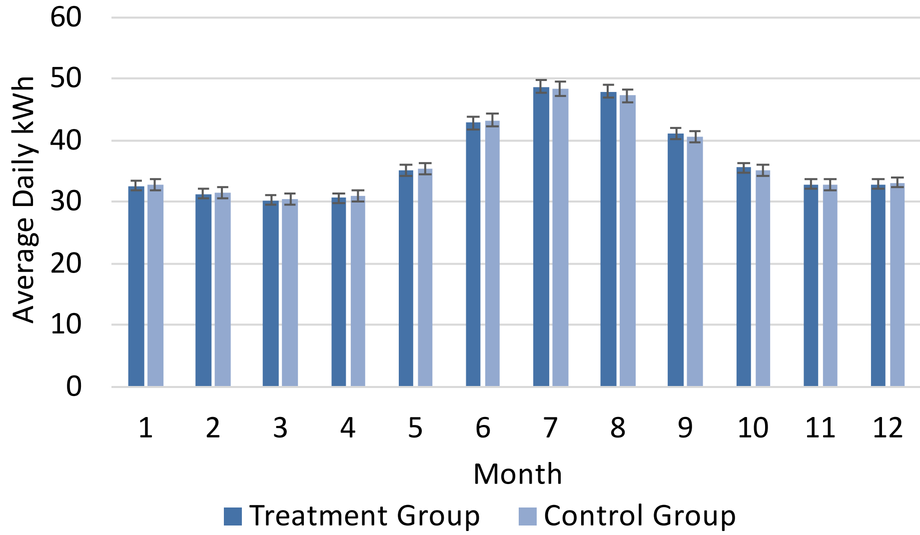


Figure A-15 Certified-Install Pool Pump and Motor Pre-Treatment Equivalency (FY 18/19)

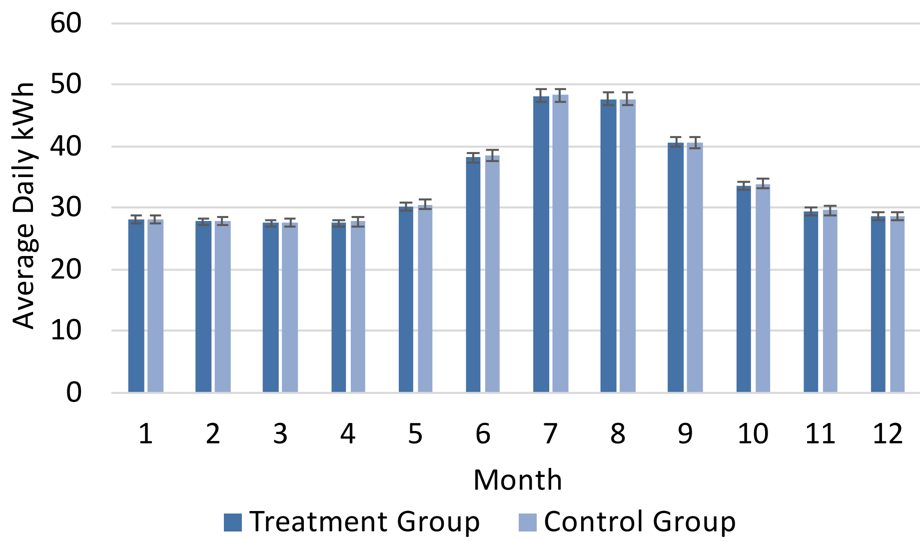


Figure A-16 Certified-Install Pool Pump and Motor Pre-Treatment Equivalency (FY 19/20)

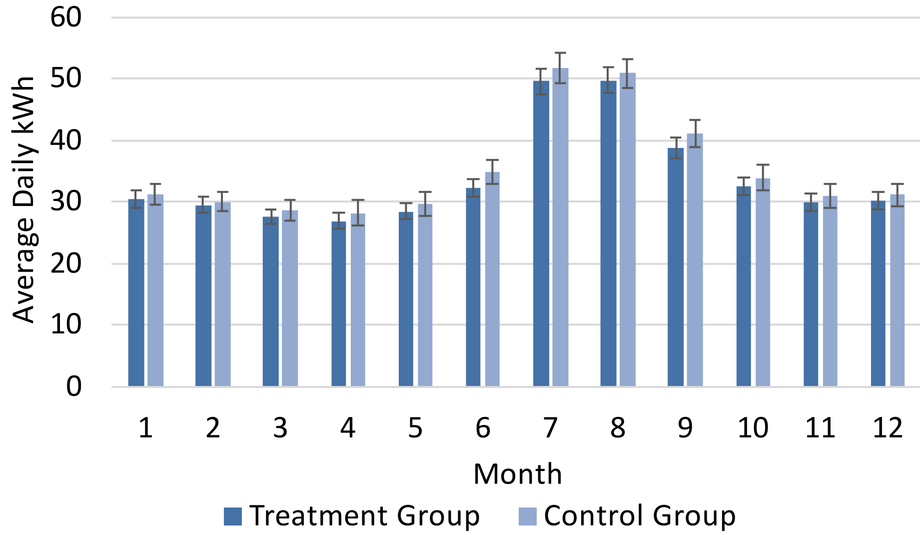


Figure A-17 CRP Pool Pump and Motor Pre-Treatment Equivalency (FY 15/16)

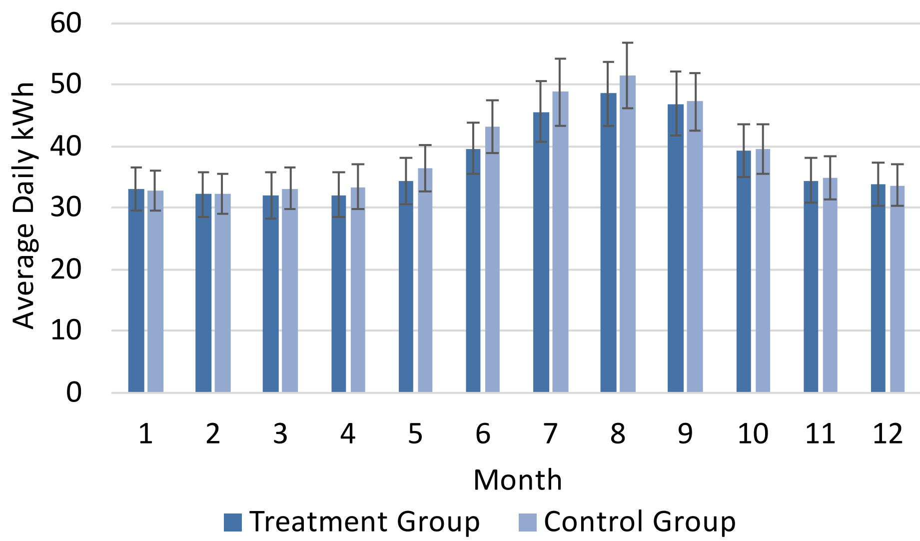


Figure A-18 CRP Pool Pump and Motor Pre-Treatment Equivalency (FY 16/17)

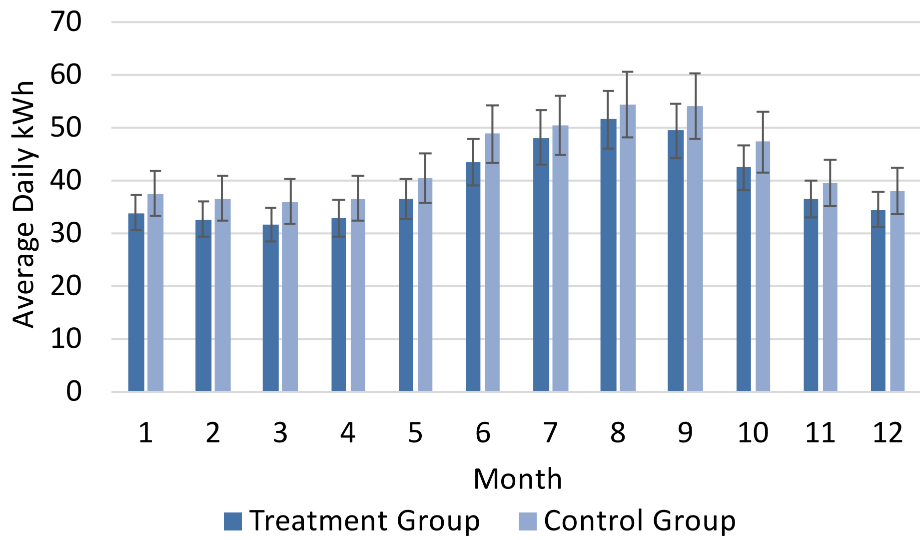


Figure A-19 CRP Pool Pump and Motor Pre-Treatment Equivalency (FY 17/18)

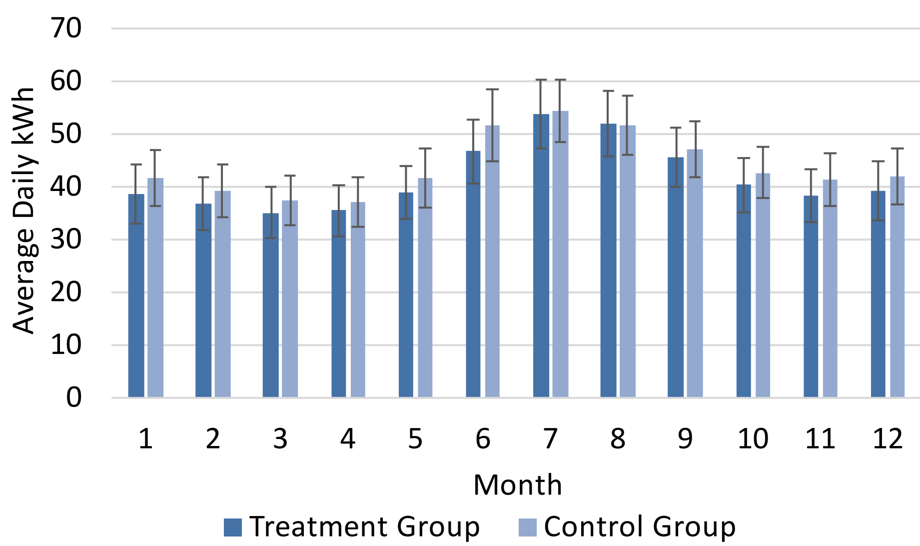


Figure A-20 CRP Pool Pump and Motor Pre-Treatment Equivalency (FY 15/20)

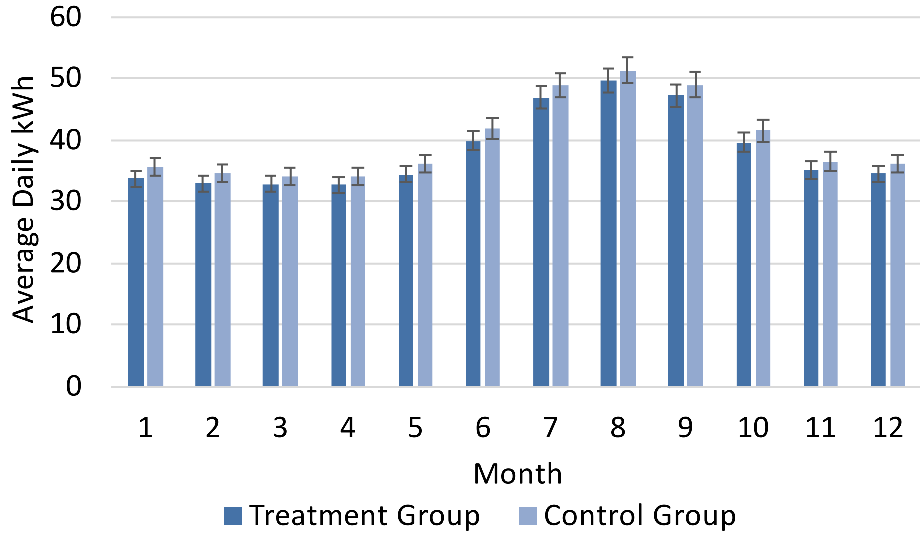


Table A-77 CRP Certified-Install Pool Pump and Motor Pre-Treatment T-Test (FY 15/16)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	31.950	31.984	0.041	0.967
2	30.884	30.897	0.017	0.987
3	30.298	30.655	0.451	0.652
4	30.262	30.681	0.521	0.603
5	32.571	33.390	0.960	0.337
6	38.107	39.458	1.362	0.173
7	46.649	47.828	1.002	0.316
8	48.976	50.226	1.019	0.308
9	45.418	46.846	1.246	0.213
10	38.142	38.940	0.805	0.421
11	33.443	33.818	0.430	0.667
12	32.547	33.174	0.735	0.463

Table A-78 CRP Certified-Install Pool Pump and Motor Pre-Treatment T-Test (FY 16/17)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	32.399	32.329	-0.103	0.918
2	30.649	30.692	0.066	0.948
3	29.463	29.846	0.595	0.552

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
4	29.615	30.245	0.971	0.331
5	33.317	33.882	0.796	0.426
6	40.316	41.454	1.365	0.172
7	45.601	44.807	-0.913	0.361
8	48.877	48.348	-0.565	0.572
9	47.145	46.841	-0.330	0.741
10	40.926	40.476	-0.560	0.575
11	34.472	34.608	0.192	0.848
12	33.267	33.248	-0.029	0.977

Table A-79 CRP Certified-Install Pool Pump and Motor Pre-Treatment T-Test (FY 17/18)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	32.607	32.802	0.326	0.744
2	31.323	31.581	0.419	0.675
3	30.193	30.486	0.477	0.633
4	30.650	30.868	0.363	0.716
5	35.165	35.246	0.129	0.897
6	42.819	43.235	0.578	0.563
7	48.690	48.337	-0.448	0.654
8	47.906	47.172	-0.950	0.342
9	41.051	40.549	-0.716	0.474
10	35.513	35.142	-0.590	0.555
11	32.839	32.845	0.010	0.992
12	32.877	33.129	0.416	0.678

Table A-80 CRP Certified-Install Pool Pump and Motor Pre-Treatment T-Test (FY 18/19)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	28.170	28.135	-0.075	0.940
2	27.745	27.822	0.165	0.869
3	27.450	27.536	0.188	0.851
4	27.475	27.726	0.541	0.588
5	30.055	30.490	0.842	0.400
6	38.093	38.571	0.772	0.440

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
7	48.192	48.309	0.163	0.871
8	47.669	47.632	-0.052	0.958
9	40.597	40.517	-0.130	0.897
10	33.565	33.849	0.526	0.599
11	29.439	29.528	0.181	0.857
12	28.636	28.637	0.001	0.999

Table A-81 CRP Certified-Install Pool Pump and Motor Pre-Treatment T-Test (FY 19/20)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	30.403	31.217	0.716	0.474
2	29.498	30.003	0.476	0.634
3	27.623	28.643	0.955	0.340
4	26.895	28.220	1.114	0.265
5	28.486	29.662	0.990	0.323
6	32.306	34.857	1.992	0.047
7	49.599	51.733	1.333	0.183
8	49.669	50.809	0.709	0.478
9	38.810	41.076	1.608	0.108
10	32.574	33.821	0.961	0.337
11	29.928	30.883	0.788	0.431
12	30.219	31.106	0.751	0.453

Table A-82 CRP Pool Pump and Motor Pre-Treatment T-Test (FY 15/16)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	32.998	32.702	-0.121	0.904
2	32.229	32.322	0.038	0.970
3	31.980	33.089	0.435	0.664
4	32.039	33.393	0.524	0.600
5	34.256	36.387	0.780	0.436
6	39.585	43.177	1.173	0.242
7	45.570	48.763	0.863	0.389
8	48.490	51.423	0.776	0.439
9	46.906	47.277	0.104	0.918

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
10	39.219	39.587	0.122	0.903
11	34.430	34.814	0.151	0.880
12	33.769	33.639	-0.053	0.958

Table A-83 CRP Pool Pump and Motor Pre-Treatment T-Test (FY 16/17)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	33.829	37.391	1.282	0.201
2	32.603	36.476	1.417	0.158
3	31.520	35.881	1.607	0.110
4	32.688	36.542	1.384	0.168
5	36.450	40.426	1.314	0.190
6	43.429	48.679	1.488	0.138
7	48.051	50.414	0.607	0.545
8	51.504	54.269	0.652	0.515
9	49.383	53.860	1.088	0.278
10	42.419	47.259	1.330	0.185
11	36.504	39.346	0.995	0.321
12	34.390	37.950	1.268	0.206

Table A-84 CRP Pool Pump and Motor Pre-Treatment T-Test (FY 17/18)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	38.594	41.630	0.774	0.440
2	36.754	39.249	0.690	0.491
3	35.043	37.249	0.648	0.518
4	35.376	37.073	0.489	0.626
5	38.767	41.476	0.706	0.481
6	46.577	51.542	1.070	0.286
7	53.603	54.284	0.152	0.880
8	51.871	51.524	-0.083	0.934
9	45.450	47.028	0.398	0.691
10	40.303	42.475	0.601	0.548
11	38.131	41.187	0.856	0.393

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
12	39.037	41.903	0.734	0.464

Table A-85 CRP Pool Pump and Motor Pre-Treatment T-Test (FY 15/20)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	33.778	35.677	1.873	0.061
2	32.974	34.668	1.693	0.091
3	32.809	34.152	1.356	0.175
4	32.698	34.076	1.384	0.167
5	34.386	36.106	1.661	0.097
6	39.846	41.922	1.763	0.078
7	46.887	48.875	1.429	0.153
8	49.622	51.235	1.101	0.271
9	47.191	48.925	1.232	0.218
10	39.629	41.476	1.548	0.122
11	35.165	36.492	1.282	0.200
12	34.527	36.175	1.610	0.108

The final participant count for the participant and comparison groups are presented in Table A-86 through Table A-87.

Table A-86 CRP Certified Install Pool Pump and Motor Final Sample Size

Fiscal Year	Participant Group Size	Non-participant Group Size
15/16	1,269	1,269
16/17	2,229	2,229
17/18	2,970	2,970
18/19	2,482	2,482
19/20	653	653

Table A-87 CRP Pool Pump and Motor Final Sample Size

Fiscal Year	Participant Group Size	Non-participant Group Size
15/16	120	120
16/17	108	108
17/18	113	113

Fiscal Year	Participant Group Size	Non-participant Group Size
15/16 to 19/20	750	750

A.10.1.5.4. Degree Day Base Optimization

After developing the participant and non-participant group, the Evaluator used historical weather data to optimize the heating degree day (HDD) and cooling degree day (CDD) bases for each customer. HDDs were calculated using 50-, 55-, 60-, and 65-degree bases. CDDs were calculated at 65-, 70-, 75-, and 80-degree bases.

The regression equation to determine CDD/HDD fit is specified by Equation A-24:

$$Average\ Daily\ kWh_i = \alpha + \beta_1 \cdot post + \beta_2 \cdot CDD_{i,n} + \beta_3 \cdot HDD_{i,n} + \beta_4 \cdot CDD_{i,n} + \beta_5 \cdot HDD_{i,n} \cdot post + \varepsilon \qquad \textit{Equation A-24}$$

Where:

- i represents each individual customer for each month,
- n represents each iteration of base pairs,
- $post$ is an indicator variable indicating whether the period is in the post or pre period,
- $CDD_{i,n}$ is the CDD calculated for iteration *n* for customer *i,*
- $HDD_{i,n}$ is the HDD calculated for iteration *n* for customer *i,*
- α is the intercept term,
- β_1 is the main effect of the post period,
- β_2 is the main effect of CDD,
- β_3 is the main effect of HDD,
- β_4 is the additional effect of CDD on the post period,
- β_5 is the additional effect of HDD on the post period, and
- ε is the error term.

For each customer, all 16 combinations were tested to determine which combination provided the best fit. The pair of CDD and HDD bases that provided the highest adjusted R-squared for each customer was selected as that customer's respective CDD and HDD base.

A.10.1.5.5. Regression Model

To estimate participant savings, the Evaluator used a post-period regression with pre-period control variables. This model isolates the post-treatment period and uses customer-specific variables generated from the pre-treatment period to control for individual variation. The Evaluator developed four pre-treatment variables for use in the regression:

- The average daily kWh for winter (December through February),
- The average daily kWh for spring (March through May),
- The average daily kWh for summer (June through September), and
- The average daily kWh for fall (October through November).

The regression equation is specified by Equation A-25.

$$
\begin{aligned}
Average\ Daily\ kWh_i &= \alpha + \beta_1 \cdot treatment + \beta_2 \cdot CDD_i + \beta_3 \cdot HDD_i \ + \beta_4 \cdot CDD_i \\
&\cdot treatment + \beta_5 \cdot HDD_i \cdot treatment + \beta_6 \cdot pre\ usage\ winter_i + \beta \\
&\cdot pre\ usage\ spring_i + \beta_8 \cdot pre\ usage\ summer_i + \beta_9 \\
&\cdot pre\ usage\ fall_i + \beta_{10} \cdot month_1 + \cdots + \beta_n \cdot month_{12} + \beta_{n+1} \\
&\cdot month_1 \cdot pre\ usage\ winter_i + \cdots + \beta_{n+x} \cdot month_{12} \\
&\cdot pre\ usage\ fall_i + \ \varepsilon
\end{aligned}
\qquad \textit{Equation A-25}
$$

Where:

- i represents each individual customer for each month,
- $treatment$ is an indicator variable indicating whether the customer is in the participant or comparison group,
- CDD_i is the CDD calculated for customer *i,*
- HDD_i is the HDD calculated for customer *i,*
- $pre\ usage\ winter_i$, $pre\ usage\ spring_i$, $pre\ usage\ summer_i$, and $pre\ usage\ fall_i$ are the customer-specific pre-treatment control variables,
- $month_1$ through $month_{12}$ are indicator variables indicating if the month is January through December,
- α is the intercept term,
- β_1 is the main effect of program participation,
- β_2 is the main effect of CDD,
- β_3 is the main effect of HDD,
- β_4 is the CDD-dependent effect of program participation,

- β_5 is the HDD-dependent effect of program participation,
- β_6 through β_9 are the main effects of pre-treatment consumption,
- β_9 through β_n are the main effects of month,
- β_{n+1} through β_{n+x} are the interactive effects of month and pre-treatment consumption, and
- ε is the error term.

The regression coefficients of interest for estimating savings are β_1, β_4, and β_5. Table A-88 through Table *A-96* provide information regarding the regression coefficients for each model and the overall model fit.

Table A-88 CRP Certified Install Pool Pump and Motor Regression Coefficients (FY 15/16)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-4.233	0.726	-5.834	0.000	0.653
Treatment x HDD	0.064	0.110	0.582	0.560	0.653
Treatment x CDD	0.086	0.097	0.882	0.378	0.653

Table A-89 CRP Certified Install Pool Pump and Motor Regression Coefficients (FY 16/17)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-2.926	0.619	-4.728	0.000	0.655
Treatment x HDD	-0.021	0.098	-0.218	0.827	0.655
Treatment x CDD	-0.047	0.097	-0.486	0.627	0.655

Table A-90 CRP Certified Install Pool Pump and Motor Regression Coefficients (FY 17/18)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-3.074	0.545	-5.640	0.000	0.599
Treatment x HDD	-0.094	0.085	-1.111	0.267	0.599
Treatment x CDD	-0.007	0.051	-0.139	0.890	0.599

Table A-91 CRP Certified Install Pool Pump and Motor Regression Coefficients (FY 18/19)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-2.978	0.360	-8.277	0.000	0.605
Treatment x HDD	0.005	0.050	0.094	0.925	0.605
Treatment x CDD	0.018	0.052	0.346	0.729	0.605

Table A-92 CRP Certified Install Pool Pump and Motor Regression Coefficients (FY 19/20)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-2.937	0.837	-3.508	0.000	0.723
Treatment x HDD	-0.022	0.124	-0.176	0.860	0.723
Treatment x CDD	0.046	0.113	0.405	0.685	0.723

Table A-93 CRP Pool Pump and Motor Regression Coefficients (FY 15/16)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-4.172	1.428	-2.922	0.004	0.781
Treatment x HDD	0.102	0.255	0.399	0.690	0.781
Treatment x CDD	0.016	0.283	0.055	0.956	0.781

Table A-94 CRP Pool Pump and Motor Regression Coefficients (FY 16/17)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-6.596	2.477	-2.663	0.008	0.785
Treatment x HDD	0.307	0.334	0.918	0.358	0.785
Treatment x CDD	-0.157	0.353	-0.445	0.656	0.785

Table A-95 CRP Pool Pump and Motor Regression Coefficients (FY 17/18)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-4.498	2.310	-1.947	0.052	0.681
Treatment x HDD	-0.382	0.399	-0.957	0.339	0.681
Treatment x CDD	-0.333	0.279	-1.194	0.233	0.681

Table A-96 CRP Pool Pump and Motor Regression Coefficients (FY 15/20)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-4.817	0.947	-5.086	0.000	0.571
Treatment x HDD	-0.028	0.162	-0.170	0.865	0.571
Treatment x CDD	0.084	0.132	0.640	0.522	0.571

The savings for each fiscal year were then calculated using the formula presented in Equation A-26.

$$Annual\ Savings = [Treatment\ Coefficient + (Treatment\ x\ CDD\ Coefficient \cdot \overline{CDD}) + (Treatment\ x\ HDD\ Coefficient \cdot \overline{HDD})] \cdot -1 \cdot 365.25$$ *Equation A-26*

Where:

- $\overline{CDD}$ is the average daily CDD for a typical weather year, and
- $\overline{HDD}$ is the average daily HDD for a typical weather year.

HDDs and CDDs were weighted relative to the nearest weather stations for the participants in each program year using TMY3. These weighted values are presented in Table A-97 and Table A-98.

Table A-97 CRP Certified Install Pool Pump and Motor Weighted Average TMY3 HDD and CDD

Fiscal Year	Average Daily HDD	Average Daily CDD
15/16	2.246	1.950
16/17	2.961	2.077
17/18	2.857	2.239
18/19	2.650	2.153
19/20	2.542	2.244

Table A-98 CRP Pool Pump and Motor Weighted Average TMY3 HDD and CDD

Fiscal Year	Average Daily HDD	Average Daily CDD
15/16	2.232	1.940
16/17	3.065	1.768
17/18	2.590	2.035
15/16 to 19/20	2.432	1.927

The average savings per household, 90% confidence intervals, and relative precision are presented in Table A-99 and Table A-100.

Table A-99 CRP Certified Install Pool Pump and Motor Average Savings per Household

Fiscal Year	Annual kWh Savings	90% Confidence Interval		Relative Precision (90% CL)
		Lower Bound	Upper Bound	
15/16	1,433	1,159	1,707	19%
16/17	1,128	880	1,375	22%
17/18	1,226	1,016	1,437	17%
18/19	1,069	931	1,208	13%
19/20	1,055	733	1,378	31%

Table A-100 CRP Pool Pump and Motor Average Savings per Household

Fiscal Year	Annual kWh Savings	90% Confidence Interval		Relative Precision (90% CL)
		Lower Bound	Upper Bound	
15/16	1,430	864	1,996	40%
16/17	2,168	1,213	3,122	44%
17/18	2,252	1,352	3,152	40%
18/19	1,724	1,358	2,091	21%
19/20	1,430	864	1,996	40%

A.10.1.5.6. Billing Data Retrofit Isolation

To evaluate HVAC-related strata (attic insulation, central air conditioner, central heat pump, and cool roof), the Evaluator used a billing data retrofit isolation approach. Several considerations were made prior to selecting the retrofit approach over a PSM regression analysis. First, results from the 2019 Residential Appliance Saturation Survey (RASS) suggest a volatile saturation of central HVAC equipment in LADWP service territory (only 10.2% to 37.8% of residential customers have electric space heating depending on building type; only 20.4% to 69.3% of residential customers have central space cooling depending on building type). This renders a PSM inappropriate as there is a high probability that comparison customers selected via PSM may not have comparable equipment installed despite being matched based on energy consumption. Second, results from customer surveys suggest a high proportion of customers replaced HVAC equipment due to equipment failure (60%). Replace on burnout cases require additional attention as the comparable baseline for these units is no longer the customer's pre-existing equipment but the federal standard minimum efficiency equipment.

Despite the advantages for using this method to measure savings for HVAC-related strata, one inherent disadvantage stems from the increased variability associated with the arithmetic transformations to the billing data necessary to perform this analysis. Therefore, the Evaluator collapsed across the five-year Retrospective Period to bolster statistical power and increase the method's capacity in returning interpretable results.

A.10.1.5.7. Billing Data Preparation

LADWP provided participant bi-monthly billing data. As with the procedure described in Section A.10.1.5.2, customer billing data was first calendarized from billing periods to calendar years. After calendarization, customer billing data was filtered for the following criteria:

- Participants must have 12 months of post-installation data.
- Cool Roof program participants must have 12 months of pre-installation data.
- Participants must not have taken part in any other energy efficiency programs administered by LADWP during the five-year Retrospective Period.
- Participants must not have taken part in the CRP program across multiple program years.
- Participants must not have installed multiple types of CRP program measures.
- Participants with apparent photovoltaic generation, as noted by the appearance of negative billing data, were excluded from analysis.
- For Central Air Conditioner and Central Heat Pump program participants, data was restricted to the post-installation period only.
- To reduce the potential impact of the COVID-19 pandemic on results, billing data from March 2020 onward was excluded from analysis for the Central Air Conditioner, Central Heat Pump, and Cool Roof programs. This filter was not included for the Attic Insulation program due to both FY 18/19 and FY 19/20's post-installation period significantly overlapping with this period.
- Because a statistically significant savings could not be estimated for the Multifamily Attic Insulation program independently, Attic Insulation program savings were estimated for the consolidated multifamily and single family group and single family on its own.

The number of participants remaining in the data set after filtering for the above criteria is provided in the following table:

Table A-101 CRP CAC, CHP, and Cool Roof Participant Count

Strata	Number of Participants	Final Sample Size
Attic Insulation – MF + SF	17,050	5,276
Attic Insulation – SF Only	16,440	4,998
Central Air Conditioner	1,942	921
Central Heat Pump	143	79
Cool Roof	2,918	1,243

As noted in Section A.10.1.5.2, the zip code for each customer's service address was geolocated to an approximate latitude and longitude and historical weather data was obtained through NOAA for the nearest weather station.

A.10.1.5.8. Weather Normalization

After preparing the billing data, the Evaluator proceeded to normalize the billing data using a similar method as described in Section A.10.1.5.4. From the candidate HDD and CDD bases, the base pair that provided the best adjusted R-squared was selected as the HDD and CDD base for that individual customer based on the equation provided in Equation A-27. The pre-period and post-period for cool roofs were normalized independent of one another to generate appropriate regression coefficients for weather-normalization. Additionally, central air conditioners were solely optimized for CDD, with the HDD terms removed from the regression analysis.

The regression equation for weather normalization is presented in *Equation A-27*.

$$Average\ Daily\ kWh_i = \alpha + \beta_1 \cdot CDD_{i,n} + \beta_2 \cdot HDD_{i,n} \qquad \text{Equation A-27}$$

Where:

- i represents each individual customer for each month,
- n represents each iteration of base pairs,
- $CDD_{i,n}$ is the CDD calculated for iteration *n* for customer *i,*
- $HDD_{i,n}$ is the HDD calculated for iteration *n* for customer *i,*
- α is the intercept term,
- β_2 is the main effect of CDD,
- β_3 is the main effect of HDD, and
- ε is the error term.

After obtaining the optimal HDD and CDD pairs for each customer and each period, the Evaluator used the regression coefficients for HDD and CDD to normalize the average daily kWh to TMY3, as presented in Equation A-28.

$$\begin{aligned} NADC_i = Average\ Daily\ kWh_i &- \left(\beta_1 \cdot CDD_{i,h}\right) + \left(\beta_1 \cdot CDD_{i,TMY3}\right) \\ &- \left(\beta_2 \cdot HDD_{i,h}\right) + \left(\beta_2 \cdot HDD_{i,TMY3}\right) \end{aligned} \qquad \text{Equation A-28}$$

Where:

- $NADC_i$ represents the normalized average daily consumption,

- $CDD_{i,h}$ and $HDD_{i,h}$ are the CDD and HDD values calculated using historical weather data, and
- $CDD_{i,TMY3}$ and $HDD_{i,TMY3}$ are the CDD and HDD values calculated using TMY3.

A.10.1.5.9. Isolation of Weather-Dependent Load

After normalizing the billing data to TMY3, the Evaluator proceeded to extract the weather-dependent load for each customer for the pre and post periods under the assumption that most weather-dependent loads for residential homes is attributable to HVAC. To accomplish this, the Evaluator first detected a month with minimal HVAC load by selecting, for each customer in each period, the month with the lowest average daily kWh. The Evaluator deemed this value as "baseload," representing the typical household consumption in absence of HVAC. The weather-dependent load for each customer in each month of each period could then be determined by subtracting the baseload from that month's normalized average daily consumption.

For the purposes of this analysis, weather-dependent load between the months of April through October were treated as cooling load while weather-dependent load between November through March were treated as heating load.

A.10.1.5.10. CAC and CHP Savings Calculation

After calculating the post period weather-dependent load, the cooling load and heating load were then used to estimate the approximate effective full load hours (EFLHs) for cooling and heating for each customer. The equations for estimating the EFLHs are presented in Equation A-29 and Equation A-30. Equipment efficiency information including SEER and equipment capacity was obtained via the tracking data. Average HSPF values for central heat pumps were estimated using the AHRI database relative to the reported SEER and equipment capacity.

$$EFLH_{cool} = \frac{kWh_{cool,e} \cdot SEER_e \cdot 1000}{CAPY_{cool}}$$

Equation A-29

$$EFLH_{heat} = \frac{kWh_{heat,e} \cdot HSPF_e \cdot 1000}{CAPY_{heat}}$$

Equation A-30

The EFLHs obtained using the post period data were then applied to the equation presented in Equation A-31 and Equation A-32 to estimate baseline equipment consumption.

$$kWh_{cool,b} = \frac{EFLH_{cool} \cdot CAPY_{cool}}{1000 \cdot SEER_b}$$

Equation A-31

$$kWh_{heat} = \frac{EFLH_{heat} \cdot CAPY_{heat}}{1000 \cdot HSPF_b} \qquad \textit{Equation A-32}$$

The Evaluator estimated baseline consumption for both an early replacement (ER) and replace on burnout (ROB) scenario. DEER standard baseline equipment efficiencies for the ER scenario were obtained from the DEER resources workpapers and mapped appropriately back to customers based on vintage. Vintage information could not be obtained for all customers due to gaps in county assessor data. Federal standard baseline values were used for the new construction or replace on burnout scenario.

Savings were then estimated by taking the difference in consumption between the baseline scenario and efficient equipment consumption. Savings for central air conditioners were limited to the difference between baseline and efficient cooling only. ER and ROB savings per unit are presented in Table A-102 with the 90% confidence interval of the savings estimate.

Table A-102 CRP CAC and CHP Participant-Level Savings

Strata	Scenario	Annual kWh Savings	90% Confidence Interval		Relative Precision (90% CL)
			Lower Bound	Upper Bound	
Central Air Conditioner	ER	639.80	609.14	670.37	5%
Central Air Conditioner	ROB	200.97	190.65	211.29	5%
Central Heat Pump	ER	1006.87	701.55	1312.19	30%
Central Heat Pump	ROB	165.79	132.69	198.88	20%

A.10.1.5.11. Attic Insulation and Cool Roof Savings Calculation

For the Attic Insulation and Cool Roof programs, the difference in pre and post weather-dependent load was treated as the savings for each customer, as represented in Equation A-33.

$$\Delta kWh_{HVAC} = kWh_{HVAC\ Pre} - kWh_{HVAC\ Post} \qquad \textit{Equation A-33}$$

The individual savings was then aggregated to create an average per household savings, as represented in Table A-103.

Table A-103 CRP Attic Insulation & Cool Roof Participant-Level Savings

Strata	Annual kWh Savings	90% Confidence Interval		Relative Precision (90% CL)
		Lower Bound	Upper Bound	
Attic Insulation – MF + SF	212.29	165.29	259.29	22%
Attic Insulation - SF	226.65	177.91	275.39	22%
Cool Roof	167.24	59.21	275.27	65%

A.10.1.5.12. Peak Demand Reduction Estimation

In absence of interval meter data, the Evaluator used 8,760 end use load profiles sourced from the California Energy Commission's 2018 California Investor-Owned Utility Load Shape Project to estimate energy to demand factor (ETDFs) for each measure for FY 15/16 through FY 17/18. The ESP data for years FY 18/19 through FY 19/20 included the LADWP utility specific coincident peak time periods within the load shape data and was utilized as an ETDF factor. The ETDFs are presented in Table A-104.

Table A-104 CRP ETDFs for Billing Analysis Measures

Measure	End Use	ETDF	
		FY 15/16 to FY 17/18	FY 18/19 to FY 19/20
Attic Insulation – MF	Building Envelope	0.000200	0.001152
Attic Insulation – SF	Building Envelope	0.000200	0.001202
Central Air Conditioner	Cooling	0.000747	0.001202
Central Heat Pump	Heat Pump	0.000425	0.000915
Cool Roof	Building Envelope	0.000508	0.001152
Pool Pump and Motor	Miscellaneous	0.000214	0.000138

The Evaluator then estimated demand savings by applying the ETDF to the annual kWh savings.

A.10.1.6. Online Survey Data Collection

The CRP participant survey invited participants via email to participate in an online survey. The survey participant pool represented 8,029 installed measures. Of those participants that were contacted, 212 responses were obtained and summarized in the following table. Very few responses for attic insulation rebates were obtained; two reasons were that the rebate started in FY 18/19, and FY 17/18, FY 19/20 data updates were received from LADWP after the survey was deployed.

Table A-105 CRP Completed Participant Surveys

Strata	Completed Participant Surveys				
	FY 15/16	FY 16/17	FY 17/18	FY 18/19	FY 19/20
Attic Insulation	0	0	0	5	5
Central Air Conditioner	7	12	1	7	0
Cool Roof	4	17	4	15	0
Dual Pane Windows	1	1	0	0	0
Pool Pump and Motor	28	30	1	31	0
Refrigerator	30	8	0	0	0
Room Air Conditioner	4	0	0	0	0
Whole House Fan	0	1	0	0	0
Total	74	69	6	58	5

A.10.2. Impact Evaluation

This section presents the findings of the impact evaluation of the CRP during the Retrospective Period. Ex-post gross energy savings and peak demand reduction are presented at the measure level.

A.10.2.1. Description of Factors Affecting Gross Realized Savings

The number of verified participants affected all the measures in the estimation of the Ex-Post gross realized savings determined by TRM or workpaper based algorithms. The review of the Ex-Ante data resulted in a dataset of verified participants from which energy savings and peak demand reduction were calculated for each verified participant.

A.10.2.1.1. VSD Pool Pump and Motor

The largest contributor to Ex-Post gross energy savings totaling less than the Ex-Ante savings was attributed to the VSD pool pumps and motor measure. The CRP Pool Pump program has an Ex-Ante energy savings of 650 kWh. The certified pool pump measure does not occur as a stand-alone measure but is paired with the CRP pool pump measure for a combined Ex-Ante energy savings of 1,686 kWh. Table A-106 lists this relationship with the Ex-Post energy and demand savings. The billing analysis did not identify any additional savings for the pool pumps installed by a certified installer.

Table A-106 CRP Pool Pump Measures

Measure (s)	Energy Savings (kWh)		Incentive	Peak Demand (kW)
	Ex-Ante Program Data	Ex-Post Billing Analysis		
CRP Pool Pump	650	1,724*	$500	0.104
Certified Pool Pump	1,036	N/A	$500	0.436

Measure (s)	Energy Savings (kWh)		Incentive	Peak Demand (kW)
	Ex-Ante Program Data	Ex-Post Billing Analysis		
CRP + Certified	1,686	1,178	$1,000	0.540

*CRP Pool Pump analysis smaller sample size than Certified Pool Pump; less precision

From the CRP participant survey data, the base case mostly complies with the program guidelines, with under 7% of the responses replacing a two-speed or VSD pool pump motor instead of the required single speed motor. The age of the replaced equipment was not obtained during the survey effort.

Table A-107 CRP Pool Pump Survey Responses – Baseline Pump Type

Measure	Existing Pump Not Working	Additional Pump or New Pool	Existing Pump Working and Replaced		
			Single Speed	Two Speed	VSD
CRP Pool Pump	3	2	5	0	0
Certified Pool Pump	23	0	34	2	3
Total	26	2	39	2	3

Although the population and survey sample of the CRP Pool Pump program participants were smaller than the Certified Pool Pump, none of the eight responses of the CRP Pool Pump indicated the pump only runs at night, which would infer a peak demand of zero.

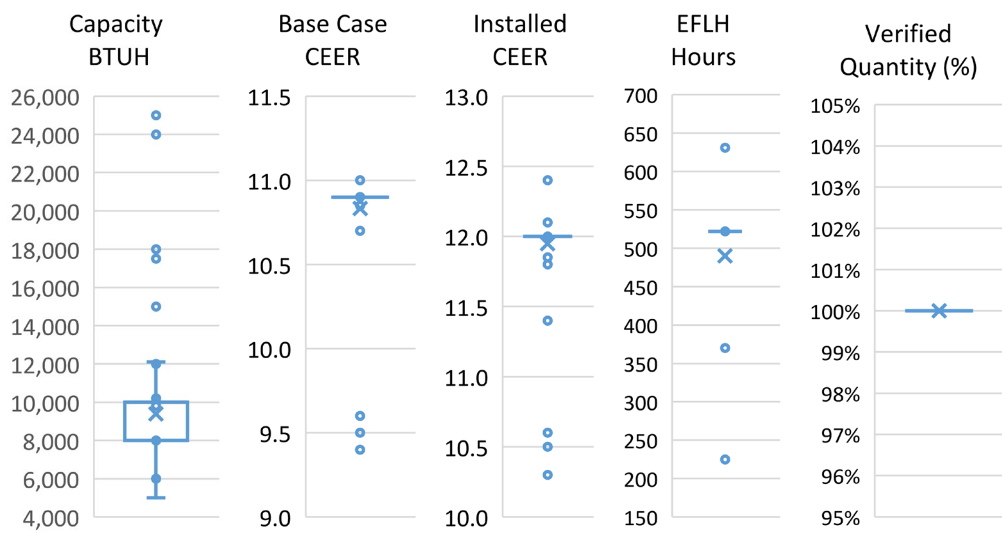
Table A-108 CRP Pool Pump Survey Responses Programming Schedule and Speed

Measure	Pump Speed (Hz)	Pool Pump Operates at the speed range and period: (may operate more than one range)			
		0-6 hrs. per day and some night	7-12 hrs. per day and some night	Only at night	Other schedule
CRP Pool Pump	500 to 1000	2	1	-	-
	1001 to 1500	2	-	-	-
	1501 to 2500	2	-	-	-
	2500 to 3600	1	-	-	-
Certified Pool Pump	500 to 1000	2	2	6	1
	1001 to 1500	5	2	7	1
	1501 to 2500	5	4	4	1
	2500 to 3600	2	2	3	2
Total		21	11	21	5

A.10.2.1.2. Room Air Conditioners

The Ex-Ante savings per room air conditioner was a deemed per-unit value of 106 kWh. The Ex-Post savings varied due to Capacity, Base Case CEER, Installed CEER, EFLH Hours and the Verified Quantity. The box plot of the inputs in Figure A-21 indicates the variations of the inputs among the participants. The box plot illustrates the distribution of the data, concentrating on the middle 50th percentile of the data represented in the blue rectangles, and less emphasis on the outlying data. The 50th percentile for Capacity ranges from 8,000 to 10,000 BTUh, but the 50th percentile for the other inputs has a very small range, indicated but just a flat bar instead of a box. The remaining points are outliers, not counted within the percentile, as they did not occur as often.

Figure A-21 Room Air Conditioner Data Distribution of Algorithm Inputs



The Ex-Ante savings is 106 kWh for all capacities, efficiency, and climate zones. The Ex-Post savings were estimated from the installed capacity, installed efficiency and climate zone. The baseline was the same size unit with the code based minimum efficiency. Applying the most common capacity from the data (10,000 BTUh), and Climate zone 9, would result in annual energy savings of 44 kWh, from the SCE Room Air Conditioner workpaper. The Ex-Post average savings of 68 kWh/unit is between the Ex-Ante of 106 kWh and the SCE Workpaper of 44 kWh.

A.10.2.1.3. Cool Roofs

The Cool Roof measure had a low realization rate for energy savings and peak demand reduction determined by the billing data analysis, indicating the Ex-Ante deemed savings per square foot of roof may be overestimating the energy reduction impact.

The billing analysis considered the existing roof as the baseline, but most of the LADWP customers reside in the city limits of Los Angeles, and since 2014 have been under the building code regulation with a Cool Roof SRI requirement. Most of the cool roof participant survey responses (97%), replaced 50% or more of the roof, which is the threshold for partial roof replacements for code required cool roof material. The participant survey also indicated 40% of the responses installed attic insulation at the same time which is a tradeoff exemption for the state of California under CA Title 24, but the City of Los Angeles has a mandatory requirement for cool roofs that meet the requirements for replaced roof are, and not eligible for the tradeoff.

Lastly, the participant tracking data indicated that 85% of the roof material installed was just equal to code requirements, while 15% of the roof material exceeded code by at least 10 SRI. Table A-109 summarizes the survey responses for the area of the replaced roof.

Table A-109 CRP Cool Roof Participant Survey – Base Case

Base Case	Responses	% Responses	Percent of Roof Area Replaced	% Responses
Older roof replaced, existing cool roof	3	7.5%	90-100	97.0%
Older roof replaced, not cool roof	35	85.5%	50-90	0.0%
New Construction	0	0.0%	<50	3.0%
Storm damage replacement	2	5.0%		
Along with home addition	1	2.0%		
Total	41	100.0%		100.0%

Asphalt shingles are the predominate base case at 82% of the participant survey responses, as shown in Table A-110.

Table A-110 CRP Cool Roof Participant Survey – Base Case Material

Base Case	Responses	% Responses
Asphalt Shingles	32	82%
Metal Roofing	2	5%
Tile	0	0%
Roof Coating	2	5%
Membrane	1	3%
Other material	2	5%
Total	41	100%

Attic Insulation is a CA Title 24 tradeoff for Cool Roofs when permitted with accompaniment of an appropriate energy study; however, this does not apply to the City of Los Angeles, where the Cool Roof is a mandatory requirement for a replacement of more than 50% of the surface area. Forty percent of survey respondents that added additional attic insulation achieved additional energy savings but would not have qualified for a CA Title 24 tradeoff from using cool roof products, when replacing the roof surface; see Table A-111.

Table A-111 CRP Cool Roof Participant Survey – Base Case Insulation

Base Case	Responses	% Responses
Added attic insulation same time	16	40%
Did not add attic insulation	24	60%
Total	41	100%

The majority (77%) of the cool roof measures in the category of Steep Slope 16 SRI are in the above code baseline group, with a smaller percentage of measures in the category exceeding code.

Table A-112 CRP Cool Roof Tracking Data – Code and Exceeding Code Installed Square Feet

Cool Roof Measure	Installed (sq. ft.)	% Area
Steep Slope 16 SRI	7,654,259	77%
Steep Slope 35 SRI	150,330	2%
Low Slope 75 SRI	839,846	8%
Low Slope 85 SRI	1,303,020	13%
Total	9,947,455	100%

The average SRI of the “above code” is significantly above the code threshold of Steep Slope 16 SRI, with an average value of 21.8. The tracking data has some Steep Slope measures with SRI values exceeding 35 in the Steep Slope 16 SRI measure and some less than in the Steep Slope 35 SRI measure category, and therefore appear to be improperly aligned.

Table A-113 CRP Cool Roof Tracking Data & CRRP SRI Average

Cool Roof Measure	3 Year SRI	Program Data with Valid CRRP Number
Steep Slope 16 SRI*	21.8	1137
Steep Slope 35 SRI*	20.5	4
Low Slope 75 SRI	81.0	261
Low Slope 85 SRI	88.2	295

*Improperly aligned measures.

A.10.2.1.4. Dual Pane Windows

There was not adequate tracking data for the window products to determine the installed U-factor. The survey responses for the dual panel window were low with only three responses; however, all respondents stated the base case condition was a single pane window.

The CMUA TRM Measure 222 was the best fit for the impact analysis of dual pane windows. The measure requirement with an efficient case U-factor less than or equal to 0.35, along with the survey responses indicating a base case of single pane window, aligned best with the CMUA TRM measure that's modeled with a base case of single pane windows and efficient case of a window with a U-factor of 0.32.

Table A-114 CRP Dual Pane Window Participant Survey

Cool Roof Measure	Response	% Response
New Construction/Addition	0	0%
Double/Triple Pane	0	0%
Single Pane	3	100%
New window opening	0	0%
Total	3	100%

The Ex-Ante energy savings estimate was based on 0.44 kWh/square feet of window installed. The CMUA TRM deemed savings value for CZ09 is 4.2 kWh/square feet. The climate CZ09 is appropriate for this comparison, as 86% of the total installed window area was located in climate zone 9.

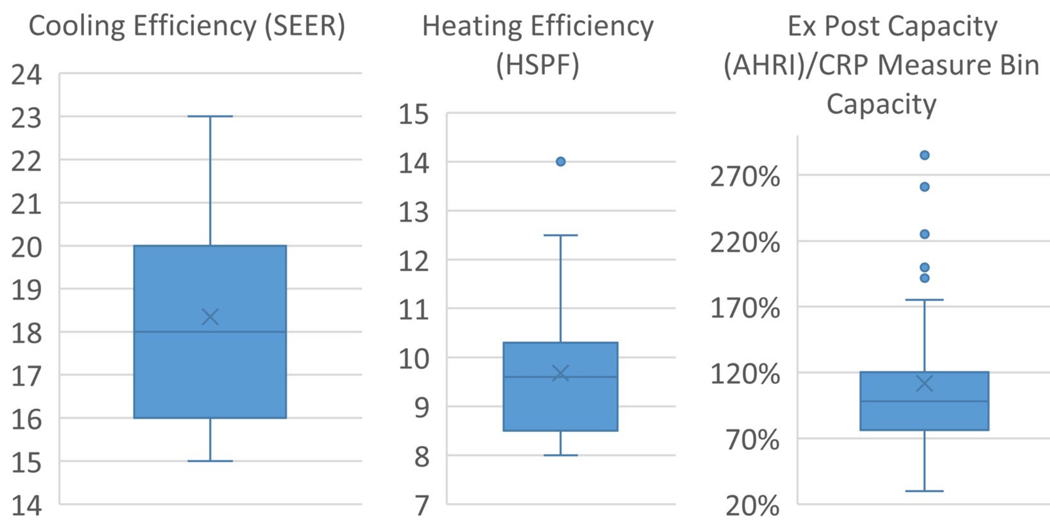
A.10.2.1.5. Central HVAC Replacement

The Ex-Post savings for central heat pumps were calculated through a billing analysis and produced a realization rate of 48%. The evaluation team also researched the AHRI reference numbers, when provided in the tracking data. Figure A-22 summarizes the data collection from the AHRIdirectory.org database for equipment by cross referencing the applicant provided AHRI equipment number. The CRP measure qualification for central heat pumps is a SEER of 15 and an HSPF of 8.5. The SEER of 15 exceeds the federal appliance minimum efficiency of SEER 14. The box plot indicates heat pump units significantly exceeded the minimum federal requirement with the 50% percentile ranging from 16 SEER to 20 SEER.

The HSPF efficiency for heating also exceeded the program minimum requirement in the 2nd box plot with an average of 9.7 HSPF.

The third box plot is the ratio of the AHRI capacity in BTUh compared to the CRP measure bin capacity. Some variation is expected due to the half-ton resolution of the measure bins, but the 25% percentiles were significantly different. The AHRI reference number reported in the application was not always representative of the installed system, as the condenser model aligned with the AHRI configured system, but the evaporator coil model number did not. The AHRI rating for a system, with the model of the condenser and the evaporator together, provides the best energy efficiency rating of the installed equipment, as compared to the AHRI rate of just a condensing unit or an evaporator coil.

Figure A-22 Central Heat Pump Data Distribution of Product Data



A.11. EPM Program

This section details the impact evaluation for the Efficient Products Marketplace (EPM) Program that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation was to calculate energy savings and peak demand impacts attributable to the Program.

A.11.1. Evaluation Methodology

This section presents the methodology used to establish program participation, obtain product data not available in the tracking data, the findings of the tracking data review, and the methods used to calculate energy savings for EPM. Table A-115 shows the data collection activities performed for EPM.

Table A-115 EPM Program Evaluation Data Collection

Data	Source
Program Tracking Data	Data requests to LADWP for all measure level program tracking data

Data	Source
Program Participant Surveys	Survey administered to a sample of program participants via email contact information
Recipient and control group billing data	Data requests to LADWP for all relevant billing data in the study period
Participation in other LADWP programs	Data requests to LADWP for all residential program participation in the study period
Recipient and control group customer data	Data requests to LADWP for other customer information (e.g., demographics, contact permissions)

Tracking data was reviewed to ensure that the data provided sufficient information to verify program participation and to calculate energy savings and peak demand reduction.

Field data collection consisted of participant surveys. In home data collection did not occur for the Retrospective Period due to the COVID-19 pandemic. Savings were evaluated via billing analysis and engineering desk reviews for the program measures.

The approach the Evaluator used to determine Ex-Post kWh and Ex-Post peak kW for EPM was based on statistical analysis of billing data for the weather sensitive measures such as thermostats, and for variable speed pool pump and motors. Desk reviews were performed for appliances such as room air conditioners, power strips, and refrigerators.

A.11.1.1. Tracking Data Review

Program data aggregated at the measure level was obtained from the ESP database platform. Participant data (tracking data) was sourced from spreadsheet data in Excel format and was provided securely by LADWP.

Table A-116 lists the workbooks referenced to aggregate the participant data and which was then compared to ESP measure level report data.

Table A-116 EPM Program Tracking Data Sources

Workbook File Name	Participant Records
EPM Program Data.xlsx	4,054
EPM Program Participation Data 2016-2020.xlsx	11,823
EPM Paid Rebate List.xlsx	6,993
LADWP FY SB1037 Report.export.csv (each year)	0
Total	22,870

The Evaluator reviewed available program data and counted the total number of unique households that participated in each fiscal year. These household counts were used to extrapolate household-level regression analysis to program-level savings for each Retrospective fiscal year.

The Evaluator was not provided Ex-Ante peak kW reduction by measure and was unable to estimate program tracking data peak demand reduction. The Evaluator found the monthly measure count and savings summaries difficult to match with the measure-level tracking data. In many cases, the measure names in one data source did not match the measure names in another data source; therefore, measure-level counts were unable to be recreated using the available tracking data.

The Evaluator recommends that the measure-level tracking data also include measure-level kWh and kW savings for each line item. This change would ensure that measure- and program-level counts and savings are consistent across all data sources.

A.11.1.2. M&V Sample Design

Participant information from the tracking data was cross referenced to LADWP account data to determine which account holders were willing to be contacted. The email address for those that did not have a "no contact" flag was aggregated by their measure from the EPM program, and by fiscal year in which participation took place. Table A-117 summarizes the survey sample deployed through an email invitation for an online participant survey.

Table A-117 EPM Deployed Participant Surveys

Strata	Deployed Participant Surveys			
	FY 16/17	FY 17/18	FY 18/19	FY 19/20
Advanced Power Strips	0	2	18	7
ENERGY STAR Lighting	44	42	32	32
ENERGY STAR Refrigerator	278	273	252	825
ENERGY STAR Room AC	21	53	19	93
ENERGY STAR Television	49	32	28	7
Smart & Web Thermostats	23	604	330	1,034
Total	415	1,006	679	1,998

Table A-118 summarizes the sampling design for the measures offered by the EPM program. The savings were determined by a billing analysis or desk review based on DEER workpaper methodology, supplemented by participant survey respondent data.

Table A-118 EPM Sample Design

Strata	Analysis Method	Sample
Advanced Power Strips	Desk Review	Census
ENERGY STAR Lighting	Desk Review	Census
ENERGY STAR Refrigerator	Desk Review	Census
ENERGY STAR Room AC	Desk Review	Census

Strata	Analysis Method	Sample
ENERGY STAR Television	Desk Review	Census
Smart & Web Thermostats	Billing Analysis	Census

A.11.1.3. Ex-Ante Savings Review

The Ex-Ante data review had three objectives. The first objective was to compare the tracking data energy savings to the aggregate measure level energy savings in ESP. Next, it was to compare the number of units and incentive cost to the ESP data. Finally, to review the available measure data used by the program to estimate energy savings and peak demand reduction.

For FY 16/17, the tracking data did not contain energy savings or peak demand reduction. The Evaluator assigned the deemed same measure savings from FY 19/20 to FY 16/17 measure tracking data for each participant. The result was that 63% of the ESP measures were found within the tracking data. As there was no Ex-Ante data for FY 19/20 to assign to the same measures, there was no comparison performed for peak demand in Table A-119.

Table A-119 EPM FY 15/16 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh*	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Advanced Power Strips Tier 1	96	-	N/A	0.01	N/A	N/A
Advanced Power Strips Tier 2	1,908	2,120	11.1%	0.28		
ENERGY STAR Lighting	1,454	1,367	-6.0%	0.00		
ENERGY STAR Refrigerator	179,525	60,555	-66.3%	22.77		
ENERGY STAR Refrigerator Most Eff	65,474	22,132	-66.2%	4.38		
ENERGY STAR Room Air Conditioner	35,588	7,582	-78.7%	42.40		
ENERGY STAR Television	16,117	13,762	-14.6%	0.20		
ENERGY STAR Television Most Efficient	2,413	2,327	-3.6%	0.05		
Smart Program Thermostats	164,260	179,303	9.2%	0.00		
Web Enabled Program Thermostats	8,600	10,077	17.2%	0.00		
Total	475,436	299,226	-37.1%	70.09	N/A	N/A

*Program Tracking Ex-Ante kWh not available; applied FY 19/20 deemed unit values

Similarly, for FY 17/18, the tracking data did not contain energy savings nor peak demand reduction. FY 19/20 deemed measure per unit savings values were assigned to the tracking data. The result was the identification of 80% of the ESP energy savings within the tracking data.

Table A-120 EPM FY 17/18 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh*	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Advanced Power Strips Tier 1	72	72	0.0%	0.01	N/A	N/A
Advanced Power Strips Tier 2	3,816	3,816	0.0%	0.56		
ENERGY STAR Lighting	13,680	1,761	-87.1%	-		
ENERGY STAR Refrigerator	169,735	69,421	-59.1%	24.27		
ENERGY STAR Refrigerator Most Efficient	92,829	34,055	-63.3%	6.21		
ENERGY STAR Room Air Conditioner	38,543	8,541	-77.8%	45.92		
ENERGY STAR Television	24,507	14,512	-40.8%	0.20		
ENERGY STAR Television Most Efficient	-	259	N/A	-		
Smart Programmable Thermostats	983,876	919,672	-6.5%	-		
Web Enabled Programmable Thermostats	31,992	39,584	23.7%	-		
Total	1,359,050	1,091,692	-19.7%	77.16	N/A	N/A

*Program Tracking Ex-Ante kWh not available; applied FY 19/20 deemed unit values

The FY 18/19 partially contained energy savings per participant but did not provide peak demand reduction. The result was that 98% of the ESP savings was identified in the tracking data.

Table A-121 EPM FY 18/19 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh*	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Advanced Power Strips Tier 1	-	120	N/A	-	N/A	N/A
Advanced Power Strips Tier 2	36,676	40,280	9.8%	5.04		
ENERGY STAR Lighting	2,350	2,484	5.7%	0.25		
ENERGY STAR Refrigerator	-	71,178	N/A	-		
ENERGY STAR Refrigerator Most Efficient	155,704	40,446	-74.0%	32.29		
ENERGY STAR Room Air Conditioner	9,441	10,371	9.9%	10.38		
ENERGY STAR Television	12,808	12,342	-3.6%	1.76		
Smart Programmable Thermostats	-	846,358	N/A	-		
Web Enabled Programmable Thermostats	31,992	35,933	12.3%	944.20		
Washer	2,091	-	N/A	0.46		
Total	1,077,516	1,059,511	-1.7%	944.38	N/A	N/A

*Program Tracking Ex-Ante kWh partially available; supplemented PY19/20 deemed unit values

The FY 19/20 tracking data did contain energy savings for all measures, resulting in 101% of the ESP energy savings identified within the tracking data as show in Table A-122.

Table A-122 EPM FY 19/20 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh*	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Advanced Power Strips Tier 2	15,688	15,688	0.0%	3.04	N/A	N/A
ENERGY STAR Lighting	2,191	2,191	0.0%	0.29		
ENERGY STAR Refrigerator	74,523	74,523	0.0%	14.44		
ENERGY STAR Refrigerator Most Efficient	33,432	33,432	0.0%	6.48		
ENERGY STAR Room Air Conditioner	11,736	11,852	1.0%	14.11		
ENERGY STAR Television	2,044	2,044	0.0%	0.40		
ENERGY STAR Television Most Efficient	1,034	1,034	0.0%	0.20		
Smart Programmable Thermostats	546,419	556,088	1.8%	657.03		
Web Enabled Programmable Thermostats	57,573	58,114	0.9%	69.23		
Total	744,640	754,966	1.4%	765.22	N/A	N/A

*Program Tracking Ex-Ante kWh not available; applied FY 19/20 deemed unit values

The Evaluator continued with the review of the Ex-Ante savings by also comparing the number of units and the incentive rebate cost for each measure by fiscal year, as the results of the energy review had high variability, ranging from 64% to 101% of the expected ESP energy savings identified in the tracking data.

The first review for units and incentive rebate cost for FY 16/17, provided improved confidence of the comparison of the two data sets with 95% of the units and 95% of the incentive cost identified in the tracking data; see Table A-123.

Table A-123 EPM FY 16/17 Ex-Ante Savings Source Comparison

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Matched	ESP Data	Program Data	% Matched
Advanced Power Strips Tier 1	4	-	0%	20	-	0%
Advanced Power Strips Tier 2	9	10	111%	135	155	115%
ENERGY STAR Lighting	756	712	94%	1,890	1,878	99%
ENERGY STAR Refrigerator	1,518	1,449	95%	98,670	94,145	95%
ENERGY STAR Refrigerator Eff	292	283	97%	21,900	21,225	97%
ENERGY STAR Room AC	265	261	98%	13,250	12,995	98%
ENERGY STAR Television	201	202	100%	2,010	2,020	100%
ENERGY STAR Television Eff	25	27	108%	625	675	108%
Smart Thermostats	955	888	93%	71,625	66,600	93%
Web Enabled Thermostats	50	48	96%	2,500	2,400	96%

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Matched	ESP Data	Program Data	% Matched
Total	4,075	3,880	95%	212,625	202,092	95%

The review of FY 17/18 identified 105% of the ESP unit quantity in the tracking data and 106% of the incentive costs. It could not be determined if there was mis-binning of the program activity based on date ordered versus the date of status update, but aggregating FY 16/17 with FY 17/18 indicated 101% of the measures were identified in the tracking data compared to the ESP report data; see Table A-124.

Table A-124 EPM FY 17/18 Ex-Ante Savings Source Comparison

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Matched	ESP Data	Program Data	% Matched
Advanced Power Strips Tier 1	3	3	100%	15	15	100%
Advanced Power Strips Tier 2	18	18	100%	270	270	100%
ENERGY STAR Lighting	855	917	107%	2,138	2,303	108%
ENERGY STAR Refrigerator	1,576	1,660	105%	102,440	107,830	105%
ENERGY STAR Refrigerator Eff	414	437	106%	31,050	32,775	106%
ENERGY STAR Room AC	287	294	102%	14,350	14,700	102%
ENERGY STAR Television	197	213	108%	1,970	2,195	111%
ENERGY STAR Television Eff	-	3	-	-	75	-
Smart Thermostats	4,412	4,580	104%	330,900	343,322	104%
Web Enabled Thermostats	186	195	105%	-	9,750	-
Total	7,948	8,320	105%	483,133	513,235	106%

The unit quantity listed in the ESP report for FY 18/19 was a value of 1 and could not be compared to the tracking data. The incentive costs were 109% of the ESP report costs; see Table A-125.

Table A-125 EPM FY 18/19 Ex-Ante Savings Source Comparison

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Matched	ESP Data	Program Data	% Matched
Advanced Power Strips Tier 1	-	5	N/A	-	25	-
Advanced Power Strips Tier 2	1	190		2,538	2,837	112%
ENERGY STAR Lighting	1	1,294		3,026	3,208	106%
ENERGY STAR Refrigerator	-	1,702		-	110,600	-
ENERGY STAR Refrigerator Eff	1	519		134,565	38,925	29%

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Matched	ESP Data	Program Data	% Matched
ENERGY STAR Room AC	1	357		16,250	17,850	110%
ENERGY STAR Television	1	182		2,010	1,990	99%
ENERGY STAR Television Eff	-	-		-	-	-
Smart Thermostats	-	4,210		-	315,629	-
Washer	1	-		40	-	0%
Web Enabled Thermostats	2	179		302,097	8,950	3%
Total	8,638	8	N/A	460,526	500,014	109%

The unit quantity for FY 19/20 was also a measure total value of 1 and could not be compared to the tracking data, but the incentive costs for all measures aligned 100% from the tracking data to ESP report data; see Table A-126.

Table A-126 EPM FY 19/20 Ex-Ante Savings Source Comparison

Measure	Quantity of Units			Incentive $		
	ESP Data	Program Data	% Matched	ESP Data	Program Data	% Matched
Advanced Power Strips Tier 2	2	74	N/A	1,110	1,110	100%
ENERGY STAR Lighting	3	1,141		2,744	2,744	100%
ENERGY STAR Refrigerator	3	1,782		115,840	115,830	100%
ENERGY STAR Refrigerator Eff	3	429		32,165	32,175	100%
ENERGY STAR Room AC	3	408		22,750	22,750	100%
ENERGY STAR Television	2	30		300	300	100%
ENERGY STAR Television Eff	2	12		300	300	100%
Smart Thermostats	3	2,780		208,268	208,268	100%
Web Enabled Thermostats	3	294		14,665	14,665	100%
Total	24	6,950	N/A	398,142	398,142	100%

A.11.1.4. M&V Methods – Algorithm Based Savings

The Evaluator used engineering-based equations to calculate energy savings and peak demand reduction for advanced power strips, ENERGY STAR refrigerators, room air conditioners, televisions, and lighting. The following sections provide calculation details for each type of equipment.

A.11.1.4.1. Advanced Power Strips Tier 1

Advanced Power Strips Tier 1 (APS Tier 1) save energy by reducing the idle peripheral load when plugged into the power strip compared to the base case of no power strip or a standard power strip. The energy and demand impacts for the APS Tier 1 were estimated using the algorithm in the Smart Power Strips DEER workpaper, published by the

Southern California Edison Company (SCE). The workpaper is based on monitored energy usage over 12 months in the baseline scenario and another three months in the efficient scenario of an APS Tier 1. The Ex-Post savings estimate referenced the table, “Home Office Electrical Energy Savings Summary” and “Home Entertainment Center Electrical Energy Savings Summary” to obtain the electrical energy savings (EES), of peripheral equipment. The Evaluator surveyed participants of the program to collect data for the type and number of peripherals used in the new power strip. The average savings of the surveyed participants were then factored by the verified number of participants and the ISR factor; see Equation A-34. The peak demand reduction was also determined by the same algorithm and the EES_kW peripheral values.

$$EES\_kWh = Average \sum_{k=0}^{n} \left(EES_{peripheral}\ x\ PER_{Survey}\right)^{n-k}\ x\ Participants_{verified}\, x\ ISR\ x\ IE \qquad \textit{Equation A-34}$$

The inputs for each surveyed home in the following table determined an average power strip savings which was factored by the number of participants and the In Service Rate.

Table A-127 EPM Advanced Power Strips Tier 1 Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
EES_kWh, EES_kW	Measure savings per program year	NA.	NA.
EES_peripheral	Savings per peripheral equipment	Table 10,11 Smart Power Strip Workpaper, SCE13CS002	0.42 to 4.2 kWh/year
PER_{survey}	Peripheral by type	Participant Survey, 2021	2 to 8 power strips
P_{ver}	Participants verified per program year	Tracking Data	0 to 5 per year
ISR	In Service Rate	Participant Survey, 2021	100%
IE	Interactive Effects Factor by climate zone	DEER Interior Lighting	1.22 to 1.30

A.11.1.4.2. Advanced Power Strips Tier 2

Advanced Power Strips Tier 2 (APS Tier 2) also reduce idle phantom power and have “Smart” capabilities that control the peripherals plugged into the power strip. The Ex-Post savings were estimated by referencing the Smart Power Strips workpaper from SCE, which reported savings based on a monitoring study conducted in California. The workpaper expressed savings as percentage of the plugged in load and provided an average energy savings per power strip. The Ex-Post reports savings based on the deemed savings value factored by the number of verified participants and the ISR; see Equation A-35.

$$kWh = 240\frac{kWh}{strip}x\ Participants_{verified}\ x\ ISR\ x\ IE \qquad \text{Equation A-35}$$

Table A-128 EPM Advanced Power Strips Tier 2 Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
EES_kWh	Energy savings per program year	Smart Power Strips, SCE17CS014	Percent of load or deemed per unit
EES_kW	Peak demand reduction per program year	Smart Power Strips, SCE17CS014	Percent of load or deemed per unit
P_{ver}	Participants verified per program year	Tracking Data	0 to 5 per year
ISR	In Service Rate	Participant Survey, 2021	100%
IE	Interactive Effects Factor by climate zone	DEER Interior Lighting	1.22 to 1.30

A.11.1.4.3. ENERGY STAR Refrigerator

The energy savings for the purchase of new ENERGY STAR refrigerators and the ENERGY STAR most efficient refrigerators were determined by the efficiency of the new unit compared to the same type with the federal standard energy use. This is the same method used by the DEER database and workpapers and is compliant with CA Title 20. The manufacturer and model number from the tracking data were cross-referenced to the ENERGY STAR online database to obtain the unit energy consumption (UEC); see Equation A-36.

$$kWh = \left(UEC_{fed\_base} - UEC_{efficient}\right)x\ ISR\ x\ Participants_{verified} \qquad \text{Equation A-36}$$

Table A-129 EPM ENERGY STAR Refrigerator Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
kWh, kW	Measure savings per program year	NA.	NA.
UEC_{fed_base}	Unit Energy Consumption – Federal and CA state baseline	US DOE Federal Refrigerator Standards, CA Title 20	Varies by freezer & refrigerator volume, defrost, door configuration, icemaker
$UEC_{efficient}$	United Energy Consumption - efficient	US DOE Federal Refrigerator Standards, CA Title 20	193 to 855 kWh
$Participants_{verified}$	Participants verified per program year	Tracking Data	2,161 to 2,996

Variable Name	Input	Source	Value Range
ISR	In Service Rate	Participant Survey, 2021	100%
IE	Interactive Effects Factor by climate zone	DEER Interior Lighting	1.22 to 1.48

A.11.1.4.4. ENERGY STAR Room Air Conditioner

The energy savings for the purchase of new ENERGY STAR room air conditioners were determined by the efficiency of the new unit compared to the same type with the federal standard energy use; see Equation A-37. This is the same method used by the DEER database and workpapers and is compliant with CA Title 20. The manufacturer and model number from the tracking were cross referenced to the ENERGY STAR online database to obtain the unit combined energy efficiency rating (CEER). The DEER workpapers listed aggregated savings, but sourced savings from the "Residential Retrofit High Impact Measure Evaluation Report (The Cadmus Group)". From this monitoring study, the Evaluator obtained the effective full load hours (EFLH) for climate zones.

$$kWh = EFLH\ x\ Capacity\ x\ \frac{\frac{1}{CEER_{base}} - \frac{1}{CEER_{eff}}}{1000}\ x\ Participant_{verified}$$

Equation A-37

Table A-130 EPM ENERGY STAR Room Air Conditioner Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
kWh, kW	Measure savings per program year	NA.	NA.
EFLH	Effective Full Load Hours	Residential Retrofit High Impact Measure Evaluation Report (The Cadmus Group, Inc.)	225 to 631 hours
Capacity	Capacity of new unit, BTUh	Tracking Data Model and ENERGY STAR Database	5,000 to 25,000
$CEER_{base}$	CEER – federal baseline	US DOE Federal Regulations	Varies by capacity, louver, reverse cycle
$CEER_{eff}$	CEER - efficient	Tracking Data Model and ENERGY STAR Database	9.7 to 14.7
$Participants_{verified}$	Participants verified	Tracking data review	
ISR	In Service Rate	Participant Survey, 2021	100%

A.11.1.4.5. ENERGY STAR Television

The energy savings for the purchase of ENERGY STAR televisions were determined by the UES of the new unit compared to the same size of a non-ENERGY STAR television. The method listed in the TV Disposition Workpaper for determination of the base case UES was built on televisions with screen sizes from 10” to >=50”. The Evaluator obtained current data from the FTC television certification database to obtain data for non-ENERGY STAR televisions. The relationship of screen size to UES was developed for ENERGY STAR 6.1, 7 and 8 for the revisions that occurred during the Retrospective Period. The energy savings for energy were determined by Equation A-38, and a similar equation for peak demand savings.

$$kWh = \left(UES_{base} - UES_{eff}\right) x\ IE\ x\ ISR\ xParticipants_{verified}$$ *Equation A-38*

Table A-131 EPM ENERGY STAR Television Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
kWh, kW	Measure savings per program year	NA.	NA.
UES_{base}	UES for baseline television	Television UES Baseline	Following table
UES_{eff}	UES for ENERGY STAR television	Model data and ENERGY STAR Database	28 to 305 kWh
$Participants_{verified}$	Participants per program year	Tracking Data	42 to 229 per year
ISR	In Service Rate	Participant Survey, 2021	100%
IE	Interactive Effects Factor by climate zone	DEER Interior Lighting	0.92 to 1.08 kWh 1.01 to 1.30 kW

Table A-132 was built with data from the FTC database that generates the Energy Guide label required on all new televisions. The minimum ENERGY STAR on-power rating is listed for the midpoint of each screen size bin along with baseline UES. The population for each UES group was the average of all non-ENERGY STAR televisions.

Table A-132 EPM Television UES Baseline

Screen Size (diag. inch)	Quantity	USE Baseline by ENERGY STAR version		
		6.1	7	8
10 to 25.5	151	46.0	45.4	45.4
25.5 to 35	157	64.1	57.2	57.2
35 to 40	65	92.3	78.4	78.4
401 to 43	168	107.9	101.7	101.7
43 to 49	105	127.4	113.6	113.6
49 to 50	260	146.8	141.6	141.6
50 to 55.5	431	162.5	155.4	155.4

Screen Size (diag. inch)	Quantity	USE Baseline by ENERGY STAR version		
		6.1	7	8
55.5 to 60	114	151.0	147.4	147.4
60 to 70	518	202.9	202.5	202.5
70 to 80	243	258.0	258.0	258.0
80 to 90	126	321.6	321.6	321.6
90 to 200	6	660.0	660.0	660.0

A.11.1.4.6. ENERGY STAR Lighting

The program offered many types of LED lamps, including general service A-lamp, reflectors, BR, PAR, and candelabra lamps. The LED market has changed significantly through the Retrospective Period. The market had been moving to a more efficient lighting baseline after the Energy Independence and Security Act of 2007 (EISA), but was accelerated with the California Appliance Regulation, Title 20. The Title 20 regulations occurred in tiers by lamp type, as outlined below.

- CA Title 20 Tier 1
    - Effective January 1, 2018
    - A-Lamp GSL,310 to 3,300 lumens: 45 LPW or greater
    - State regulated LED Lamps: 68 LPW
- CA Title 20 Tier 2
    - Effective July 1, 2019
    - State regulated LED Lamps: 80 LPW
- CA Title 20 Tier 2
    - Effective January 1, 2020
    - All GSL: 45 LPW or greater

As the mixture of existing lamps in the home moved from mostly incandescent, some compact fluorescent lamps (CFL) and no LED to less incandescent and more CFL and LED, the baseline required adjusting through the Retrospective Period. The Evaluator utilized the 2018 Screw in Lamp Disposition memo for the baseline WRR factor for directional, globe and candelabra products. The LED A-lamp baseline also changed in 2018 and follows the Approved LED A-Lamp Measure Definitions with delta watts for EISA wattage bins and lumen per watt output.

The algorithm for lighting energy savings is:

$$kWh = HOU \times (watts_{base} - watts_{efficient})/1000 \times IE \times Participants_{verified} \qquad \textit{Equation A-39}$$

Table A-133 EPM ENERGY STAR Lighting Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
kWh, kW	Measure savings per program year	NA.	NA.
UES_{base}	UES for baseline television	Television UES Baseline	Following table
UES_{eff}	UES for ENERGY STAR television	Model data and ENERGY STAR Database	28 to 305 kWh
$Participants_{verified}$	Participants per program year	Tracking Data	42 to 229 per year
ISR	In Service Rate	Participant Survey, 2021	100%
IE	Interactive Effects Factor by climate zone	DEER Interior Lighting	0.92 to 1.08 kWh 1.01 to 1.30 kW

A.11.1.5. M&V Methods- Billing Data Based Savings

The billing analysis approach for Smart and Web Enabled Programmable Thermostats largely follows the billing data retrofit isolation approach for CRP Cool Roofs documented in Section A.10.1.5.6. As with the evaluation of CRP Cool Roofs, the analysis was collapsed across all fiscal years to compensate for the increased error associated with arithmetic transformations of billing data.

Although Smart and Web Enabled Programmable Thermostats are isolated as separate strata, an insufficient number of web-enabled programmable thermostats were rebated through the program to provide enough statistical power to analyze this stratum independently. Thus, the billing analysis was performed on both the Smart Programmable Thermostats independently and Web Enabled and Smart Programmable Thermostats combined into a single stratum.

The remainder of Section A.11.1.5 details any key differences in the evaluation methodology and provides key metrics pertaining to the billing analysis.

A.11.1.5.1. Billing Data Preparation

Billing data was prepared using the method detailed in Section A.10.1.5.2. The number of participants included in the analysis are presented in Table A-134.

Table A-134 EPM Smart & Web Thermostat Participant Count

Strata	Number of Participants	Final Sample Size
Smart Programmable Thermostat	10,697	2,360
Web Enabled & Smart Programmable Thermostat	11,070	2,488

A.11.1.5.2. Weather Normalization

Participant billing data was normalized to TMY3 using the method described in Section 10.1.5.8.

A.11.1.5.3. Isolation of Weather-Dependent Load

Weather-dependent loads were isolated using the method described in Section 10.1.5.9.

A.11.1.5.4. Savings Calculations

The savings calculation method is described in Section A.10.1.5.11. Annual per household savings, 90% confidence intervals, and relative precision are presented in Table A-135.

Table A-135 EPM Smart & Web Thermostat Annual Savings per Household

Strata	Annual kWh Savings	90% Confidence Interval (Lower Bound)	90% Confidence Interval (Upper Bound)	Relative Precision (90% CL)
Smart Programmable Thermostat	299.9	215.3	384.4	28%
Web Enabled & Smart Programmable Thermostat	295.8	213.4	378.3	28%

A.11.1.5.5. Peak Demand Reduction Estimation

The peak demand reduction estimation followed the method described in Section 10.1.5.12. The ETDFs used for peak demand reduction estimation are presented in Table A-136.

Table A-136 EPM Smart & Web Thermostat ETDFs

Strata	ETDF
Smart Programmable Thermostat	0.000359
Web Enabled & Smart Programmable Thermostat	0.000359

A.11.1.6. Online Survey Data Collection

The Evaluator administered an online survey designed to verify the measures that customers implemented through EPM. The evaluator designed the survey to achieve 90% confidence and ±10% precision for the program during the Retrospective Period. The survey sample was stratified by equipment type and participants within the strata were randomly sampled to receive an email invitation.

To develop the sample frame of program projects, the Evaluator used data on program participation and matched this data to current customer records provided by LADWP. Samples were developed from participants in each year of the Retrospective Period.

The Evaluator excluded customers who opted out of email communications from the samples. For cases where a customer participated in more than one program, the customer was sampled at random to receive a survey invitation for a single program (i.e., participants were not asked to complete multiple surveys).

The Evaluator administered the survey online and contacted program participants by email to complete the survey. Participants were entered into a drawing for one of four $50 gift cards.

Table A-137 summarizes the completed surveys by measure from the deployed email invitations to 1,998 participants.

Table A-137 EPM Completed Participant Surveys

Strata	Completed Participant Surveys			
	FY 16/17	FY 17/18	FY 18/19	FY 19/20
Advanced Power Strips	0	0	4	2
ENERGY STAR Lighting	3	2	1	9
ENERGY STAR Refrigerator	20	19	41	97
ENERGY STAR Room AC	5	1	0	9
ENERGY STAR Television	3	0	2	0
Smart & Web Thermostats	4	57	50	151
Total	35	79	98	268

A.11.2. Impact Evaluation

This section presents the findings of the impact evaluation of the EPM during the Retrospective Period. Ex-post gross energy savings and peak demand reduction are presented at the measure level.

A.11.2.1. Description of Factors Affecting Gross Realized Savings

The number of verified participants affected all the measures in the estimation of the Ex-Post gross realized savings determined by TRM or workpaper based algorithms. The review of the Ex-Ante data resulted in a dataset of verified participants from which energy and demand impacts were calculated for each verified participant. The following sections list additional factors that caused variation in the gross realization rates.

A.11.2.1.1. ENERGY STAR Lighting

All types and wattages of ENERGY STAR lighting received the same Ex-Ante deemed energy savings value of 1.92 kWh/lamp.

The number of lamps in a package ranged from 1 to 10. The Ex-Ante deemed savings considered the number of products per order, but not the quantity of lamps per retail package. The Ex-Post savings estimate researched product model numbers with the letters “PK” and a forward slash in the nomenclature to develop the table below to determine the quantity of lamps per measure.

Table A-138 EPM Marketplace Lighting Lamps per Package

Tracking Data Product	Lamps per Package
EcoSmart ECS B11 CA 40WE W27 LP E12 120 3PK	3
EcoSmart ECSBR4075DL3PK	3
Feit BPA1540W950CAFIL2/RP	2
Feit BPA1960CL930CAFIL2RP	2
Feit BPCECFC/827/6	6
Feit BPCECFC/927/6	6
Feit BPCECFC/927/6(C)	6
Feit BPCFC40950CAFIL/2/RP	2
Feit BPCFT/LED	2
Feit BPETC60927CAFIL/2/RP	2
Feit BPG1660927CAFIL/2/RP	2
Feit G2560W950CAFIL3RP	3
BPG1660W950CAFIL2/RP	2
Sunco Lighting SCA19D2D6PK	6
Sunco Lighting SCBR3010PK27K	10
Sunco Lighting SCBR3010PK3K	3
Sunco Lighting SCG2510PK5K	10
Sunco Lighting SCPAR3010PK27K	10
Utilitech A19608015-27	8

The Ex-Post savings considered the changing baseline case for each fiscal year, using the wattage reduction values in the “2018 Screw-In Lamp Savings Methods Disposition” and the CPUC Approved LED A-Lamp Measure Definitions to determine the base case wattages.

The Hours of Use included both interior and exterior hours of use from the EPM Participant Survey for Decorative, Globe, and Reflector lamps, and the General Population Lighting Survey hours from the RLEP program for A-lamps.

A.11.2.1.2. Advanced Power Strips Tier 1 and Tier 2

The per unit energy savings for the APS Tier 1 of 24 kWh was similar to the Ex-Post value of 20.8 kWh. The Ex-Post savings per unit utilized the DEER workpaper with the savings by peripheral type, with the types and quantities of peripherals per home determined through the participant survey.

For the APS Tier 2, the Ex-Post savings of 259 kWh referenced from the workpaper “SCE Tier 2 Advanced Smart Power Strips” was higher than the Ex-Ante value of 212 kWh.

The ISR was 100% for both measures.

A.11.2.1.3. Smart and Web Enabled Thermostats

The population of Smart Thermostats was larger, as well as the survey sample. The Ex-Post impact analysis method using billing data, yielded a units savings value of 300 kWh and 295 kWh for the Smart and Web Enabled Thermostats respectively. The values are similar, but there is some additional uncertainty in the Web thermostat billing analysis due to the smaller population, which was aggregated with the Smart thermostat population. The Smart thermostat savings per unit value of 300 kWh consisted of only Smart thermostat participants (and non-participants).

The large variation in realization rates in FY 18/19 is attributed to the ESP database binning of the Web Enabled and Smart Thermostats, with zero ESP Ex-Ante savings for the Smart thermostat and an unusually large measure savings for the Web Enabled thermostat.

A.11.2.1.4. Washer and Home

The review by the Evaluator of the Ex-Ante tracking data did not identify any records for washers in the tracking data workbooks for this period. There was one occurrence of a washer measure in FY 18/19 in the ESP data export.

A.11.2.1.5. ENERGY STAR Television and Television Most Efficient

The workpapers for ENERGY STAR Televisions have not had recent updates, made evident by the upper bin for screen size being listed as “>=50”. The Ex-Post evaluation continued with the same screen size binning method for the baseline case by collected FTC television data and extending the baseline case table to 100” screen size. The Ex-Post savings also considered the revisions of the ENERGY STAR television thresholds starting at ENERGY STAR version 6.1 to version 7 and 8. Television screen size and the corresponding power from the FTC Energy Guide website were binned to ENERGY STAR and Non ENERGY STAR for each revision level of the federal standard; see Table A-139.

Table A-139 EPM ENERGY STAR Television Base Case Watts

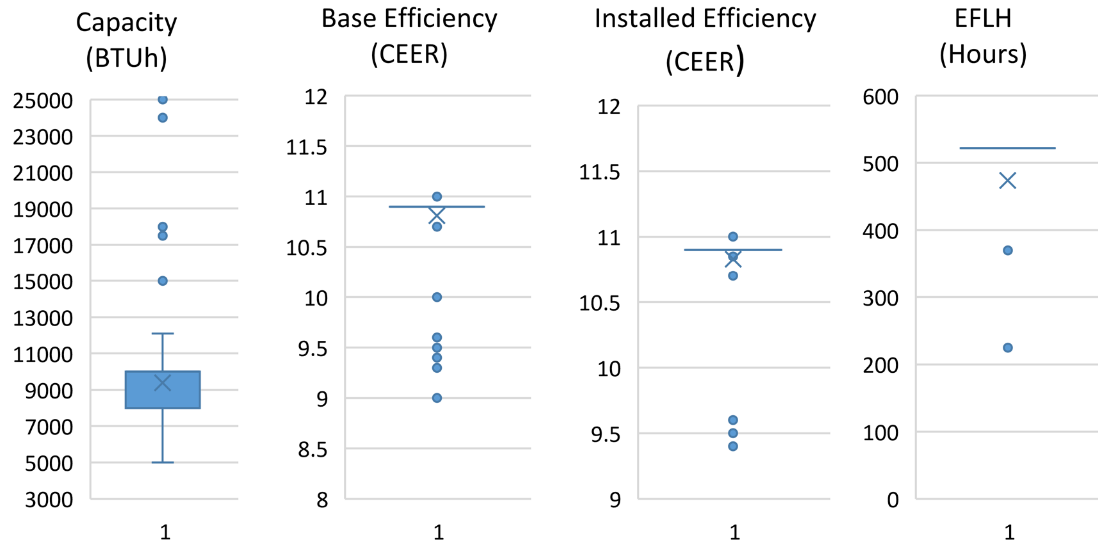
Diagonal Screen Size (in)		Bin Size Count	Base Case (watts) ENERGY STAR Version		
Min	Max		6.1	7.0	8.0
10	25.5	151	46.0	45.4	45.4
25.5	35.0	157	64.1	57.2	57.2
35	41	65	92.3	78.4	78.4
41	43	168	107.9	101.7	101.7
43	49	105	127.4	113.6	113.6

Diagonal Screen Size (in)		Bin Size Count	Base Case (watts) ENERGY STAR Version		
Min	Max		6.1	7.0	8.0
49	50	260	146.8	141.6	141.6
50	55.5	431	162.5	155.4	155.4
55.5	60	114	151.0	147.4	147.4
60	70	518	202.9	202.5	202.5
70	79	243	258.0	258.0	258.0
80	90	126	321.6	321.6	321.6
90	100	6	382.0	382.0	382.0

A.11.2.1.6. ENERGY STAR Room Air Conditioner

The Room Air Conditioner energy realization rate was 33% to 30% in FY 16/17 and FY 17/18, and 174% to 177% in FY 18/19 to FY 19/20. The Ex-Ante savings were not expressed in the tracking data for the early Retrospective fiscal years, and the quantity of units was not expressed in the ESP data in the latter Retrospective fiscal years. It appears that the deemed per unit savings value was 134 kWh for the first two years, then 29 kWh for the last two years of the Retrospective Period. The Ex-Post savings per unit method was the same for all four years, as the latest US DOE Federal Code change was in 2014 and the minor ENERGY STAR revision from 4.0 to 4.1 during this period did not change the CEER values. The Ex-Post savings varied with Capacity, Base Case CEER, Installed CEER, EFLH Hours. The box plot of the inputs in Figure A-23 indicate the variations of the inputs among the program participants. The box plot illustrates the distribution of the data, concentrating on the middle 50th percentile of the data in the blue boxes, and less emphasis on data outliers. The 50th percentile on the efficiency and EFLH figures appear as a line due to the narrow distribution of data around the average value.

Figure A-23 Room Air Conditioner Data Distribution Algorithm Inputs



A.12. ESAP

This section details the impact evaluation for the Energy Savings Assistance Program (ESAP) that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation is to calculate energy savings and peak demand impacts attributable to the Program.

A.12.1. Evaluation Methodology

This section presents the findings of the tracking data review and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program.

A.12.1.1. Tracking Data Review

LADWP provided the Evaluator with the available program tracking data for measures installed between January 4, 2016, through March 15, 2020. LADWP provided the following datasets:

- Quarterly billable amounts by measure;
- Measure-level tracking data including customer accounts, premise address, measures installed, quantity of measures installed, contractor name, measure cost, and install date; and
- Monthly measure count summaries with associated measure-level Ex-Ante kWh savings.

The Evaluator reviewed available program data and counted the total number of unique households that participated in each fiscal year. These household counts were used to extrapolate household-level regression analysis to program-level savings for each Retrospective fiscal year.

The Evaluator was not provided Ex-Ante peak kW reduction by measure and was unable to estimate program tracking data demand reduction. The Evaluator found the monthly measure count and savings summaries difficult to match with the measure-level tracking data. In many cases, the measure names in one data source did not match the measure names in another data source; therefore, measure-level counts were unable to be recreated using the available tracking data.

A.12.1.2. Ex-Ante Savings Review

The following table summarizes the discrepancy the Evaluator found comparing the reported ESP Ex-Ante kWh savings and peak kW reduction with the Ex-Ante kWh and peak kW impacts presented in the tracking data, delivered by LADWP.

Table A-140 ESAP Ex-Ante Savings Source Comparison

Fiscal Year	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
15/16	212,282	152,154	-28.3%	0.00	N/A	N/A
16/17	1,798,202	2,484,140	38.1%	0.00		
17/18	5,004,635	5,157,782	3.1%	0.00		
18/19	3,001,815	3,081,210	2.6%	295.68		
19/20	4,710,378	3,698,085	-21.5%	691.90		
Total	14,727,312	14,573,372	-1.0%	987.58	N/A	N/A

The largest discrepancy is displayed in FY 15/16. The Evaluator was provided with tracking data that displayed 72% of the reported ESP Ex-Ante kWh savings. In addition, the program tracking data did not provide estimated peak kW reduction for the measures in the program, whereas the reported ESP Ex-Ante values reported peak kW impacts for FY 18/19 and FY 19/20.

A.12.1.3. M&V Approach

Table A-141 summarizes the data sources used in the ESAP impact evaluation.

Table A-141 ESAP Data Sources

Data	Source
Program tracking data	Data requested for all data tracking program participation, rebate applications, and measure details
Recipient billing data	Monthly billing data provided by LADWP for customers that have participated in ESAP in the study periods

Data	Source
Nonparticipant billing data	Monthly billing data provided by LADWP for customers that have not participated in ESAP in the study periods
Participation in other LADWP programs	Data provided by LADWP for all residential program participation in the study periods

The database review process started with a review of tracking data to ensure that sufficient information was provided to calculate energy savings and peak demand reduction.

Field data collection was not completed for ESAP. Savings were evaluated via billing analysis for the program. In addition, no sampling plan was required for this program, as savings were evaluated via billing analysis with a census of participants.

The approach the Evaluator used to determine Ex-Post kWh savings and peak kW reduction for ESAP was based on statistical analysis of billing data. The Evaluator took the following steps during the evaluation approach:

- First, the Evaluator conducted an exploratory data analysis that made use of all provided participant billing data;
- Second, the Evaluator used regression models to make longitudinal and cross-sectional comparisons of energy consumption before and after installation of energy efficiency measures to determine how electricity use changed after a measure was installed at a household; and
- Third, the Evaluator quantified whole home savings by extrapolating regression model outputs with weather and number of participants in each study period.

Ex-Post savings were determined using the regression coefficients. Further details of the billing analysis approach are summarized in Section A.12.1.4.

A.12.1.4. Billing Analysis Approach

The billing analysis approach for ESAP follows the pooled billing data regression approach with PSM comparison group described in Section A.10.1.5.1. The remainder of Section A.12.1.4 will describe any key differences in the ESAP analysis approach and provide an overview of key regression metrics.

A.12.1.4.1. Billing Data Preparation

The billing data preparation steps follow the steps described in Section A.10.1.5.2 with the following modifications:

- Section A.10.1.5.2 describes filtering non-participants with regards to whether they had a swimming pool—this filter was not included for the ESAP analysis.

- A stricter outlier filtering for 1.645 times the standard deviation of the annual average daily kWh was adopted for FY 16/17 and FY 19/20 due to lack of sufficient PSM for these two fiscal years. Assuming a normal distribution of energy consumption, the results from these two fiscal years still reflect the average impact of program participation despite reducing the variability in the participant and non-participant pools by trimming the upper and lower 5% of participants.

The count of participants and non-participants before and after data filtering are presented in Table A-142.

Table A-142 ESAP Participant Count

Fiscal Year	Number of Participants*	Participant Pool Count	Number of Non-participants with Billing Data	Non-participant Pool Count
15/16	1,417	1,121	441,032	304,530
16/17	4,255	3,031	441,032	267,611
17/18	5,651	3,745	441,032	251,291
18/19	3,781	2,460	441,032	281,682
19/20	3,941	988	441,032	289,142

*This represents the number of customers for which the Evaluator received billing data.

A.12.1.4.2. Propensity Score Matching

The PSM method for ESAP follows the method described in Section A.10.1.5.3 without any modifications. The results of the MANOVA on the five pre-treatment variables are presented in Table A-143. As can be seen in the table, the distributions for the five pre-treatment variables did not differ for the participant and comparison groups.

Table A-143 ESAP Pre-Treatment MANOVA

Fiscal Year	Pillai's Trace	F-statistic	Num DF	Den DF	P-value
15/16	0.002	0.838	5	2,326	0.523
16/17	0.000	0.110	5	6,282	0.990
17/18	0.000	0.597	5	7,704	0.702
18/19	0.000	0.388	5	5,016	0.857
19/20	0.001	0.693	5	4,860	0.629

The T-tests for the 12-month pre-treatment period after matching treatment and comparison group treatment start dates are presented in Figure A-24 through Figure A-28. As can be seen in the tables, no fiscal year exceeded the tolerance band established for pre-treatment equivalence.

Figure A-24 ESAP Pre-Treatment Equivalency (FY 15/16)

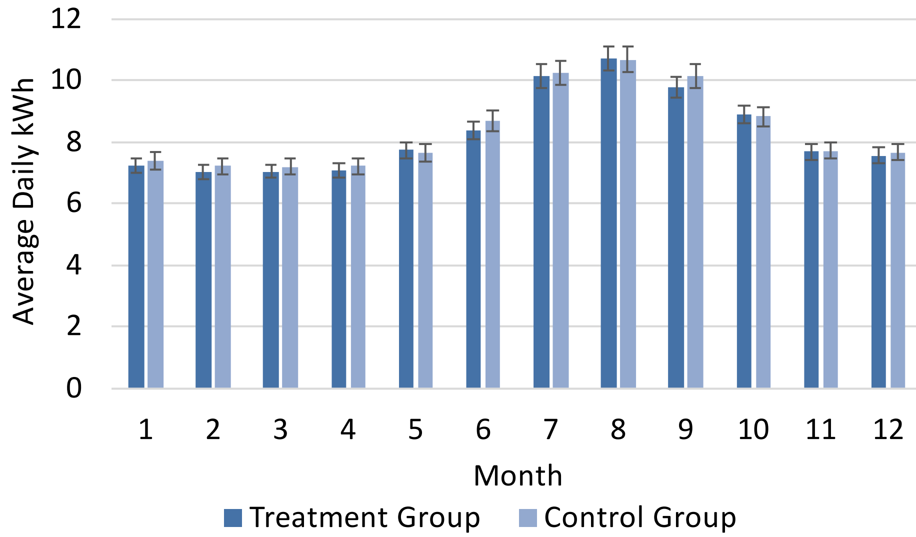


Figure A-25 ESAP Pre-Treatment Equivalency (FY 16/17)

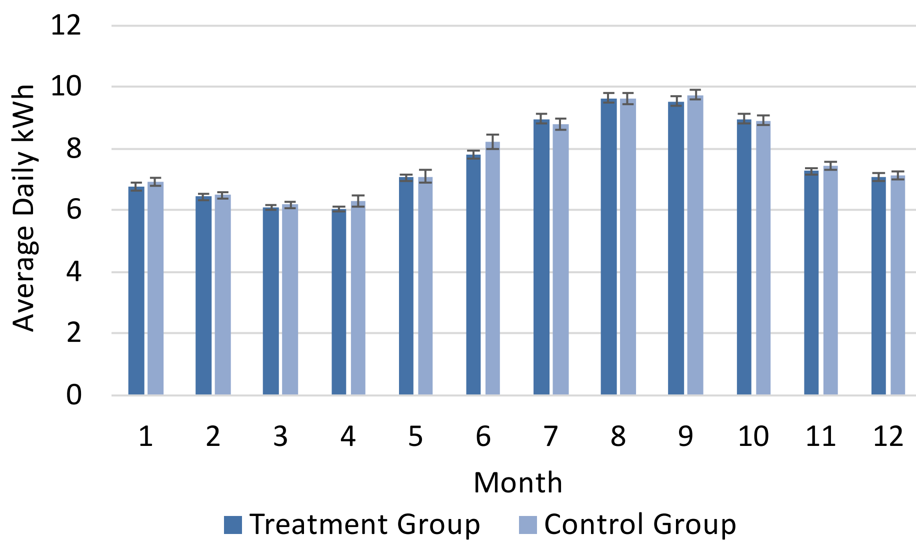


Figure A-26 ESAP Pre-Treatment Equivalency (FY 17/18)

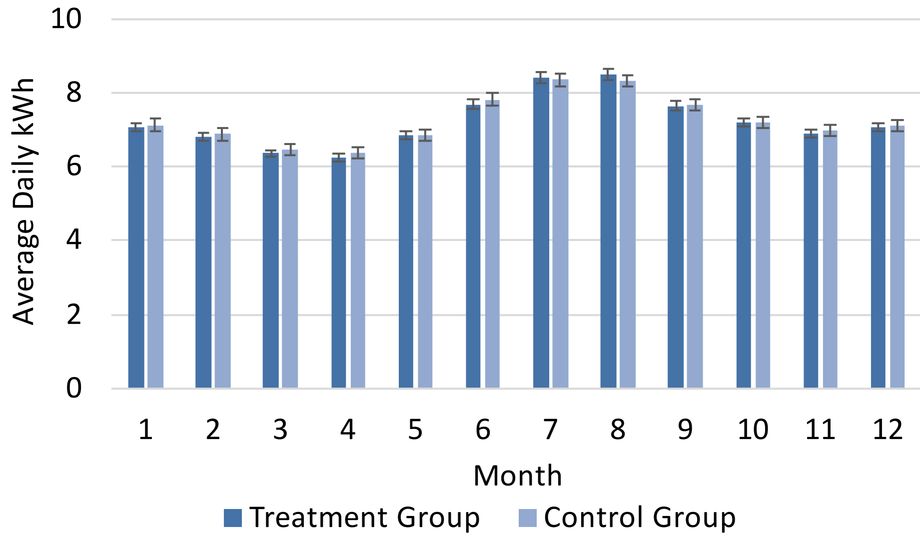


Figure A-27 ESAP Pre-Treatment Equivalency (FY 18/19)

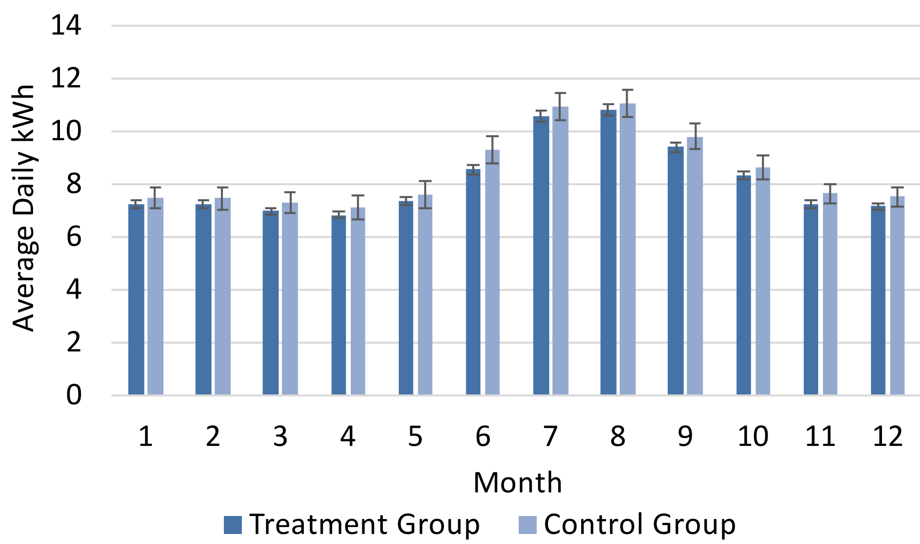


Figure A-28 ESAP Pre-Treatment Equivalency (FY 19/20)

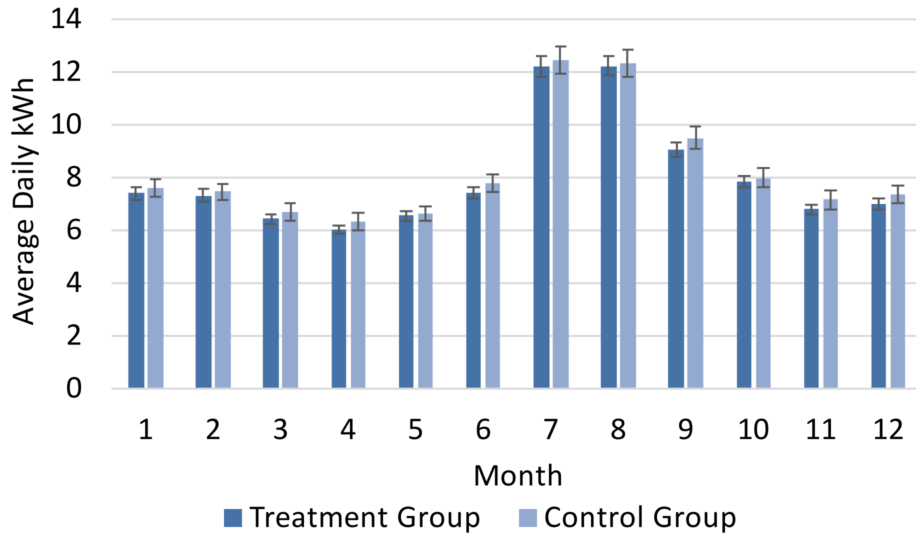


Table A-144 ESAP Pre-Treatment T-Test (FY 15/16)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	7.245	7.388	0.779	0.436
2	7.036	7.209	0.984	0.325
3	7.046	7.194	0.874	0.382
4	7.083	7.206	0.700	0.484
5	7.734	7.668	-0.338	0.736
6	8.378	8.667	1.290	0.197
7	10.136	10.249	0.409	0.683
8	10.704	10.663	-0.141	0.888
9	9.752	10.141	1.527	0.127
10	8.897	8.825	-0.333	0.739
11	7.673	7.712	0.205	0.838
12	7.550	7.659	0.569	0.570

Table A-145 ESAP Pre-Treatment T-Test (FY 16/17)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	6.761	6.895	1.570	0.116
2	6.434	6.487	0.687	0.492
3	6.075	6.173	1.356	0.175
4	6.033	6.300	2.667	0.008
5	7.052	7.091	0.320	0.749
6	7.814	8.229	3.140	0.002
7	8.961	8.795	-1.438	0.150
8	9.639	9.604	-0.274	0.784
9	9.525	9.741	1.808	0.071
10	8.958	8.909	-0.447	0.655
11	7.263	7.418	1.783	0.075
12	7.081	7.135	0.597	0.550

Table A-146 ESAP Pre-Treatment T-Test (FY 17/18)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	7.070	7.124	0.529	0.596
2	6.784	6.869	0.868	0.386
3	6.356	6.455	1.110	0.267
4	6.243	6.368	1.426	0.154
5	6.848	6.849	0.014	0.989
6	7.685	7.806	1.094	0.274
7	8.389	8.343	-0.411	0.681
8	8.472	8.306	-1.480	0.139
9	7.642	7.651	0.090	0.928
10	7.205	7.188	-0.180	0.857
11	6.891	6.955	0.680	0.496
12	7.059	7.107	0.480	0.631

Table A-147 ESAP Pre-Treatment T-Test (FY 18/19)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	7.203	7.455	1.177	0.239
2	7.232	7.438	0.955	0.340
3	6.955	7.286	1.506	0.132
4	6.813	7.104	1.268	0.205
5	7.319	7.579	0.975	0.329
6	8.550	9.257	2.515	0.012
7	10.570	10.917	1.188	0.235
8	10.791	11.041	0.862	0.389
9	9.383	9.792	1.551	0.121
10	8.319	8.606	1.195	0.232
11	7.238	7.629	1.929	0.054
12	7.143	7.505	1.757	0.079

Table A-148 ESAP Pre-Treatment T-Test (FY 19/20)

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	7.385	7.588	0.959	0.338
2	7.301	7.438	0.663	0.508
3	6.417	6.684	1.403	0.161
4	6.025	6.312	1.556	0.120
5	6.538	6.629	0.536	0.592
6	7.404	7.776	1.873	0.061
7	12.200	12.436	0.730	0.465
8	12.209	12.278	0.212	0.833
9	9.031	9.487	1.807	0.071
10	7.820	7.977	0.734	0.463
11	6.794	7.136	1.723	0.085
12	6.996	7.339	1.637	0.102

The final size of the participant and comparison groups are presented in Table A-149.

Table A-149 ESAP Final Sample Size

Fiscal Year	Participant Group Size	Non-participant Group Size
15/16	1,121	1,121
16/17	3,031	3,031
17/18	3,745	3,745
18/19	2,460	2,460
19/20	988	988

A.12.1.4.3. Degree Day Optimization

The method for optimizing CDD and HDD bases follows the method described in Section A.10.1.5.4.

A.12.1.4.4. Regression Model

The regression method for ESAP follows the regression method described in Section A.10.1.5.5. The regression coefficients of interest and regression model fits are presented in Table A-150 through Table A-154.

Table A-150 ESAP Regression Coefficients (FY 15/16)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-0.724	0.196	-3.697	0.000	0.500
Treatment x HDD	-0.001	0.034	-0.043	0.966	0.500
Treatment x CDD	-0.015	0.041	-0.371	0.711	0.500

Table A-151 ESAP Regression Coefficients (FY 16/17)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-0.540	0.117	-4.613	0.000	0.516
Treatment x HDD	-0.035	0.018	-1.917	0.055	0.516
Treatment x CDD	0.032	0.019	1.721	0.085	0.516

Table A-152 ESAP Regression Coefficients (FY 17/18)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-0.516	0.139	-3.700	0.000	0.355
Treatment x HDD	-0.010	0.023	-0.440	0.660	0.355
Treatment x CDD	-0.003	0.012	-0.223	0.823	0.355

Table A-153 ESAP Regression Coefficients (FY 18/19)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-0.430	0.102	-4.232	0.000	0.824
Treatment x HDD	0.002	0.018	0.115	0.909	0.824
Treatment x CDD	0.021	0.020	1.052	0.293	0.824

Table A-154 ESAP Regression Coefficients (FY 19/20)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-0.828	0.193	-4.296	0.000	0.621
Treatment x HDD	0.065	0.034	1.921	0.055	0.621
Treatment x CDD	0.079	0.033	2.402	0.016	0.621

The average daily HDD and CDD using TMY3 weighted by participant are presented in Table A-155.

Table A-155 ESAP Weighted Average TMY3 HDD and CDD

Fiscal Year	Average Daily HDD	Average Daily CDD
15/16	2.579	1.786
16/17	2.900	1.590
17/18	2.833	1.574
18/19	2.340	1.564
19/20	2.414	1.938

The annual savings per household, 90% confidence intervals, and relative precision are presented in Table A-156.

Table A-156 ESAP Weighted Average Savings per Household

Fiscal Year	Annual kWh Savings	90% Confidence Interval (Lower Bound)	90% Confidence Interval (Upper Bound)	Relative Precision (90% CL)
15/16	275.859	197.136	354.583	29%
16/17	215.796	170.044	261.549	21%
17/18	200.618	146.651	254.584	27%
18/19	143.240	103.520	182.961	28%
19/20	189.544	113.680	265.409	40%

A.12.1.4.5. Peak Demand Reduction Estimation

The peak demand reduction estimation followed the method described in Section A.10.1.5.12. The ETDF for ESAP is presented in Table A-157.

Table A-157 ESAP ETDF for Billing Analysis

Strata	ETDF
Whole House	0.000196

A.12.2. Impact Evaluation

The Evaluator estimated verified energy and demand impacts from ESAP for each fiscal year in the Retrospective Period using the billing analysis methodology presented in Section A.12.1.4.

A.13. HEIP

This section details the impact evaluation for the Home Energy Improvement Program (HEIP) that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation was to calculate energy savings and peak demand impacts attributable to the Program.

A.13.1. Evaluation Methodology

This section presents the findings of the tracking data review and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program.

A.13.1.1. Tracking Data Review

LADWP provided the Evaluator with the available program tracking data for measures installed between January 4, 2016, through March 15, 2020. LADWP provided the following datasets:

- Quarterly billable amounts by measure;
- Measure-level tracking data including customer accounts, premise address, measures installed, quantity of measures installed, contractor name, measure cost, and install date; and
- Monthly measure count summaries with associated measure-level Ex-Ante kWh savings.

The Evaluator reviewed available program data and counted the total number of unique households that participated in each fiscal year. These household counts were used to extrapolate household-level regression analysis to program-level savings for each Retrospective fiscal year.

The Evaluator was not provided Ex-Ante peak kW reduction by measure and was unable to estimate program tracking data peak demand reduction. The Evaluator found the monthly measure count and savings summaries difficult to match with the measure-level tracking data. In many cases, the measure names in one data source did not match the measure names in another data source; therefore, measure-level counts were unable to be recreated using the available tracking data.

A.13.1.2. Ex-Ante Savings Review

The tables below outline the kWh savings and peak kW reduction by measure for HEIP in each FY, comparing the savings found in the ESP with those found in the tracking data.

Table A-158 HEIP FY 15/16 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante kW	Program Data Ex-Ante kW	Ex-Ante Peak kW Percent Change
Window AC	174,407	187,610	7.6%	264.10	282.19	6.8%
LED	5,300	5,702	7.6%	3.65	3.91	7.1%
CFL	4,449,921	4,786,795	7.6%	3,068.34	3,278.50	6.8%
Pipe Wrap	12,576	13,528	7.6%	3.33	3.56	6.9%
Toilet	66,467	71,499	7.6%	0.00	0.00	N/A
Showerhead	106,740	114,821	7.6%	21.79	23.28	6.8%
Aerator	22,765	24,488	7.6%	4.65	4.96	6.7%
Attic Insulation	99,444	106,973	7.6%	51.77	55.32	6.9%
Duct Sealing	11,477	12,346	7.6%	21.94	23.44	6.8%
Air Sealing	429,496	462,010	7.6%	886.43	947.15	6.8%
Toilet Gasket	19,327	20,790	7.6%	36.06	38.85	7.7%
Total	5,397,920	5,806,561	7.6%	4,362.06	4,661.16	6.9%

Table A-159 HEIP FY 16/17 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante kW	Program Data Ex-Ante kW	Ex-Ante Peak kW Percent Change
Window AC	137,411	144,905	5.5%	205.39	217.95	6.1%
LED	3,090,541	3,259,101	5.5%	2,103.57	2,232.19	6.1%
CFL	2,317,483	2,443,881	5.5%	1,577.40	1,673.85	6.1%
Pipe Wrap	6,270	6,612	5.5%	1.64	1.74	6.1%
Toilet	61,477	64,830	5.5%	0.00	0.00	N/A
Showerhead	99,626	105,060	5.5%	20.07	21.30	6.1%
Aerator	20,414	21,528	5.5%	4.11	4.36	6.1%
Attic Insulation	11,944	12,595	5.5%	6.27	6.65	6.1%

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante kW	Program Data Ex-Ante kW	Ex-Ante Peak kW Percent Change
Duct Sealing	6,640	7,002	5.5%	12.45	13.22	6.2%
Air Sealing	421,418	444,402	5.5%	832.24	883.13	6.1%
Toilet Gasket	14,457	15,246	5.5%	26.85	28.49	6.1%
Total	6,187,681	6,525,162	5.5%	4,790.00	5,082.88	6.1%

Table A-160 HEIP FY 17/18 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante kW	Program Data Ex-Ante kW	Ex-Ante Peak kW Percent Change
Window AC	142,205	143,445	0.9%	212.65	215.76	1.5%
LED	4,512,352	4,551,689	0.9%	3,072.59	3,117.47	1.5%
CFL	207,921	209,734	0.9%	141.58	143.65	1.5%
Pipe Wrap	3,014	3,040	0.9%	0.79	0.80	1.3%
Toilet	57,820	58,324	0.9%	0.00	0.00	N/A
Showerhead	89,537	90,318	0.9%	18.05	18.31	1.4%
Aerator	15,007	15,138	0.9%	3.02	3.07	1.7%
Attic Insulation	137,399	138,597	0.9%	71.41	72.45	1.5%
Duct Sealing	9,470	9,553	0.9%	17.46	17.71	1.4%
Air Sealing	347,663	350,694	0.9%	708.76	719.11	1.5%
Toilet Gasket	10,600	10,692	0.9%	19.69	19.98	1.5%
Total	5,532,990	5,581,224	0.9%	4,266.00	4,328.31	1.5%

Table A-161 HEIP FY 18/19 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante kW	Program Data Ex-Ante kW	Ex-Ante Peak kW Percent Change
Window AC	128,845	128,845	0.0%	172.84	193.80	12.1%
LED	3,690,943	3,691,174	0.0%	388.87	2,528.04	550.1%
CFL	396,470	396,490	0.0%	41.78	271.56	550.0%
Pipe Wrap	2,508	2,508	0.0%	0.19	0.66	247.4%
Toilet	74,130	73,912	-0.3%	17.83	0.00	-100.0%
Showerhead	86,355	85,914	-0.5%	20.77	17.42	-16.1%
Aerator	11,758	11,487	-2.3%	2.83	2.33	-17.7%
Attic Insulation	138,693	138,712	0.0%	186.05	71.39	-61.6%
Duct Sealing	8,054	8,056	0.0%	10.79	13.68	26.8%
Air Sealing	432,476	432,476	0.0%	567.88	845.44	48.9%
Toilet Gasket	5,148	5,148	0.0%	6.91	9.62	39.2%

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante kW	Program Data Ex-Ante kW	Ex-Ante Peak kW Percent Change
Total	4,975,380	4,974,722	0.0%	1,416.74	3,953.93	179.1%

Table A-162 HEIP FY 19/20 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante kW	Program Data Ex-Ante kW	Ex-Ante Peak kW Percent Change
Window AC	56,210	56,210	0.0%	67.59	84.55	25.1%
LED	1,966,988	1,967,073	0.0%	261.66	1,347.25	414.9%
CFL	11,804	11,804	0.0%	1.57	8.09	415.3%
Pipe Wrap	2,660	2,660	0.0%	0.28	0.70	150.0%
Toilet	38,951	38,837	-0.3%	8.86	0.00	-100.0%
Showerhead	48,844	48,599	-0.5%	11.11	9.85	-11.3%
Aerator	5,447	5,313	-2.5%	1.24	1.08	-12.9%
Attic Insulation	73,272	73,291	0.0%	88.10	38.28	-56.5%
Duct Sealing	3,549	3,552	0.1%	4.27	7.17	67.9%
Air Sealing	238,306	238,398	0.0%	279.10	471.37	68.9%
Toilet Gasket	198	198	0.0%	0.24	0.37	54.2%
Total	2,446,230	2,445,935	0.0%	724.01	1,968.71	171.9%

A.13.1.3. M&V Approach

For the Retrospective impact evaluation, the Evaluator performed the following data collection activities:

Table A-163 HEIP Data Sources for Impact Evaluation

Data	Source
Program Tracking Data	Data requested to LADWP for all data tracking program participation and rebate applications
Program Participant Surveys	Survey administered to a sample of customers who participated in the rebate program
Recipient and control group billing data	Data requested to LADWP for all relevant billing data in the study period
Participation in other LADWP programs	Data requested to LADWP for all residential program participation in the study period
Recipient and control group customer data	Data requested to LADWP for other customer information (e.g., demographics, etc.)

The database review process started with a review of tracking data to ensure that sufficient information was provided to calculate energy and peak demand impacts.

Field data collection was not completed for HEIP. Savings were evaluated for the program via billing analysis and engineering calculations. In addition, no sampling plan was required for this program, as savings were evaluated via billing analysis with a census of participants and desk reviews were performed on a census of projects.

The approach the Evaluator used to determine Ex-Post kWh savings and peak kW reduction for HEIP was based on statistical analysis of billing data for weather sensitive measures and desk reviews for lighting and water saving measures. The weather sensitive measures were window AC, pipe wrap, attic insulation, duct sealing and air sealing. The lighting and water savings measures were toilet, toilet gasket, aerator, and showerhead.

For the weather sensitive measures, the Evaluator took the following steps during the evaluation approach:

- First, the Evaluator conducted an exploratory data analysis that made use of all provided participant billing data.
- Second, the Evaluator used regression models to make longitudinal and cross-sectional comparisons of energy consumption before and after installation of energy efficiency measures to determine how electricity use changed after a measure was installed at a household.
- Third, the Evaluator quantified whole home savings by extrapolating regression model outputs with weather and number of participants in each study period.

Ex-Post savings were determined using the regression coefficients. Additional details of the billing analysis approach are summarized in Section A.13.1.4.

A.13.1.3.1. ENERGY STAR Lighting

Verified energy savings for lighting measures (LEDs and CFLs) were calculated using lighting savings equations found in DEER Workpapers (Equation A-40 and Equation A-41). The savings equations were employed to estimate savings for each rebated lighting measure. The results were then adjusted by the measure ISR for the appropriate fiscal year and summed to provide measure-level savings for the program.

$$kWh = Qty_{ver} x\ HOU\ x\left(Watts_{base} - Watts_{efficient}\right) x \frac{IE_{kWh}}{1000\,\frac{Watt}{kW}} x\ ISR$$ *Equation A-40*

$$kW = Qty_{ver} x\ \left(Watts_{base} - Watts_{efficient}\right) x\ \frac{IE_{kW}}{1000\,\frac{Watt}{kW}}\ x\ CDF x\ \ ISR$$ *Equation A-41*

Table A-164 HEIP LED and CFL Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
kWh	Measure savings per program year		
Annual Hours of Operation	Annual Hours of Operation	DEER Workpapers	541
Interactive Effects (kWh)	Energy Interactive Effects (LED), Energy Interactive Effects (CFL)	DEER Workpapers	1.02 to 1.1504
WRR	Wattage Reduction Ratio	DEER Workpapers	2.96
ΔWatts/lamp	Demand Difference (watts per lamp) = (W x WRR) - W	DEER Workpapers	117.6 to 294
Peak Coincidence Factor	Peak Coincidence Factor	DEER Workpapers	1.2671
Interactive Effects (kW)	Energy Interactive Effects (LED), Energy Interactive Effects (CFL)	DEER Workpaper	0.12 to 0.15
ISR	In Service Rate	Participant Survey, 2021	72%-99%

A.13.1.3.2. Low Flow Showerhead and Faucet Aerator

Verified energy savings for showerhead and aerator measures were calculated by multiplying climate zone 9 unit-level deemed savings in the DEER Workpapers by the quantity of measures in the tracking database for that household. The results were then adjusted by the measure ISR for the appropriate fiscal year and summed to provide measure-level savings for the program.

Table A-165 HEIP Aerator and Showerhead Deemed Savings by Weather Zone

Climate Zone	Faucet Aerators (1.0 GPM)		Low Flow Showerheads (1.5 GPM)	
	kWh	kW	kWh	kW
1	37.25	0.00374	132.36	0.0133
2	37.07	0.00372	131.73	0.01323
3	36.26	0.00364	128.88	0.01295
4	35.02	0.00352	124.44	0.0125
5	36	0.00362	127.93	0.01285
6	34.13	0.00343	121.28	0.01218
7	33.32	0.00335	118.43	0.0119
8	32.34	0.00325	114.94	0.01155
9	32.97	0.00331	117.16	0.01177
10	32.61	0.00328	115.89	0.01164
11	33.86	0.00347	120.33	0.01209

Climate Zone	Faucet Aerators (1.0 GPM)		Low Flow Showerheads (1.5 GPM)	
	kWh	kW	kWh	kW
12	34.93	0.00351	124.13	0.01247
13	32.7	0.00329	116.21	0.01167
14	34.57	0.00347	122.86	0.01234
15	27.44	0.00276	97.53	0.0098
16	38.76	0.00389	137.74	0.01384

A.13.1.3.3. Water Efficient Toilet

Verified energy savings for the toilet measures were calculated using multiple sources of data. First, verified water savings for this measure was determined using the kWh savings per gallon value from the California Public Utilities Commission (CPUC) Water/Energy Nexus calculator[3], using inputs from the United States Environmental Protection Agency (US EPA) WaterSense calculator[4]. The verified water savings in gallons were then multiplied by the kWh savings per gallon value determined by the Water/Energy Nexus calculator to calculate verified energy savings for the measure. These results were summed to provide measure-level savings for the program. There were no ISRs gathered for the toilet measure during this evaluation and therefore the savings resulting from these calculations were not adjusted further.

kWh= (Water Savings for 0.8 GPF Toilet) x (kWh Savings Per Gallon)

kW= (kWh/8,760)

$$kWh = Water\ Saved\ per\ Toilet\ x\ kWh\ Savings\ per\ Gallon\ x\ ISR$$ *Equation A-42*

$$kW = \frac{kWh}{8{,}760}\ x\ ISR$$ *Equation A-43*

[3] https://www.cpuc.ca.gov/nexus_calculator/

[4] https://www.epa.gov/watersense/watersense-calculator

Table A-166 HEIP CPUC Water Energy Nexus Calculator kWh Savings per Acre Foot

Region	Extraction and conveyance	Treatment	Distribution	Wastewater collection and treatment	Outdoor (upstream of customer)	Indoor (all components) kWh/AF	Gallons per AF	kWh per Gallon (kWh/AF)/ (Gallons per AF)
SC	0	490	470	1245	961	2206	326,000	0.006766871

Table A-167 HEIP US EPA WaterSense Calculator Toilet Water Savings

Toilet Water Savings	
Average flushes per day	5.05
GPF pre 1980 toilet	5
GPF 1980-1994 toilet	3.5
Average GPF of pre 1994 toilet	4.25
Annual gallons used pre 1994 toilet	7,834
Annual gallons used 0.8 GPF toilet	1,475
Annual Water Savings (Gallons) of 0.8 GPF Toilet (Avg Gal pre 1994 toilet – Gal used 0.8 GPF toilet)	6,359

A.13.1.4. Billing Analysis Approach

A billing analysis approach was used for strata deemed inappropriate for savings calculation via desk review. These strata include Air Sealing, Attic Insulation, and Duct Sealing. However, due to the nature of the program, most participants installed multiple measure types as part of their program participation. Given that the billing analysis approach relies on whole house billing data, the impacts of other measures could not be isolated or removed from the impact estimated via billing analysis, nor could the impacts of the three measures be isolated from one another. Additionally, almost all participants in the program also participated in other energy efficiency programs. Thus, a comparison between participants and non-participants or a simple pre/post comparison were not appropriate for this analysis.

Thus, a hybrid approach was used for this analysis in which weather-dependent loads were isolated from whole house load and compared to the weather-dependent loads from a comparison group using a regression framework. Thus, Air Sealing, Attic Insulation, Duct Sealing, Pipe Wrapping, and Window Air Conditioners were evaluated via this billing analysis as a single stratum— “Weather-Sensitive Measures.”

The participant sample was drawn from HEIP participants who also installed one specific measure from another program only without participating in any other programs other than HEIP and that specified program. The non-participant sample was drawn from program participants who installed that measure only without participating in any other programs. Based on the size and nature of cross-program participation, the Evaluator determined that HEIP participants who cross-participated by installing the CRP Pool Pump and Motor stratum were the best candidates for this analysis. By retaining the participant and comparison group regression framework for this analysis, the impacts associated with the installation of the pool pump and motor were thus subtracted out from the savings.

Additionally, due to the increase in variability associated with arithmetic transformations of billing data, all five fiscal years in the Retrospective Period were analyzed together.

The remainder of Section A.13.1.4 describes the HEIP Weather-Sensitive Measures billing data analysis method.

A.13.1.4.1. Billing Data Preparation

The billing data preparation largely follows the method described in Section A.10.1.5.2 with the following modifications:

- Due to a lack of participants who only installed a single measure without participating in other programs, the participant group was filtered for HEIP participants who only installed one other measure via one other program—CRP Pool Pump and Motor. Although cross participation with ACOP was another candidate program from which to derive a participant group, the Evaluator opted not to use these participants due to the increased variability associated with participating in two weatherization-based programs.
- Rather than draw a comparison group from a pool of non-participants, the comparison group was drawn from CRP Pool Pump and Motor participants who only installed a single CRP Pool Pump and Motor measure throughout the Retrospective Period.
- The post-period data was defined as the 12-month period after all measures were installed rather than solely the measure of interest.

Table A-168 presents the total number of customers in the participant and comparison pools prior to PSM.

Table A-168 HEIP Weather-Sensitive Measures Participant Count

Number of Participants	Participant Pool Count	Number of CRP Pool Pump Participants	Comparison Pool Count
198	151	18,418	16,771

A.13.1.4.2. Propensity Score Matching (PSM)

The PSM follows the method described in Section A.10.1.5.3 with the following modification:

- The pre-treatment period for matching consisted of the 12-month pre-treatment period before the earliest measure was installed for both the participant and comparison group.
- A pseudo-treatment start date was not assigned for the comparison group based on the participant-to-comparison group matching. Rather, the post-period was always defined as the 12-month period after the most recent measure was installed for both groups.
- A one-to-five treatment-to-control group match was used due to providing adequate pre-treatment equivalence rather than lowering the match to a one-to-one ratio.

Table A-169 and Figure A-29 provide metrics of pre-treatment equivalence post-PSM, with the MANOVA representing the pre-treatment equivalence of the five pre-treatment variables used for PSM and the T-test representing the pre-treatment equivalence of each individual month of the pre-treatment period. Both metrics suggest good matching of the participant and comparison groups.

Table A-169 HEIP Weather-Sensitive Measures Pre-Treatment MANOVA

Pillai's Trace	F-statistic	Num DF	Den DF	P-value
0.004	0.088	5	1,098	0.994

Figure A-29 HEIP Weather-Sensitive Measures Pre-Treatment Equivalency

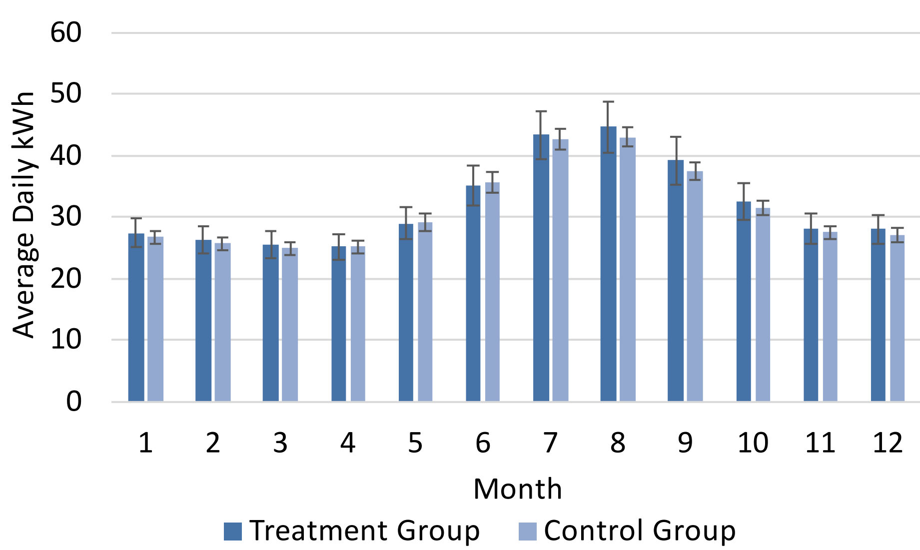


Table A-170 HEIP Weather-Sensitive Measures Pre-Treatment T-Test

Month	Participant Group (Average Daily kWh)	Non-Participant Group (Average Daily kWh)	T-value	P-value
1	27.401	26.679	-0.530	0.597
2	26.195	25.714	-0.381	0.704
3	25.544	24.873	-0.551	0.582
4	25.154	25.153	-0.001	0.999
5	28.931	29.127	0.133	0.895
6	35.081	35.608	0.287	0.774
7	43.295	42.577	-0.339	0.735
8	44.613	42.998	-0.720	0.472
9	39.205	37.481	-0.809	0.420
10	32.492	31.505	-0.607	0.545
11	28.126	27.509	-0.459	0.647
12	28.069	26.981	-0.807	0.421

Table A-171 presents the total number of customers in the participant and comparison groups after performing the PSM.

Table A-171 HEIP Weather-Sensitive Measures Final Sample Size

Participant Group Size	Comparison Group Size
151	755

A.13.1.4.3. Weather Normalization

After performing the PSM, participant and comparison group billing data was normalized to TMY3 using the method described in Section A.10.1.5.8.

A.13.1.4.4. Isolation of Weather-Dependent Loads

Weather-dependent loads for both the participant and comparison group were normalized to TMY3 using the method described in Section A.10.1.5.9.

A.13.1.4.5. Regression Model

The regression modeling largely follows the method described in Section A.10.1.5.5 with the following modifications:

- Rather than regress un-normalized whole house data, the independent variable was the TMY3 normalized weather-dependent load.
- The pre-treatment variables used to control the regression were calculated using the pre-treatment TMY3 normalized weather-dependent load rather than using un-normalized whole house data.

- The CDD and HDD terms were dropped from the regression model as the data had already been weather-normalized, leaving only a coefficient for the treatment effect that could be multiplied by 365.25 days.

Table A-172 presents the regression coefficient of interest and the model fit while Table A-173 presents the annual savings per household, 90% confidence interval, and relative precision.

Table A-172 HEIP Weather-Sensitive Measures Regression Coefficients

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Treatment	-1.086	0.548	-1.980	0.048	0.280

Table A-173 HEIP Weather-Sensitive Measures Annual Savings per Household

Annual kWh Savings	90% Confidence Interval (Lower Bound)	90% Confidence Interval (Upper Bound)	Relative Precision (90% CL)
396.501	67.026	725.976	83%

A.13.1.4.6. Peak Demand Reduction Estimation

The peak demand reduction estimation follows the method presented in Section A.10.1.5.12. Table A-174 presents the ETDF used for HEIP Weather-Sensitive Measures.

Table A-174 HEIP Weather-Sensitive Measures ETDF

Strata	ETDF
HEIP Weather-Sensitive Measures	0.000508

A.13.1.5. Online Survey Data Collection

The Evaluator administered an online survey designed to verify the measures that customers implemented through HEIP. The evaluator designed the survey to achieve 90% confidence and ±10% precision for the program during Retrospective Period. The survey sample was stratified by equipment type, and participants within the strata were randomly sampled to receive an email invitation.

To develop the sample frame of program projects, the Evaluator used data on program participation and matched this data to current customer records provided by LADWP. Samples were developed from participants in each year of the Retrospective Period.

The Evaluator excluded customers who opted out of email communications from the samples. For cases where a customer participated in more than one program, the customer was sampled at random to receive a survey invitation for a single program (i.e., participants were not asked to complete multiple surveys).

The Evaluator administered the survey online and contacted program participants by email to complete the survey. Participants were entered into a drawing for one of four $50 gift cards.

Table A-175 summarizes the planned and achieved sample size.

Table A-175 HEIP Summary of Participant Survey Data Collection

Planned Sample Size	Number of Customers Contacted	Achieved Sample Size	Sample Type
110	2,509	320	Stratified Random Sample

A.13.2. Impact Evaluation

This section presents the findings of the impact evaluation of the HEIP during the Retrospective Period. Ex-Post gross energy savings and peak demand reduction are presented at the measure level.

A.13.2.1. Description of Factors Affecting Gross Realized Savings

Figure A-30 through Figure A-34 display the factors affecting gross realized savings for HEIP in each fiscal year of the Retrospective Period. The factors are separated into three categories:

- Inappropriate Deemed Savings Correction;
- M&V; and
- In-Service Rate.

Figure A-30 FY 15/16 Ex-Post kWh Impact Factors

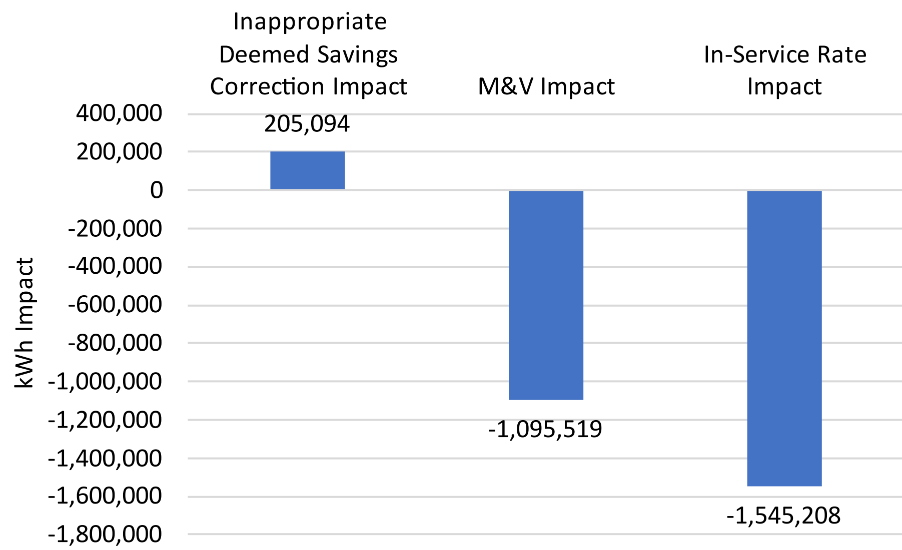


Figure A-31 FY 16/17 Ex-Post kWh Impact Factors

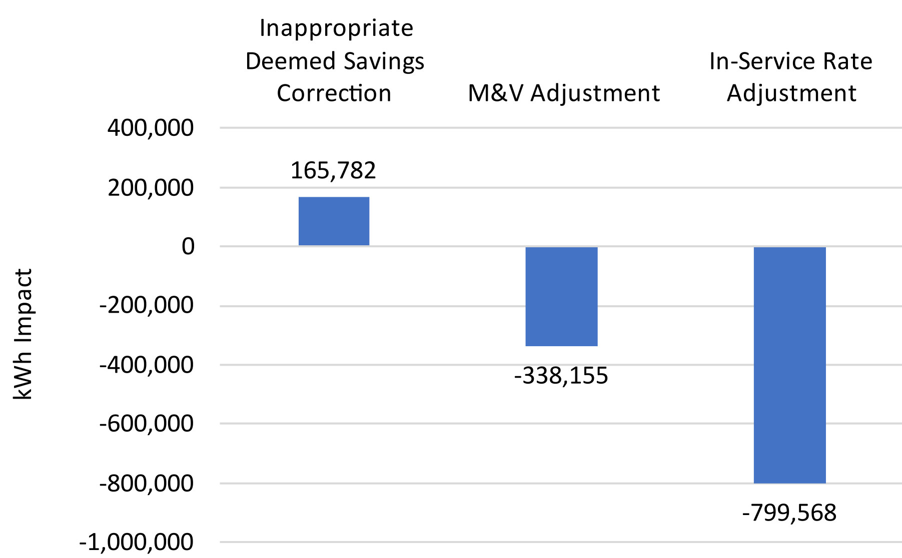


Figure A-32 FY 17/18 Ex-Post kWh Impact Factors

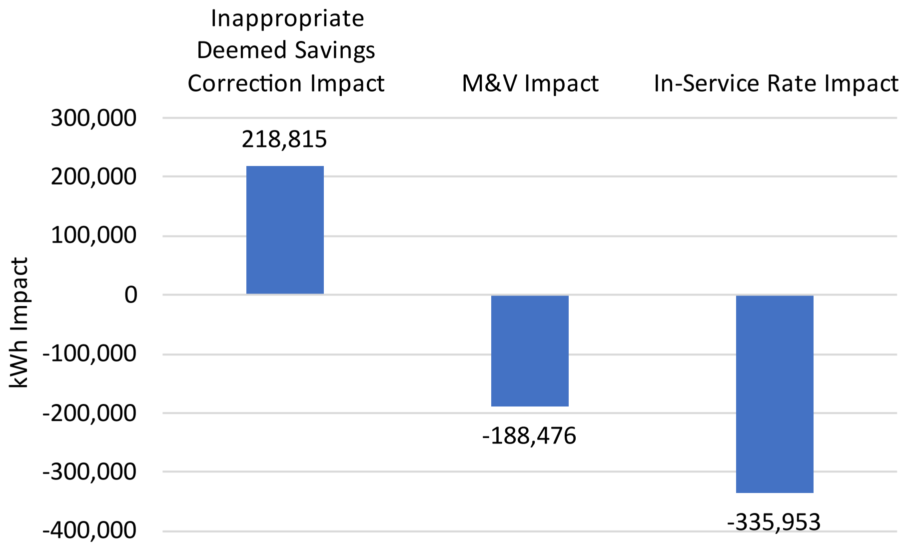


Figure A-33 FY 18/19 Ex-Post kWh Impact Factors

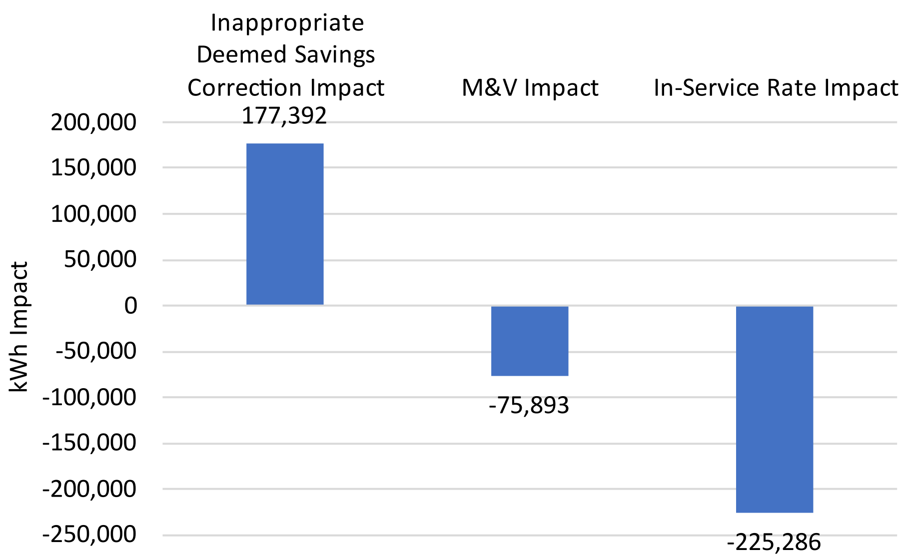
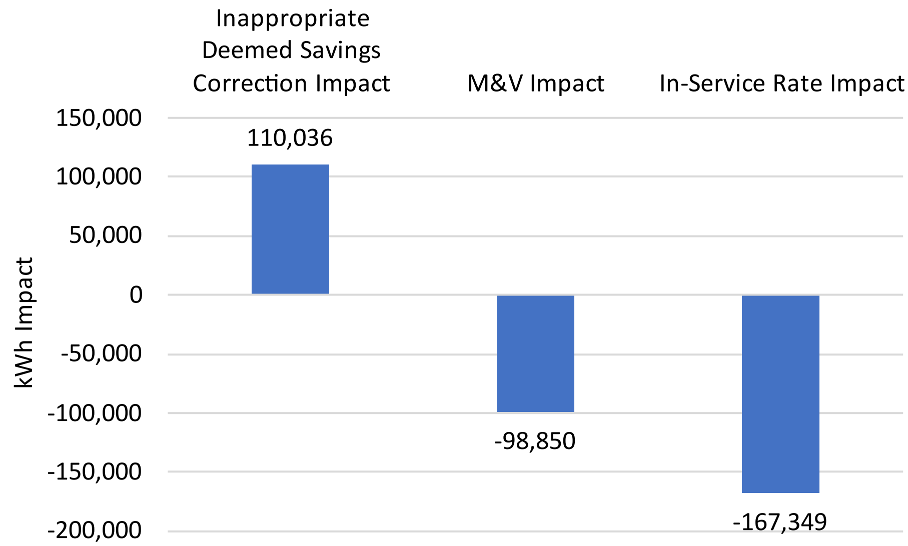


Figure A-34 FY 19/20 Ex-Post kWh Impact Factors



A.14. LIREP

This section details the impact evaluation for the Refrigerator Exchange Program (REP) that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation is to calculate energy savings and peak demand impacts attributable to the Program.

A.14.1. Evaluation Methodology

This section provides a description of the methodology used by the Evaluator in the impact evaluation of the REP Program during the Retrospective Period.

A.14.1.1. Tracking Data Review

LADWP provided the Evaluator with reports from ESP summarizing the program activity for FY 15/16 through 19/20. These reports provided summary records of the number of new refrigerators installed during each fiscal year of the Retrospective Period. Additionally, the spreadsheets contained summary Ex-Ante estimates of energy and peak demand impacts. The ESP reports, however, did not include measure quantities.

LADWP provided additional program tracking data administered by ARCA with details including participant contact information, appliance characteristics and other information collected at the time of pick-up. The ARCA tracking data was provided in the form of spreadsheet extracts from the ARCA program tracking database. The ARCA tracking data could not be easily tied to the LADWP ESP summary reports to verify that both sources represented the same number of refrigerators delivered during the Retrospective Period. The Evaluator asked LADWP which per-unit savings values were used for refrigerators delivered through the REP Program. LADWP provided the following Ex-Ante values via email communication:

- 822 kWh for 18 cu. ft. units;
- 692 kWh for 15 cu. ft. units; and
- 0.122 kW.

The ESP summary reports were then used to establish Ex-Ante energy savings and peak demand reduction for each fiscal year. Per-unit energy and peak kW impacts were extrapolated to the ARCA tracking data by taking the summary ESP Ex-Ante savings and dividing by the number of delivered units in the ARCA tracking data. This calculation was done independently for each fiscal year. The Evaluator used the per-unit savings calculated from the ESP and ARCA tracking data for the evaluation of the program.

A.14.1.2. Ex-Ante Savings Review

The following section presents a comparison of ESP savings and program tracking savings. Program tracking data was provided by ARCA without per-unit energy savings, and LADWP provided per-unit energy savings as described in Section A.14.1.1. ESP summary savings were combined with the ARCA tracking data to develop per-unit energy savings by measure and by FY as discussed in Section A.14.1.1. Table A-176 shows a comparison of ESP savings and Program Tracking savings. The ESP and program tracking Ex-Ante kWh savings were closely aligned, but Peak kW was more variable.

Table A-176 REP Ex-Ante Savings Source Comparison

Fiscal Year	Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
15/16	Refrigerator	7,472,186	7,894,212	5.6%	1,126.00	1,189.01	5.6%
16/17	Refrigerator	3,414,844	3,397,234	-0.5%	506.64	512.64	1.2%
17/18	Refrigerator	8,096,652	8,089,686	-0.1%	1,213.00	1,213.05	0.0%
18/19	Refrigerator	3,817,056	3,912,970	2.5%	975.96	585.60	-40.0%
19/20	Refrigerator	4,475,788	4,476,610	0.0%	1,181.00	676.49	-42.7%
Total		27,276,526	27,770,712	1.8%	5,002.60	4,176.79	-16.5%

A.14.1.3. M&V Approach

This section describes the energy savings calculation approach used for the REP.

The Evaluator estimated gross energy and demand impacts for REP through a deemed savings calculation. To determine the appropriate baseline for REP, the Evaluator assumed that the average full year unit energy consumption (UEC) was equal to the UEC of the pre-existing refrigerator. The reason for this assumption was that participants in REP were expected to exchange their primary refrigerator and therefore the refrigerator being exchanged would be considered a primary unit for the evaluation. The full year UEC was calculated according to the method outlined in Sections A.15.1.3.3 through A.15.1.3.5 based on the RETIRE Program impact evaluation.

Then, the ENERGY STAR UEC[5] (ES UEC) for the efficient refrigerator was calculated using Equation A-44.

$$ES\ UEC = 7.26 * AV + 210.3 \qquad \textit{Equation A-44}$$

Where, AV is equal to the cu. ft. capacity of the new refrigerator.

The cu. ft. capacity was obtained by reviewing the ARCA tracking data and looking up the correct actual cu. ft. capacity value by referencing the new refrigerator model number.

Gross per-unit Ex-Post energy savings were then calculated by subtracting the ES UEC from the Average Full Year UEC for each unit exchanged in the program using Equation A-45:

$$Gross\ Ex\ Post\ kWh\ = Full\ Year\ UEC - ES\ UEC \qquad \textit{Equation A-45}$$

Gross peak demand savings were calculated based on the critical peak demand definition provided by LADWP. Measure specific normalized 8,760 hour load shapes were used to identify the average demand during this on-peak period. These load shapes assign a portion of estimated gross kWh energy savings to each hour of the year. After identifying the total kWh savings that fall into the defined on-peak hours, dividing by the total number of hours in the peak period results in the average gross peak demand reduction. The specific appliance load shapes that were used were originally developed as part of the End-Use Load and Consumer Assessment Program (ELCAP) – a major end-use data collection program undertaken by the Bonneville Power Administration.[6]

A.14.1.4. Online Survey Data Collection

LADWP customers who participated in the program during FY 15/16 through FY 19/20 were sampled from the program tracking data and randomly prioritized in a call list to conduct a telephone survey. The participant survey included questions relevant to the impact evaluation of this study. The surveys were used to verify program participation

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[5]https://www.energystar.gov/sites/default/files/specs//ENERGY%20STAR%20Final%20Version%205.0%20Residential%20Refrigerators%20and%20Freezers%20Specification.pdf

[6] Pratt RG, CC Conner, EE Richman, KG Ritland, WF Sandusky, and ME Taylor. 1989. Description of Electric Energy Use in Single-Family Residences in the Pacific Northwest. (End-Use Load and Consumer Assessment Program [ELCAP]). DOE/BP-13795-21, prepared for Bonneville Power Administration by Pacific Northwest Laboratory, Richland, Washington.

and verify the working condition of recycled appliances. The survey was completed by 837 program participants.

A.14.2. Impact Evaluation

This section presents the findings of the impact evaluation of the REP during the Retrospective Period. Ex-Post gross energy savings and peak demand reduction are presented at the measure level.

A.14.2.1. Full Year UEC Calculations

The calculation of full year UEC is the same as the method described in Section A.15.2.2, based on the RETIRE Program impact evaluation. Table A-177 summarizes the full year UEC estimates for refrigerators.

Table A-177 REP Retrospective Period Full Year Average UEC Estimates

Fiscal Year	Appliance Type	Number of Units	Average Full Year UEC
15/16	Refrigerator	9,746	1,100
16/17	Refrigerator	4,202	1,144
17/18	Refrigerator	9,943	1,129
18/19	Refrigerator	4,800	1,148
19/20	Refrigerator	5,545	1,153

A.14.2.2. Per-Unit Gross Peak Demand Reduction

Appliance load shapes for refrigerators and freezers were used to estimate the average kW reduction occurring during LADWP's defined on-peak period. These load shapes were normalized versions of load shapes originally developed as part of the End-Use Load and Consumer Assessment program (ELCAP). Using these normalized ELCAP load shapes, the Evaluation Team determined that approximately 3.8% of the annual gross kWh savings attributable to a recycled refrigerator occurs during the on-peak period. Per-unit gross peak demand reduction for refrigerators by fiscal year are presented in Table A-178.

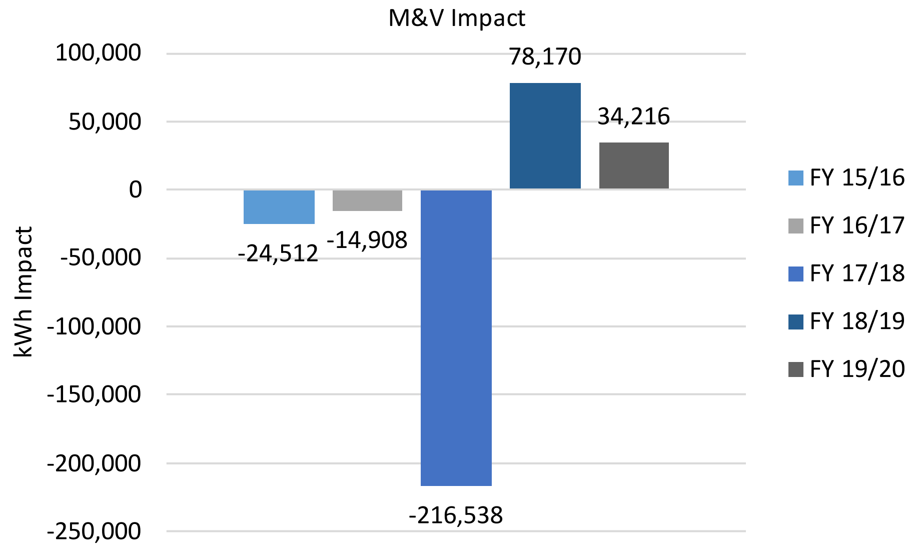
Table A-178 REP Retrospective Period Per-Unit kW Reduction

Fiscal Year	Appliance Type	Number of Units	Per-unit kW Reduction
15/16	Refrigerator	9,746	0.090
16/17	Refrigerator	4,202	0.093
17/18	Refrigerator	9,943	0.093
18/19	Refrigerator	4,800	0.094
19/20	Refrigerator	5,545	0.096

A.14.2.3. Description of Factors Affecting Gross Realized Savings

This section describes factors that affected gross realized kWh savings for the REP Retrospective Evaluation. Figure A-35 show the factors and the impact they had on overall program savings.

Figure A-35 Retrospective Period Ex-Post kWh Impact Factors



The Evaluator made one primary adjustment to program savings. The primary component of this adjustment is the calculation of full year UEC for refrigerators and comparing that to ESP Ex-Ante savings for refrigerators.

A.15. RETIRE Program

This section details the impact evaluation for the RETIRE Program that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation is to calculate energy savings and peak demand impacts attributable to the Program.

A.15.1. Evaluation Methodology

This section provides a description of the methodology used by the Evaluator in the impact evaluation of the RETIRE Program during the Retrospective Period.

A.15.1.1. Tracking Data Review

LADWP provided the Evaluator with reports from ESP summarizing the program activity for FY 15/16 through FY 19/20. These reports provided summary records of the number of refrigerators and freezers collected for recycling during each fiscal year of the Retrospective Period. Additionally, the spreadsheets contained summary Ex-Ante estimates of energy and peak demand impacts.

LADWP provided additional program tracking data administered by ARCA with details including participant contact information, appliance characteristics and other information collected at the time of pick-up. The ARCA tracking data was provided in the form of spreadsheet extracts from the ARCA program tracking database. The ARCA tracking data could not be easily tied to the LADWP ESP summary reports to verify that both sources represented the same number of refrigerators and freezers collected during the Retrospective Period. The Evaluator asked LADWP which per-unit savings values were used for refrigerators and freezers recycled through the RETIRE Program. LADWP provided the following Ex-Ante values via email communication:

- 1,946 kWh; and
- 0.3 kW.

The ESP summary reports were then used to establish Ex-Ante energy savings and peak demand reduction for each fiscal year. Per-unit energy and peak kW savings were extrapolated to the ARCA tracking data by taking the summary ESP Ex-Ante savings and dividing by the number of units in the ARCA tracking data. This calculation was done independently for refrigerators, freezers, and room ACs and by each fiscal year. The Evaluator used the per-unit savings calculated from the ESP and ARCA tracking data for the evaluation of the program.

A.15.1.2. Ex-Ante Savings Review

The following section presents a comparison of ESP savings and program tracking savings. Program tracking data was provided by ARCA without per-unit energy savings, and LADWP provided per-unit energy savings. ESP summary savings were combined with the ARCA tracking data to develop per-unit energy savings by measure and by fiscal year as discussed in Section A.15.1.1. Table A-179 shows a comparison of ESP savings and Program Tracking savings.

Table A-179 RETIRE Ex-Ante Savings Source Comparison

Fiscal Year	Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
15/16	Freezer	251,034	251,034	0.0%	38.18	38.70	1.4%
	Refrigerator	4,732,672	4,732,672	0.0%	719.82	729.60	1.4%
16/17	Freezer	537,096	591,584	10.1%	82.80	91.20	10.1%
	Refrigerator	7,961,086	8,270,500	3.9%	1227.30	1275.00	3.9%
17/18	Air Conditioner	8,865	8,832	-0.4%	0.00	8.32	N/A
	Freezer	261,724	260,764	-0.4%	0.01	40.20	>100%
	Refrigerator	5,281,350	5,261,984	-0.4%	0.29	811.20	>100%
18/19	Air Conditioner	2,280	21,804	856.3%	13.68	20.54	50.1%

Fiscal Year	Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
	Freezer	552,664	548,772	-0.7%	52.23	84.60	62.0%
	Refrigerator	10,000,494	9,928,492	-0.7%	929.46	1530.60	64.7%
19/20	Air Conditioner	8,350	46,092	452.0%	9.62	43.42	351.4%
	Freezer	214,060	221,844	3.6%	56.48	34.20	-39.4%
	Refrigerator	4,759,916	4,929,218	3.6%	1255.97	759.90	-39.5%
Grand Total		34,571,590	35,073,592	1.5%	4,385.85	5,467.48	24.7%

A.15.1.3. M&V Approach

The calculation of energy savings resulting from appliance recycling is somewhat different than most energy efficiency programs. A typical energy efficiency program generates energy savings by promoting the replacement of less efficient equipment or behaviors with more efficient equipment or behaviors. Appliance recycling, however, generates energy savings from the complete removal of less efficient equipment from the grid. There are two ways in which the removal and decommissioning of refrigerators, freezers, and room ACs produce savings:

- In participant households, the removal of an appliance may cause the participant to reduce their overall refrigeration or HVAC end-use consumption. This could reflect the participant household removing a secondary (or spare) unit that had previously been in use. It could also reflect the removal of a recently replaced primary unit that might have become a secondary unit if the program had not intervened.
- By removing working appliances from participant households, the program may also affect the level of appliance related energy consumption in non-participant households. The decommissioning of program appliances prevents their sale or transfer to other LADWP customers. With program appliances no longer available, used appliance acquirers who may have purchased a program unit in the absence of the program must now take other actions. Possible outcomes include forgoing the acquisition of a unit altogether, purchasing a new unit, or purchasing an alternative (non-program) used unit. All of these outcomes are likely to result in reduced energy use as compared to the continued use of program units.

A.15.1.3.1. Gross Energy Savings

Previous evaluations of utility sponsored appliance recycling programs have typically defined gross savings as equal to the unit energy consumption (UEC) of a given program appliance, usually with a part use factor applied to account for units that are not plugged in year-around. Issues such as free-ridership (units that would have been removed from the grid even in the absence of the program) and secondary market effects have typically been accounted for in the determination of net savings. This is the approach recommended and detailed in the U.S. Department of Energy's (DOE) Uniform Methods Project (UMP) Refrigerator Recycling Evaluation Protocol.[7] The UMP is a set of protocols developed through DOE funding that provides straightforward methods for evaluating energy savings for common energy efficiency measures offered through utility sponsored programs.

Gross savings are estimated in this evaluation using the 2010-2012 California Statewide Appliance Recycling Program (CA ARP) evaluation[8]. The CA ARP approach defines gross savings as the difference in energy consumption with and without the program. Because the program goal is removal of units from the grid, gross savings are defined in terms of consumption changes at the grid level. This requires some estimation of participant actions in the absence of the program. Table A-180 shows a simplified calculation of gross savings using the CA ARP definition.

Table A-180 CA ARP Simplified Gross Savings Calculation[9]

Unit Disposition	Location	Consumption without Program (A)	Consumption with Program (B)	Gross Savings (A-B)
Kept in Use	Participant Household	UEC as secondary unit	No consumption	UEC as secondary unit
Kept Unused	Participant Household	No consumption	No consumption	No Savings
Transferred from Participant Household	Transferee Household	UEC as primary or secondary unit	UEC as primary or secondary unit, given removal of program units	UECa - UECb

A.15.1.3.2. Verification of Units Recycled

The first aspect of conducting measurements of program activity was to verify the number of refrigerators and freezers collected and recycled through the program. When a customer schedules a pick-up, either online or over the phone, they are screened to ensure the scheduled unit(s) is operational and will be plugged in at the time of pick-up. At the time of pick-up, implementation crews are instructed to check that the unit powers on and produces air before permanently disabling the unit by cutting the power cord and damaging the appliance shell. However, it is not unreasonable to suspect that a small percentage of non-operational appliances may enter the program despite these screening

[7] http://energy.gov/sites/prod/files/2013/11/f5/53827-7.pdf

[8] http://www.calmac.org/publications/2010-2012_ARP_Impact_Evaluation_Final_Report.pdf

[9] This table is taken directly from the 2010-2012 CA ARP evaluation report.

efforts. If a non-operational unit is beyond reasonable repair, it offers no savings opportunity.

To account for this possibility, the Evaluator employed the following verification steps:

- Validating program tracking data provided by LADWP and ARCA by checking for duplicate or erroneous entries; and
- Conducting telephone surveys with a sample of program participants. The surveys were used to verify that customers listed in the program tracking database did indeed participate and that the number of appliances claimed to be recycled was accurate. Additionally, survey respondents were asked a series of questions to verify the working condition of their recycled appliances.

A.15.1.3.3. Short-Term In-Situ Metering

Past evaluations of appliance recycling programs have generally taken one of two approaches to estimating UECs. The first, and perhaps more dated, approach involves metering program refrigerators and freezers using DOE testing protocols (DOE 2008) after they are collected for recycling (or using DOE based UECs that are published at the time of manufacture). The DOE protocols specify certain test conditions that are meant to provide general UEC ratings for new appliances. However, more recent evaluations have indicated that the DOE test protocols may not reflect actual usage conditions for appliances in utility customer homes (e.g., no door openings, empty cabinets, and a 90°F test chamber).

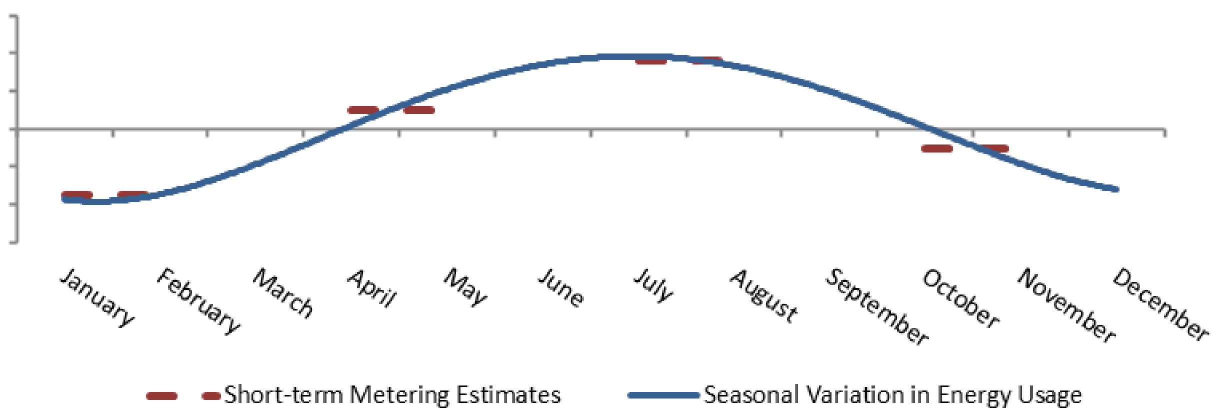
The second approach involves utilizing metered data that is collected from utility customer homes before an appliance is collected for recycling. The CA ARP protocol recommends using this in-situ (meaning “in its original place”) metering data to estimate a regression model because it accounts for environmental and usage patterns within program participating homes that might not be accurately reflected through DOE testing based metering. The Evaluator utilized short-term in situ metering performed in the Sacramento Municipal Utility District (SMUD) service territory for this evaluation. An existing database of appliances metered in the SMUD service territory in 2006, 2011, 2014, and 2015 was used for the LADWP evaluation.

A.15.1.3.4. Annualization of Short-Term Metering Data

The data collected in 2006, 2011, 2014, and 2015 represents a small window of time between when a customer schedules a pick-up and when the pick-up actually occurs. The average length of time the metering equipment was installed in customer homes was 11 days. This timeframe is sufficient for capturing multiple appliances defrost cycles as well as weekend/weekday usage differences. However, the ideal metering study would record data from program appliances in customer homes for a full year to capture seasonal effects. This approach is not feasible because participating customers have usually enrolled in the program because they intend to dispose of the unit quickly.

As a result, the data collected from short-term metering requires some process of extrapolation to a full year UEC. The most straightforward approach to extrapolation is to simply multiply the average hourly kW readings from the monitoring period by 8,760 hours. However, this method of extrapolation does not consider that energy use for an appliance varies with outdoor temperature (albeit mediated by changes in indoor temperature and indoor-internal cabinet temperatures). Figure A-36 below illustrates the challenge presented by this simple approach to annualization. The blue line shows the typical seasonal variation in appliance energy use over one year. The dotted red line shows the energy usage during four hypothetical monitoring periods. A simple extrapolation of average energy usage during these metering periods would misrepresent the annual usage because it does not account for this seasonality. Units metered in the summer months would extrapolate to annual UECs that are likely overestimated, while the opposite is true of units metered in the wintertime.

Figure A-36 Bias of Simple Extrapolation due to Seasonality



To account for seasonality in extrapolating the short term metering data to full year UECs, the Evaluator used a model developed in an evaluation of the 2004-2005 California Statewide Appliance Recycling Program.[10] The 2004-2005 evaluation utilized long term appliance metering data collected in California in the 1990's to develop models of the relationship between hourly consumption and hourly outdoor temperature.[11] The result of these models were equations that have been used to develop appliance and weather

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[10] http://www.calmac.org/publications/EM&V_Study_for_2004-2005_Statewide_RARP_-_Final_Report.pdf

[11] These models are based on relatively old appliance metering data that might not accurately reflect the refrigerators and freezer recycled through the 2011-2013 program. However, the models were recently tested against newly developed models based on metering data from the 2010-2012 CA ARP study and performed reasonably well.

specific load shapes of refrigerator and freezer energy usage. Monthly expansion factors were then used to adjust short-term metering measurements to full year UEC based on the appliance type and month in which the metering occurred. The 2004-2005 evaluation estimated separate models for freezers, secondary refrigerators, primary top-freezer refrigerators, and primary side-by-side refrigerators. Table A-181 provides the model for primary refrigerators with top freezers.

Table A-181 Top Freezer Extrapolation Model from 2004-2005 ARP Evaluation (Dependent Variable = watthour per hour)

Operating Condition	Measure 1	Measure 2
Intercept	-98.3825	1.1320
Mean Watt Hours	0.9815	0.0005
January Dummy	3.8639	0.9129
February Dummy	-0.1099	0.9076
March Dummy	5.6952	0.9017
April Dummy	12.9591	0.9349
May Dummy	7.6151	0.9584
June Dummy	9.6176	1.0150
July Dummy	16.1311	1.0329
August Dummy	6.4387	1.0690
September Dummy	6.8108	1.0193
October Dummy	15.1539	1.1215
November Dummy	4.4912	0.9349
December Dummy	Suppressed	
Ambient Temperature (F)	1.4172	0.0186
Appliance Volume (cubic feet)	3.0881	0.0578
January Dummy * App Volume	-0.5238	0.0524
February Dummy * App Volume	-0.4686	0.0559
March Dummy * App Volume	-0.8596	0.0588
April Dummy * App Volume	-1.6752	0.0583
May Dummy * App Volume	-1.7853	0.0608
June Dummy * App Volume	-1.6470	0.0610
July Dummy * App Volume	-1.7913	0.0625
August Dummy * App Volume	-1.2161	0.0643
September Dummy * App Volume	-0.9315	0.0623
October Dummy * App Volume	-2.1263	0.0768
November Dummy * App Volume	-0.8015	0.0571
December Dummy * App Volume	Suppressed	
Ambient Temperature * App Volume	-0.0488	0.0010

Operating Condition	Measure 1	Measure 2
January Dummy * App Volume * Ambient Temperature	0.0079	0.0007
February Dummy * App Volume * Ambient Temperature	0.0096	0.0008
March Dummy * App Volume * Ambient Temperature	0.0145	0.0007
April Dummy * App Volume * Ambient Temperature	0.0228	0.0007
May Dummy * App Volume * Ambient Temperature	0.0307	0.0007
June Dummy * App Volume * Ambient Temperature	0.0309	0.0006
July Dummy * App Volume * Ambient Temperature	0.0301	0.0006
August Dummy * App Volume * Ambient Temperature	0.0279	0.0007
September Dummy * App Volume * Ambient Temperature	0.0209	0.0007
October Dummy * App Volume * Ambient Temperature	0.0264	0.0009
November Dummy * App Volume * Ambient Temperature	0.0118	0.0008
December Dummy * App Volume * Ambient Temperature	Suppressed	
	R-square	0.5189

A.15.1.3.5. Full-year Unit Energy Consumption (UEC) Calculations

After establishing estimates of annual in situ UEC for the sample of appliances that received short term metering, the next step was to estimate unit level annual consumption for non-metered program units recycled during 2011-2013, 2014, and 2015. This was accomplished through the use of multiple linear regression analysis to model end-of-life UEC of the recycled refrigerators and freezers based on characteristics recorded in the program tracking data. In analytical terms, the regression analysis involved estimating the parameters of a regression model:

$$UEC = \text{function of } (V1, V2, V3\ldots, V_n) \qquad \textit{Equation A-46}$$

Where UEC is a measure of the annual energy use of a refrigerator and the Vi are independent variables (e.g., age, size, configuration, etc.) used to explain the amount of energy consumption. This approach to estimating refrigerator and freezer energy use is fairly standard, and is the recommended method described in the UMP Protocol.

Applying the regression equations to the program tracking data for the Retrospective Period provides the final full year per-unit UEC estimates.

A.15.1.3.6. Part-Use and Counterfactual Action Factors

The full-year UEC estimates must be adjusted to account for the fact that not all appliances are in continuous operation year-round. The part-use factor reflects the percentage of the year that an appliance is plugged in and operational. For primary refrigerators, the part-use factor is assumed to be 100%, as it is unlikely a customer will go without any food refrigeration. For secondary refrigerators and freezers, the possibility of part-use becomes more likely.

The participant survey was used to estimate part-use factors for secondary refrigerators and freezers, separately. Respondents were asked to indicate whether the appliance they recycled was in full use, part use, or disuse during the 12 months prior to collection. If a respondent indicated part use, they were asked to estimate the number of months the unit was in operation (out of the prior 12 months). Gross baseline consumption of recycled appliances was calculated as the full year UEC estimates multiplied by the part-use factors.

Next, the part-use factors, which are based on historical usage of the recycled appliances, are combined with participants' self-reported actions had the program not been available. Specifically, whether they would have kept or discarded the unit. This information is important because it informs what type of part-use profile the unit would have had in the absence of the program (for example, if a respondent indicates that they would have kept a primary refrigerator and continued to use it as a primary unit, a part-use factor of 1 is appropriate).

A.15.1.3.7. Gross Peak Demand Reduction

Gross peak demand savings were calculated based on the critical peak demand definition provided by LADWP. Measure specific normalized 8,760 hour load shapes were used to identify the average demand during this on-peak period. These load shapes assign a portion of estimated gross kWh energy savings to each hour of the year. After identifying the total kWh savings that fall into the defined on-peak hours, dividing by the total number of hours in the peak period results in the average gross peak demand reduction. The specific appliance load shapes that were used were originally developed as part of the End-Use Load and Consumer Assessment Program (ELCAP) – a major end-use data collection program undertaken by the Bonneville Power Administration.[12]

A.15.1.3.8. Removal of Room Air Conditioners

The energy savings for the removal of old room air conditioners were determined by the efficiency of the old unit. This is the same method used by the DEER database and workpapers and is compliant with CA Title 20. The DEER workpapers listed aggregated savings by climate zone as show in Table A-182.

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[12] Pratt RG, CC Conner, EE Richman, KG Ritland, WF Sandusky, and ME Taylor. 1989. Description of Electric Energy Use in Single-Family Residences in the Pacific Northwest. (End-Use Load and Consumer Assessment Program [ELCAP]). DOE/BP-13795-21, prepared for Bonneville Power Administration by Pacific Northwest Laboratory, Richland, Washington.

Table A-182 RETIRE Room Air Conditioner Aggregated Savings by Climate Zone

Climate Zone	kWh Usage	Peak kW Impact
6	201	0.014
7	240	0.015
8	333	0.034
9	485	0.041
10	592	0.063

A.15.1.4. Online Survey Data Collection

LADWP customers who participated in the program during FY 15/16 through FY 19/20 were sampled from the program tracking data and randomly prioritized in a call list in order to conduct an online survey. The participant survey included questions relevant to the impact evaluation of this study. The surveys were used to verify program participation, verify the working condition of recycled appliances, and determine what the participant customer would have done with the appliance in the absence of the program. The survey was completed by 673 program participants representing 636 recycled refrigerators and 37 recycled freezers.

A.15.2. Impact Evaluation

This section presents the findings of the impact evaluation of the RETIRE Program during the Retrospective Period. Ex-post gross energy savings and peak demand reduction are presented at the measure level. Topics are covered in the following order:

- Full year UEC calculation;
- Part-use factors;
- Verification of units recycled;
- Per-unit gross impacts; and
- Overall program savings.

A.15.2.1. Verification of Units Recycled

The Evaluator reviewed program tracking data provided by LADWP and ARCA for accuracy. LADWP provided the Evaluator with excel spreadsheets summarizing the program activity for the Retrospective Period. In addition, detailed tracking data provided by ARCA included information about participating customers, recycled units, and specific pick-up dates. There was one spreadsheet provided for each fiscal year. The ARCA data was comprehensively reviewed by order number, unit ID number, and identifiable customer information. No duplicate or erroneous entries were found.

Participants who responded to the Evaluator's survey were asked to confirm whether or not they recycled an appliance(s) through LADWP's program. They were also asked to confirm the total number of appliances and appliance type (refrigerator/freezer). Finally, respondents were asked to verify the working condition of the appliance(s) at the time of pick-up.

In order for participating appliances to accrue energy savings by being taken out of service, the units must be in working condition at the time of pick-up. Survey respondents were questioned regarding whether the recycled appliances were in working condition at the time of pick-up. If a respondent indicated that the unit was not in working condition, they were asked a follow-up question to make sure the unit was truly inoperable, as opposed to a minor flaw. Table A-183 shows the resulting verification rates by measure.

Table A-183 RETIRE Claimed vs. Verified Units in Working Condition

Fiscal Year	Measure	Survey Sample Size (n)	Program Claimed Units	Verification Rate (%)	Verified Units
15/16	Freezer	6	129	100.0%	129
	Refrigerator	90	2,432	95.6%	2,324
16/17	Freezer	8	304	100.0%	304
	Refrigerator	118	4,250	94.9%	4,061
17/18	Freezer	8	134	100.0%	134
	Refrigerator	102	2,704	97.1%	2,584
18/19	Freezer	11	282	100.0%	282
	Refrigerator	203	5,102	97.5%	4,875
19/20	Freezer	4	114	100.0%	114
	Refrigerator	123	2,533	96.7%	2,420

A.15.2.2. Full-Year UEC Calculation

Full year UEC estimates were derived using the regression modeling of in situ data from 103 appliances that were metered just before decommissioning in the SMUD service territory. The short-term metering data was first extrapolated to full year UEC estimates as described in Section A.15.1.3.4. Next, the full year UECs for metered units were used as the dependent variable in a regression relating unit characteristics to annual energy usage.

In selecting variables for this model, a number of considerations were taken. The independent variables needed to be readily available in the program tracking data to ensure successful application of the model to the program population. Based on data availability and modeling recommendations from the UMP protocol, the following variables were considered:

- Appliance age/vintage at the time of metering;
- Appliance size (cubic feet);
- Appliance type and configuration (refrigerator, freezer; side-by-side, top freezer, bottom freezer, single door, upright, chest);
- Primary or secondary usage;
- Metering cohort (2006, 2011, 2014);
- Label Amps; and
- Weather variables (CDD, HDD).

The final model specification did not include weather variables, as there was limited variability in temperature data across zip codes within the SMUD service territory. Label amps were also excluded from the final model specification as they explained little variation in the overall model after accounting for the other variables. The specification and parameter estimate of the selected model are shown in Table A-184.

Table A-184 UEC Regression Model Estimates

Independent Variable	Coefficient	t-ratio
Intercept	-190.28	-0.548
Appliance Age ***	25.11	2.854
Dummy: Manufactured Pre-1990	66.52	0.443
Appliance Size (cubic feet) *	25.41	1.662
Dummy: Freezer	6.91	0.058
Dummy: Refrigerator	Suppressed – base variable	
Dummy: Side-by-Side Configuration	224.84	1.634
Dummy: All Other Refrigerator Configurations	Suppressed – base variable	
Dummy: Primary Usage Type	61.49	0.467
Dummy: Secondary Usage Type	Suppressed – base variable	
Dummy: 2006 Metering Cohort **	269.64	2.217
Dummy: 2011 Metering Cohort **	309.99	2.575
Dummy: 2014 Metering Cohort	Suppressed – base variable	
* Significant at the 0.10 level ** Significant at the 0.05 level *** Significant at the 0.01 level	R – Square = 0.35	

The program tracking database included information regarding appliance type, configuration, size, age, and correct pickup address for units collected during the Retrospective Period. These units were used to calculate average program characteristics for calculating program UECs. Table A-185 through Table A-189 show the average program values by appliance type.

Table A-185 RETIRE FY 15/16 Average Program Appliance Characteristics

Measure	Refrigerators (n =2,432)	Freezers (n = 129)
Average Age (Years)	15.4	19.6
Percentage of Units Manufactured before 1990	4.3%	20.9%
Average Size (Cubic Feet)	19.8	17.2
Percentage Side-by-Side	28.0%	0%
Percentage Primary Usage*	74.4%	0%
2011 Cohort Dummy Percentage**	0.5	0.5
** ADM relied on estimates from the participant survey in determining the percentage of primary refrigerators used to extrapolate program UECs. All freezers are considered secondary appliances. **This estimate assumes that appliances recycled during the 2011-2013 program cycle are similar to units metered in both 2011 and 2014.*		

Table A-186 RETIRE FY 16/17 Average Program Appliance Characteristics

Measure	Refrigerators (n =4,250)	Freezers (n = 304)
Average Age (Years)	17.9	20.4
Percentage of Units Manufactured before 1990	8.6%	22.4%
Average Size (Cubic Feet)	19.5	16.8
Percentage Side-by-Side	22.4%	0%
Percentage Primary Usage*	73.7%	0%
2011 Cohort Dummy Percentage**	0.5	0.5
*ADM relied on estimates from the participant survey in determining the percentage of primary refrigerators used to extrapolate program UECs. All freezers are considered secondary appliances. **This estimate assumes that appliances recycled during the 2011-2013 program cycle are similar to units metered in both 2011 and 2014.*		

Table A-187 RETIRE FY 17/18 Average Program Appliance Characteristics

Measure	Refrigerators (n =2,704)	Freezers (n = 134)
Average Age (Years)	17.1	19.4
Percentage of Units Manufactured before 1990	5.3%	14.9%
Average Size (Cubic Feet)	19.6	16.8
Percentage Side-by-Side	27.0%	0%
Percentage Primary Usage*	60.8%	0%
2011 Cohort Dummy Percentage**	0.5	0.5
** ADM relied on estimates from the participant survey in determining the percentage of primary refrigerators used to extrapolate program UECs. All freezers are considered secondary appliances. **This estimate assumes that appliances recycled during the 2011-2013 program cycle are similar to units metered in both 2011 and 2014.*		

Table A-188 RETIRE FY 18/19 Average Program Appliance Characteristics

Measure	Refrigerators (n =5,102)	Freezers (n = 282)
Average Age (Years)	17.9	19.9
Percentage of Units Manufactured before 1990	7.9%	15.2%
Average Size (Cubic Feet)	19.8	17.1
Percentage Side-by-Side	22.3%	0%
Percentage Primary Usage*	66.0%	0%
2011 Cohort Dummy Percentage**	0.5	0.5
** ADM relied on estimates from the participant survey in determining the percentage of primary refrigerators used to extrapolate program UECs. All freezers are considered secondary appliances. **This estimate assumes that appliances recycled during the 2011-2013 program cycle are similar to units metered in both 2011 and 2014.*		

Table A-189 RETIRE FY 19/20 Average Program Appliance Characteristics

Measure	Refrigerators (n =2,533)	Freezers (n = 114)
Average Age (Years)	18.4	20.6
Percentage of Units Manufactured before 1990	6.2%	17.5%
Average Size (Cubic Feet)	19.7	17.4
Percentage Side-by-Side	18.8%	0%
Percentage Primary Usage*	69.9%	0%

Measure	Refrigerators (n =2,533)	Freezers (n = 114)
2011 Cohort Dummy Percentage**	0.5	0.5
** ADM relied on estimates from the participant survey in determining the percentage of primary refrigerators used to extrapolate program UECs. All freezers are considered secondary appliances. **This estimate assumes that appliances recycled during the 2011-2013 program cycle are similar to units metered in both 2011 and 2014.*		

The appliance characteristics shown in Table A-185 through Table A-189 were used in conjunction with the parameter estimates in Table A-184 to calculate annual UEC estimates for program participating refrigerators and freezers. Table A-190 summarizes the full year UEC estimates for refrigerators and freezers.

Table A-190 RETIRE Full Year Average UEC Estimates

Fiscal Year	Appliance Type	Number of Units	Average Full Year UEC
15/16	Refrigerator	2,324	1,100
	Freezer	129	1,036
16/17	Refrigerator	4,061	1,144
	Freezer	304	1,045
17/18	Refrigerator	2,548	1,129
	Freezer	134	1,015
18/19	Refrigerator	4,875	1,148
	Freezer	282	1,038
19/20	Refrigerator	2,420	1,153
	Freezer	114	1,064

The values above do not yet represent final gross consumption or energy savings. To determine gross savings under the UMP definition, they must first be adjusted for part-use. Under the CA ARP definition, they must also be adjusted for certain appliance dispositions in the absence of the program.

A.15.2.3. Part Use Factors and Counterfactual Actions

One final adjustment to the full year UECs was made to account for the fact that not all refrigerators and freezers are plugged in year-round. This part-use adjustment assigns different part-use factors based on three categories into which recycled appliances fall:

1) Some units that were recycled are not likely to operate at all in the absence of the program. The part-use factor for such units therefore would be zero.

2) Other units are likely to have operated part-time in the absence of the program. For these units, the part-use factor is calculated by dividing the number of months in the past

year that the unit had been plugged in and running by the number of months in the year (i.e., 12).

3) Units used all of the time have a use factor of one (1). It is assumed that all primary refrigerators operate year round.

The overall part-use factor and the corresponding part-use adjusted UECs are calculated as a weighted average across the three categories, where the weights are determined by the percentages of units falling into the three categories. The participant survey is used to determine the percentage of refrigerators that are primary units, and the part-use estimates for secondary refrigerators and freezers. Table A-191 through Table A-195 shows the calculation of the part-use adjusted UECs for refrigerators and freezers when partial use is taken into account.

Table A-191 RETIRE FY 15/16 Part-Use Factors

Operating Status of Unit	Percentage of Recycled Units in Category	Use Factor	Calculation of UEC to Adjust for Part Use
Refrigerators – Secondary (n=233*)			
Not running	5.5%	0.000	0
Running part time	18.0%	0.083	92
Running all time	76.5%	1.000	1,100
Weighted Average for Secondary Refrigerators		**0.780**	**858**
Refrigerators – All (n=90)			
Not running	0.0%	0.000	0
Running part time	3.3%	0.000	0
Running all time	96.7%	1.000	1,100
Weighted Average for Refrigerators		**0.967**	**1,063**
Freezers (n=37*)			
Not running	5.4%	0.000	0
Running part time	10.8%	0.000	0
Running all time	83.8%	1.000	1,036
Weighted Average for Freezers		**0.838**	**868**
***Includes all secondary units from FY 15/16 to FY 19/20.**			

Table A-192 RETIRE FY 16/17 Part-Use Factors

Operating Status of Unit	Percentage of Recycled Units in Category	Use Factor	Calculation of UEC to Adjust for Part Use
Refrigerators – Secondary (n=233*)			
Not running	5.5%	0.000	0
Running part time	18.0%	0.267	305
Running all time	76.5%	1.000	1,144

Operating Status of Unit	Percentage of Recycled Units in Category	Use Factor	Calculation of UEC to Adjust for Part Use
Weighted Average for Secondary Refrigerators		**0.813**	**930**
	Refrigerators – All (n=118)		
Not running	3.4%	0.000	0
Running part time	7.6%	0.292	334
Running all time	89.0%	1.000	1,144
Weighted Average for Refrigerators		**0.912**	**1,044**
	Freezers (n=37*)		
Not running	5.4%	0.000	0
Running part time	10.8%	0.083	87
Running all time	83.8%	1.000	1,045
Weighted Average for Freezers		**0.847**	**885**
***Includes all secondary units from FY 15/16 to FY 19/20.**			

Table A-193 RETIRE FY 17/18 Part-Use Factors

Operating Status of Unit	Percentage of Recycled Units in Category	Use Factor	Calculation of UEC to Adjust for Part Use
	Refrigerators – Secondary (n=233*)		
Not running	5.5%	0.000	0
Running part time	18.0%	0.233	263
Running all time	76.5%	1.000	1,129
Weighted Average for Secondary Refrigerators		**0.807**	**911**
	Refrigerators – All (n=102)		
Not running	2.9%	0.000	0
Running part time	8.8%	0.375	423
Running all time	88.2%	1.000	1,129
Weighted Average for Refrigerators		**0.915**	**1,033**
	Freezers (n=37*)		
Not running	5.4%	0.000	0
Running part time	10.8%	0.000	0
Running all time	83.8%	1.000	1,016
Weighted Average for Freezers		**0.838**	**851**
***Includes all secondary units from FY 15/16 to FY 19/20.**			

Table A-194 RETIRE FY 18/19 Part-Use Factors

Operating Status of Unit	Percentage of Recycled Units in Category	Use Factor	Calculation of UEC to Adjust for Part Use
	Refrigerators – Secondary (n=233*)		
Not running	5.5%	0.000	0

Operating Status of Unit	Percentage of Recycled Units in Category	Use Factor	Calculation of UEC to Adjust for Part Use
Running part time	18.0%	0.286	328
Running all time	76.5%	1.000	1,148
Weighted Average for Secondary Refrigerators		**0.816**	**937**
Refrigerators – All (n=203)			
Not running	3.0%	0.000	0
Running part time	8.9%	0.267	306
Running all time	88.2%	1.000	1,148
Weighted Average for Refrigerators		**0.905**	**1,040**
Freezers (n=37*)			
Not running	5.4%	0.000	0
Running part time	10.8%	0.083	87
Running all time	83.8%	1.000	1,038
Weighted Average for Freezers		**0.847**	**879**
***Includes all secondary units from FY 15/16 to FY 19/20.**			

Table A-195 RETIRE FY 19/20 Part-Use Factors

Operating Status of Unit	Percentage of Recycled Units in Category	Use Factor	Calculation of UEC to Adjust for Part Use
Refrigerators – Secondary (n=233*)			
Not running	5.5%	0.000	0
Running part time	18.0%	0.208	240
Running all time	76.5%	1.000	1,153
Weighted Average for Secondary Refrigerators		**0.803**	**925**
Refrigerators – All (n=123)			
Not running	1.6%	0.000	0
Running part time	3.3%	0.333	384
Running all time	95.1%	1.000	1,153
Weighted Average for Refrigerators		**0.962**	**1,109**
Freezers (n=37*)			
Not running	5.4%	0.000	0
Running part time	10.8%	0.500	532
Running all time	83.8%	1.000	1,064
Weighted Average for Freezers		**0.892**	**949**
***Includes all secondary units from FY 15/16 to FY 19/20.**			

Finally, the part-use factors developed from participant responses about how the appliances were used in the past are combined with responses regarding what they would have done with the unit in the absence of the program. Depending on whether the unit would have been kept or discarded and how it would have been used if it had been kept, different part-use factors are appropriate. Table A-196 through Table A-200 shows the final, prospective part-use factors that were used to adjust full-year UECs for refrigerators. Table A-201 through Table A-205 shows the final, prospective part-use factors that were used to adjust full-year UECs for freezers.

Table A-196 RETIRE FY 15/16 Refrigerator Counterfactual Action[13]

Counterfactual Action					Statewide Proportions (%)*	Program Unit Consumption under the Counterfactual			Alternative Unit Consumption under the Counterfactual			Gross Unit Energy Savings, kWh
						Full UEC	Usage	Adj. UEC	Full UEC	Usage	Adj. UEC	
					(A)	(B)	(C)	(D=(B*C))	(E)	(F)	(G=(E*F))	(H=(D-G))
Keep in Use by Participant					13.7%	1,100	0.78	858	1,100	0.00	0	858
Keep Unused Used by Participant					2.3%	1,100	0.00	0	1,100	0.00	0	0
Transferred	Destroyed by Discarder				18.2%	1,100	0.78	858	448	0.97	433	425
Transferred	Peer-to-Peer	Primary Unit	Replaced by similar free unit		1.2%	1,100	0.97	1,063	846	0.97	818	245
Transferred	Peer-to-Peer	Primary Unit	Replaced by similar purchased unit		9.9%	1,100	0.97	1,063	729	0.97	705	358
Transferred	Peer-to-Peer	Primary Unit	Replaced by new unit		8.4%	1,100	0.97	1,063	452	0.97	437	626
Transferred	Peer-to-Peer	Primary Unit	Keep Existing Unit	Replacing Existing	5.2%	1,100	0.97	1,063	846	0.97	818	245
Transferred	Peer-to-Peer	Primary Unit	Keep Existing Unit	Add a new unit	1.4%	1,100	0.78	858	0	0.78	0	858
Transferred	Peer-to-Peer	Secondary Unit	Replaced by similar free unit		0.4%	1,100	0.78	858	846	0.78	660	198
Transferred	Peer-to-Peer	Secondary Unit	Replaced by similar purchased unit		2.0%	1,100	0.78	858	729	0.78	569	289
Transferred	Peer-to-Peer	Secondary Unit	Replaced by new unit		1.2%	1,100	0.78	858	452	0.78	353	505
Transferred	Peer-to-Peer	Secondary Unit	Not replaced		3.6%	1,100	0.78	858	0	0.78	0	858
Transferred	Retail	Individual	Primary Unit	Replaced by similar purchased unit	7.4%	1,100	0.97	1,063	729	0.97	705	358
Transferred	Retail	Individual	Primary Unit	Replaced by new unit	5.7%	1,100	0.97	1,063	452	0.97	437	626
Transferred	Retail	Individual	Primary Unit – Kept Existing Unit	Replacing Existing	3.3%	1,100	0.97	1,063	846	0.97	818	245
Transferred	Retail	Individual	Primary Unit – Kept Existing Unit	Add a new unit	0.3%	1,100	0.78	858	0	0.78	0	858
Transferred	Retail	Individual	Secondary Unit	Replaced by similar purchased unit	0.9%	1,100	0.78	858	729	0.78	569	289
Transferred	Retail	Individual	Secondary Unit	Replaced by new unit	0.5%	1,100	0.78	858	452	0.78	353	505
Transferred	Retail	Individual	Secondary Unit	Not replaced	0.1%	1,100	0.78	858	0	0.78	0	858
Transferred	Retail	Primary Unit	Units purchased to install in rental units		1.1%	1,100	0.97	1,063	729	0.97	705	358
Transferred	Retail	Primary Unit	Commercial spaces		0.6%	1,100	0.97	1,063	729	0.97	705	358
Transferred	Retail	Primary Unit	Other		0.7%	1,100	0.97	1,063	729	0.97	705	358
Transferred	Retail	Destroyed by secondary market actors			11.3%	1,100	0.78	858	448	0.78	349	509
Totals**					99.4%	1,100	0.84	922	630	0.77	423	499
* Statewide proportion values sourced from 2010-2012 CA ARP evaluation.												
** Totals are a sum of the product of statewide proportion percentages and values in each row.												

[13] Table formatting taken directly from the 2010-2012 CA ARP evaluation report.

Table A-197 RETIRE FY 16/17 Refrigerator Counterfactual Action[14]

Counterfactual Action					Statewide Proportions (%)*	Program Unit Consumption under the Counterfactual			Alternative Unit Consumption under the Counterfactual			Gross Unit Energy Savings, kWh
						Full UEC	Usage	Adj. UEC	Full UEC	Usage	Adj. UEC	
					(A)	(B)	(C)	(D=(B*C))	(E)	(F)	(G=(E*F))	(H=(D-G))
Keep in Use by Participant					13.7%	1,144	0.81	930	1,144	0.00	0	930
Keep Unused Used by Participant					2.3%	1,144	0.00	0	1,144	0.00	0	0
Transferred	Destroyed by Discarder				18.2%	1,144	0.81	930	466	0.91	425	505
Transferred	Peer-to-Peer	Primary Unit	Replaced by similar free unit		1.2%	1,144	0.91	1,044	880	0.91	803	241
Transferred	Peer-to-Peer	Primary Unit	Replaced by similar purchased unit		9.9%	1,144	0.91	1,044	758	0.91	692	352
Transferred	Peer-to-Peer	Primary Unit	Replaced by new unit		8.4%	1,144	0.91	1,044	452	0.91	412	631
Transferred	Peer-to-Peer	Primary Unit	Keep Existing Unit	Replacing Existing	5.2%	1,144	0.91	1,044	880	0.91	803	241
Transferred	Peer-to-Peer	Primary Unit	Keep Existing Unit	Add a new unit	1.4%	1,144	0.81	930	0	0.81	0	930
Transferred	Peer-to-Peer	Secondary Unit	Replaced by similar free unit		0.4%	1,144	0.81	930	880	0.81	716	215
Transferred	Peer-to-Peer	Secondary Unit	Replaced by similar purchased unit		2.0%	1,144	0.81	930	758	0.81	617	314
Transferred	Peer-to-Peer	Secondary Unit	Replaced by new unit		1.2%	1,144	0.81	930	452	0.81	367	563
Transferred	Peer-to-Peer	Secondary Unit	Not replaced		3.6%	1,144	0.81	930	0	0.81	0	930
Transferred	Retail	Individual	Primary Unit	Replaced by similar purchased unit	7.4%	1,144	0.91	1,044	758	0.91	692	352
Transferred	Retail	Individual	Primary Unit	Replaced by new unit	5.7%	1,144	0.91	1,044	452	0.91	412	631
Transferred	Retail	Individual	Primary Unit – Kept Existing Unit	Replacing Existing	3.3%	1,144	0.91	1,044	880	0.91	803	241
Transferred	Retail	Individual	Primary Unit – Kept Existing Unit	Add a new unit	0.3%	1,144	0.81	930	0	0.81	0	930
Transferred	Retail	Individual	Secondary Unit	Replaced by similar purchased unit	0.9%	1,144	0.81	930	758	0.81	617	314
Transferred	Retail	Individual	Secondary Unit	Replaced by new unit	0.5%	1,144	0.81	930	452	0.81	367	563
Transferred	Retail	Individual	Secondary Unit	Not replaced	0.1%	1,144	0.81	930	0	0.81	0	930
Transferred	Retail	Primary Unit	Units purchased to install in rental units		1.1%	1,144	0.91	1,044	758	0.91	692	352
Transferred	Retail	Primary Unit	Commercial spaces		0.6%	1,144	0.91	1,044	758	0.91	692	352
Transferred	Retail	Primary Unit	Other		0.7%	1,144	0.91	1,044	758	0.91	692	352
Transferred	Retail	Destroyed by secondary market actors			11.3%	1,144	0.81	930	466	0.81	379	552
Totals**					99.4%	1,144	0.83	953	652	0.74	419	533

* Statewide proportion values sourced from 2010-2012 CA ARP evaluation.

** Totals are a sum of the product of statewide proportion percentages and values in each row.

[14] Table formatting taken directly from the 2010-2012 CA ARP evaluation report.

Table A-198 RETIRE FY 17/18 Refrigerator Counterfactual Action[15]

Counterfactual Action					Statewide Proportions (%)*	Program Unit Consumption under the Counterfactual: Full UEC	Program Unit Consumption under the Counterfactual: Usage	Program Unit Consumption under the Counterfactual: Adj. UEC	Alternative Unit Consumption under the Counterfactual: Full UEC	Alternative Unit Consumption under the Counterfactual: Usage	Alternative Unit Consumption under the Counterfactual: Adj. UEC	Gross Unit Energy Savings, kWh
					(A)	(B)	(C)	(D=(B*C))	(E)	(F)	(G=(E*F))	(H=(D-G))
Keep in Use by Participant					13.7%	1,129	0.81	911	1,129	0.00	0	911
Keep Unused Used by Participant					2.3%	1,129	0.00	0	1,129	0.00	0	0
Transferred	Destroyed by Discarder				18.2%	1,129	0.81	911	459	0.92	421	490
Transferred	Peer-to-Peer	Primary Unit	Replaced by similar free unit		1.2%	1,129	0.92	1,033	868	0.92	795	238
Transferred	Peer-to-Peer	Primary Unit	Replaced by similar purchased unit		9.9%	1,129	0.92	1,033	748	0.92	685	348
Transferred	Peer-to-Peer	Primary Unit	Replaced by new unit		8.4%	1,129	0.92	1,033	452	0.92	414	619
Transferred	Peer-to-Peer	Primary Unit	Keep Existing Unit	Replacing Existing	5.2%	1,129	0.92	1,033	868	0.92	795	238
Transferred	Peer-to-Peer	Primary Unit	Keep Existing Unit	Add a new unit	1.4%	1,129	0.81	911	0	0.81	0	911
Transferred	Peer-to-Peer	Secondary Unit	Replaced by similar free unit		0.4%	1,129	0.81	911	868	0.81	701	210
Transferred	Peer-to-Peer	Secondary Unit	Replaced by similar purchased unit		2.0%	1,129	0.81	911	748	0.81	604	307
Transferred	Peer-to-Peer	Secondary Unit	Replaced by new unit		1.2%	1,129	0.81	911	452	0.81	365	546
Transferred	Peer-to-Peer	Secondary Unit	Not replaced		3.6%	1,129	0.81	911	0	0.81	0	911
Transferred	Retail	Individual	Primary Unit	Replaced by similar purchased unit	7.4%	1,129	0.92	1,033	748	0.92	685	348
Transferred	Retail	Individual	Primary Unit	Replaced by new unit	5.7%	1,129	0.92	1,033	452	0.92	414	619
Transferred	Retail	Individual	Primary Unit	Kept Existing Unit: Replacing Existing	3.3%	1,129	0.92	1,033	868	0.92	795	238
Transferred	Retail	Individual	Primary Unit	Kept Existing Unit: Add a new unit	0.3%	1,129	0.81	911	0	0.81	0	911
Transferred	Retail	Individual	Secondary Unit	Replaced by similar purchased unit	0.9%	1,129	0.81	911	748	0.81	604	307
Transferred	Retail	Individual	Secondary Unit	Replaced by new unit	0.5%	1,129	0.81	911	452	0.81	365	546
Transferred	Retail	Individual	Secondary Unit	Not replaced	0.1%	1,129	0.81	911	0	0.81	0	911
Transferred	Retail	Primary Unit	Units purchased to install in rental units		1.1%	1,129	0.92	1,033	748	0.92	685	348
Transferred	Retail	Primary Unit	Commercial spaces		0.6%	1,129	0.92	1,033	748	0.92	685	348
Transferred	Retail	Primary Unit	Other		0.7%	1,129	0.92	1,033	748	0.92	685	348
Transferred	Retail	Destroyed by secondary market actors			11.3%	1,129	0.81	911	459	0.81	371	540
Totals**					99.4%	1,129	0.83	938	644	0.74	415	522

* Statewide proportion values sourced from 2010-2012 CA ARP evaluation.

** Totals are a sum of the product of statewide proportion percentages and values in each row.

[15] Table formatting taken directly from the 2010-2012 CA ARP evaluation report.

Table A-199 RETIRE FY 18/19 Refrigerator Counterfactual Action[16]

Counterfactual Action					Statewide Proportions (%)	Program Unit Consumption under the Counterfactual			Alternative Unit Consumption under the Counterfactual			Gross Unit Energy Savings, kWh
						Full UEC	Usage	Adj. UEC	Full UEC	Usage	Adj. UEC	
					(A)	(B)	(C)	(D=(B*C))	(E)	(F)	(G=(E*F))	(H=(D-G))
Keep in Use by Participant					a	1,148	0.82	937	1,148	0.00	0	937
Keep Unused Used by Participant					2.3%	1,148	0.00	0	1,148	0.00	0	0
Transferred	Destroyed by Discarder				18.2%	1,148	0.82	937	467	0.91	423	514
Transferred	Peer-to-Peer	Primary Unit	Replaced by similar free unit		1.2%	1,148	0.91	1,040	883	0.91	800	240
Transferred	Peer-to-Peer	Primary Unit	Replaced by similar purchased unit		9.9%	1,148	0.91	1,040	761	0.91	689	351
Transferred	Peer-to-Peer	Primary Unit	Replaced by new unit		8.4%	1,148	0.91	1,040	452	0.91	409	630
Transferred	Peer-to-Peer	Primary Unit	Keep Existing Unit	Replacing Existing	5.2%	1,148	0.91	1,040	883	0.91	800	240
Transferred	Peer-to-Peer	Primary Unit	Keep Existing Unit	Add a new unit	1.4%	1,148	0.82	937	0	0.82	0	937
Transferred	Peer-to-Peer	Secondary Unit	Replaced by similar free unit		0.4%	1,148	0.82	937	883	0.82	721	216
Transferred	Peer-to-Peer	Secondary Unit	Replaced by similar purchased unit		2.0%	1,148	0.82	937	761	0.82	621	316
Transferred	Peer-to-Peer	Secondary Unit	Replaced by new unit		1.2%	1,148	0.82	937	452	0.82	369	568
Transferred	Peer-to-Peer	Secondary Unit	Not replaced		3.6%	1,148	0.82	937	0	0.82	0	937
Transferred	Retail	Individual	Primary Unit	Replaced by similar purchased unit	7.4%	1,148	0.91	1,040	761	0.91	689	351
Transferred	Retail	Individual	Primary Unit	Replaced by new unit	5.7%	1,148	0.91	1,040	452	0.91	409	630
Transferred	Retail	Individual	Primary Unit – Kept Existing Unit	Replacing Existing	3.3%	1,148	0.91	1,040	883	0.91	800	240
Transferred	Retail	Individual	Primary Unit – Kept Existing Unit	Add a new unit	0.3%	1,148	0.82	937	0	0.82	0	937
Transferred	Retail	Individual	Secondary Unit	Replaced by similar purchased unit	0.9%	1,148	0.82	937	761	0.82	621	316
Transferred	Retail	Individual	Secondary Unit	Replaced by new unit	0.5%	1,148	0.82	937	452	0.82	369	568
Transferred	Retail	Individual	Secondary Unit	Not replaced	0.1%	1,148	0.82	937	0	0.82	0	937
Transferred	Retail	Primary Unit	Units purchased to install in rental units		1.1%	1,148	0.91	1,040	761	0.91	689	351
Transferred	Retail	Primary Unit	Commercial spaces		0.6%	1,148	0.91	1,040	761	0.91	689	351
Transferred	Retail	Primary Unit	Other		0.7%	1,148	0.91	1,040	761	0.91	689	351
Transferred	Retail	Destroyed by secondary market actors			11.3%	1,148	0.82	937	467	0.82	382	556
Totals**					99.4%	1,148	0.83	955	654	0.74	418	536

* Statewide proportion values sourced from 2010-2012 CA ARP evaluation.

** Totals are a sum of the product of statewide proportion percentages and values in each row.

16 Table formatting taken directly from the 2010-2012 CA ARP evaluation report.

Table A-200 RETIRE FY 19/20 Refrigerator Counterfactual Action[17]

Counterfactual Action					Statewide Proportions (%)*	Program Unit Consumption under the Counterfactual			Alternative Unit Consumption under the Counterfactual			Gross Unit Energy Savings, kWh
						Full UEC	Usage	Adj. UEC	Full UEC	Usage	Adj. UEC	
					(A)	(B)	(C)	(D=(B*C))	(E)	(F)	(G=(E*F))	(H=(D-G))
Keep in Use by Participant					13.7%	1,153	0.80	925	1,153	0.00	0	925
Keep Unused Used by Participant					2.3%	1,153	0.00	0	1,153	0.00	0	0
Transferred	Destroyed by Discarder				18.2%	1,153	0.80	925	469	0.96	451	474
Transferred	Peer-to-Peer	Primary Unit	Replaced by similar free unit		1.2%	1,153	0.96	1,109	887	0.96	853	256
Transferred	Peer-to-Peer	Primary Unit	Replaced by similar purchased unit		9.9%	1,153	0.96	1,109	764	0.96	735	374
Transferred	Peer-to-Peer	Primary Unit	Replaced by new unit		8.4%	1,153	0.96	1,109	452	0.96	435	674
Transferred	Peer-to-Peer	Primary Unit	Keep Existing Unit	Replacing Existing	5.2%	1,153	0.96	1,109	887	0.96	853	256
Transferred	Peer-to-Peer	Primary Unit	Keep Existing Unit	Add a new unit	1.4%	1,153	0.80	925	0	0.80	0	925
Transferred	Peer-to-Peer	Secondary Unit	Replaced by similar free unit		0.4%	1,153	0.80	925	887	0.80	712	213
Transferred	Peer-to-Peer	Secondary Unit	Replaced by similar purchased unit		2.0%	1,153	0.80	925	764	0.80	613	312
Transferred	Peer-to-Peer	Secondary Unit	Replaced by new unit		1.2%	1,153	0.80	925	452	0.80	363	562
Transferred	Peer-to-Peer	Secondary Unit	Not replaced		3.6%	1,153	0.80	925	0	0.80	0	925
Transferred	Retail	Individual	Primary Unit	Replaced by similar purchased unit	7.4%	1,153	0.96	1,109	764	0.96	735	374
Transferred	Retail	Individual	Primary Unit	Replaced by new unit	5.7%	1,153	0.96	1,109	452	0.96	435	674
Transferred	Retail	Individual	Primary Unit – Kept Existing Unit	Replacing Existing	3.3%	1,153	0.96	1,109	887	0.96	853	256
Transferred	Retail	Individual	Primary Unit – Kept Existing Unit	Add a new unit	0.3%	1,153	0.80	925	0	0.80	0	925
Transferred	Retail	Individual	Secondary Unit	Replaced by similar purchased unit	0.9%	1,153	0.80	925	764	0.80	613	312
Transferred	Retail	Individual	Secondary Unit	Replaced by new unit	0.5%	1,153	0.80	925	452	0.80	363	562
Transferred	Retail	Individual	Secondary Unit	Not replaced	0.1%	1,153	0.80	925	0	0.80	0	925
Transferred	Retail	Primary Unit	Units purchased to install in rental units		1.1%	1,153	0.96	1,109	764	0.96	735	374
Transferred	Retail	Primary Unit	Commercial spaces		0.6%	1,153	0.96	1,109	764	0.96	735	374
Transferred	Retail	Primary Unit	Other		0.7%	1,153	0.96	1,109	764	0.96	735	374
Transferred	Retail	Destroyed by secondary market actors			11.3%	1,153	0.80	925	469	0.80	377	548
Totals**					99.4%	1,153	0.85	978	657	0.77	440	538

* Statewide proportion values sourced from 2010-2012 CA ARP evaluation.

** Totals are a sum of the product of statewide proportion percentages and values in each row.

[17] Table formatting taken directly from the 2010-2012 CA ARP evaluation report.

Table A-201 RETIRE FY 15/16 Freezer Counterfactual Action[18]

<table>
<tr><th colspan="4" rowspan="2">Counterfactual Action</th><th rowspan="2">Statewide Proportions (%)*</th><th colspan="3">Program Unit Consumption under the Counterfactual</th><th colspan="3">Alternative Unit Consumption under the Counterfactual</th><th rowspan="2">Gross Unit Energy Savings, kWh</th></tr>
<tr><th>Full UEC</th><th>Usage</th><th>Adj. UEC</th><th>Full UEC</th><th>Usage</th><th>Adj. UEC</th></tr>
<tr><th colspan="4"></th><th>(A)</th><th>(B)</th><th>(C)</th><th>(D=(B*C))</th><th>(E)</th><th>(F)</th><th>(G=(E*F))</th><th>(H=(D-G))</th></tr>
<tr><td colspan="4">Keep in Use by Participant</td><td>14.2%</td><td>1,036</td><td>0.84</td><td>868</td><td>1,036</td><td>0.00</td><td>0</td><td>868</td></tr>
<tr><td colspan="4">Keep Unused Used by Participant</td><td>1.8%</td><td>1,036</td><td>0.00</td><td>0</td><td>1,036</td><td>0.00</td><td>0</td><td>0</td></tr>
<tr><td rowspan="12">Transferred</td><td colspan="3">Destroyed by Discarder</td><td>12.6%</td><td>1,036</td><td>0.84</td><td>868</td><td>395</td><td>0.84</td><td>331</td><td>537</td></tr>
<tr><td colspan="2" rowspan="4">Peer-to-Peer</td><td>Replaced by similar free unit</td><td>0.0%</td><td>1,036</td><td>0.84</td><td>868</td><td>785</td><td>0.84</td><td>658</td><td>210</td></tr>
<tr><td>Replaced by similar purchased unit</td><td>5.6%</td><td>1,036</td><td>0.84</td><td>868</td><td>747</td><td>0.84</td><td>626</td><td>242</td></tr>
<tr><td>Replaced by new unit</td><td>4.5%</td><td>1,036</td><td>0.84</td><td>868</td><td>443</td><td>0.84</td><td>371</td><td>497</td></tr>
<tr><td>Not replaced</td><td>24.0%</td><td>1,036</td><td>0.84</td><td>868</td><td>0</td><td>0.84</td><td>0</td><td>868</td></tr>
<tr><td rowspan="7">Retail</td><td rowspan="3">Individual</td><td>Replaced by similar purchased unit</td><td>5.2%</td><td>1,036</td><td>0.84</td><td>868</td><td>747</td><td>0.84</td><td>626</td><td>242</td></tr>
<tr><td>Replaced by new unit</td><td>3.6%</td><td>1,036</td><td>0.84</td><td>868</td><td>443</td><td>0.84</td><td>371</td><td>497</td></tr>
<tr><td>Not replaced</td><td>12.5%</td><td>1,036</td><td>0.84</td><td>868</td><td>0</td><td>0.84</td><td>0</td><td>868</td></tr>
<tr><td rowspan="3">Primary Unit</td><td>Units purchased to install in rental units</td><td>1.3%</td><td>1,036</td><td>0.84</td><td>868</td><td>747</td><td>0.84</td><td>626</td><td>242</td></tr>
<tr><td>Commercial spaces</td><td>0.7%</td><td>1,036</td><td>0.84</td><td>868</td><td>747</td><td>0.84</td><td>626</td><td>242</td></tr>
<tr><td>Other</td><td>0.8%</td><td>1,036</td><td>0.84</td><td>868</td><td>747</td><td>0.84</td><td>626</td><td>242</td></tr>
<tr><td colspan="2">Destroyed by secondary market actors</td><td>13.2%</td><td>1,036</td><td>0.84</td><td>868</td><td>395</td><td>0.84</td><td>331</td><td>537</td></tr>
<tr><td colspan="4">Totals**</td><td>100.0%</td><td>1,036</td><td>0.82</td><td>852</td><td>405</td><td>0.70</td><td>200</td><td>652</td></tr>
<tr><td colspan="12">* Statewide proportion values sourced from 2010-2012 CA ARP evaluation.</td></tr>
<tr><td colspan="12">** Totals are a sum of the product of statewide proportion percentages and values in each row.</td></tr>
</table>

[18] Table formatting taken directly from the 2010-2012 CA ARP evaluation report.

Table A-202 RETIRE FY 16/17 Freezer Counterfactual Action[19]

Counterfactual Action				Statewide Proportions (%)*	Program Unit Consumption under the Counterfactual			Alternative Unit Consumption under the Counterfactual			Gross Unit Energy Savings, kWh
					Full UEC	Usage	Adj. UEC	Full UEC	Usage	Adj. UEC	
				(A)	(B)	(C)	(D=(B*C))	(E)	(F)	(G=(E*F))	(H=(D-G))
Keep in Use by Participant				14.2%	1,045	0.85	885	1,045	0.00	0	885
Keep Unused Used by Participant				1.8%	1,045	0.00	0	1,045	0.00	0	0
Transferred	Destroyed by Discarder			12.6%	1,045	0.85	885	398	0.85	337	548
Transferred	Peer-to-Peer		Replaced by similar free unit	0.0%	1,045	0.85	885	792	0.85	671	214
Transferred	Peer-to-Peer		Replaced by similar purchased unit	5.6%	1,045	0.85	885	753	0.85	638	247
Transferred	Peer-to-Peer		Replaced by new unit	4.5%	1,045	0.85	885	443	0.85	375	510
Transferred	Peer-to-Peer		Not replaced	24.0%	1,045	0.85	885	0	0.85	0	885
Transferred	Retail	Individual	Replaced by similar purchased unit	5.2%	1,045	0.85	885	753	0.85	638	247
Transferred	Retail	Individual	Replaced by new unit	3.6%	1,045	0.85	885	443	0.85	375	510
Transferred	Retail	Individual	Not replaced	12.5%	1,045	0.85	885	0	0.85	0	885
Transferred	Retail	Primary Unit	Units purchased to install in rental units	1.3%	1,045	0.85	885	753	0.85	638	247
Transferred	Retail	Primary Unit	Commercial spaces	0.7%	1,045	0.85	885	753	0.85	638	247
Transferred	Retail	Primary Unit	Other	0.8%	1,045	0.85	885	753	0.85	638	247
Transferred	Retail	Destroyed by secondary market actors		13.2%	1,045	0.85	885	398	0.85	337	548
Totals**				100.0%	1,045	0.83	869	408	0.71	204	665
* Statewide proportion values sourced from 2010-2012 CA ARP evaluation.											
** Totals are a sum of the product of statewide proportion percentages and values in each row.											

[19] Table formatting taken directly from the 2010-2012 CA ARP evaluation report.

Table A-203 RETIRE FY 17/18 Freezer Counterfactual Action[20]

Counterfactual Action				Statewide Proportions (%)*	Program Unit Consumption under the Counterfactual			Alternative Unit Consumption under the Counterfactual			Gross Unit Energy Savings, kWh
					Full UEC	Usage	Adj. UEC	Full UEC	Usage	Adj. UEC	
				(A)	(B)	(C)	(D=(B*C))	(E)	(F)	(G=(E*F))	(H=(D-G))
Keep in Use by Participant				14.2%	1,016	0.84	851	1,016	0.00	0	851
Keep Unused Used by Participant				1.8%	1,016	0.00	0	1,016	0.00	0	0
Transferred	Destroyed by Discarder			12.6%	1,016	0.84	851	387	0.84	324	527
Transferred	Peer-to-Peer		Replaced by similar free unit	0.0%	1,016	0.84	851	770	0.84	645	206
Transferred	Peer-to-Peer		Replaced by similar purchased unit	5.6%	1,016	0.84	851	732	0.84	614	237
Transferred	Peer-to-Peer		Replaced by new unit	4.5%	1,016	0.84	851	443	0.84	371	480
Transferred	Peer-to-Peer		Not replaced	24.0%	1,016	0.84	851	0	0.84	0	851
Transferred	Retail	Individual	Replaced by similar purchased unit	5.2%	1,016	0.84	851	732	0.84	614	237
Transferred	Retail	Individual	Replaced by new unit	3.6%	1,016	0.84	851	443	0.84	371	480
Transferred	Retail	Individual	Not replaced	12.5%	1,016	0.84	851	0	0.84	0	851
Transferred	Retail	Primary Unit	Units purchased to install in rental units	1.3%	1,016	0.84	851	732	0.84	614	237
Transferred	Retail	Primary Unit	Commercial spaces	0.7%	1,016	0.84	851	732	0.84	614	237
Transferred	Retail	Primary Unit	Other	0.8%	1,016	0.84	851	732	0.84	614	237
Transferred	Retail	Destroyed by secondary market actors		13.2%	1,016	0.84	851	387	0.84	324	527
Totals**				100.0%	1,016	0.82	836	398	0.70	197	639

* Statewide proportion values sourced from 2010-2012 CA ARP evaluation.

** Totals are a sum of the product of statewide proportion percentages and values in each row.

[20] Table formatting taken directly from the 2010-2012 CA ARP evaluation report.

Table A-204 RETIRE FY 18/19 Freezer Counterfactual Action[21]

Counterfactual Action				Statewide Proportions (%)*	Program Unit Consumption under the Counterfactual			Alternative Unit Consumption under the Counterfactual			Gross Unit Energy Savings, kWh
					Full UEC	Usage	Adj. UEC	Full UEC	Usage	Adj. UEC	
				(A)	(B)	(C)	(D=(B*C))	(E)	(F)	(G=(E*F))	(H=(D-G))
Keep in Use by Participant				14.2%	1,038	0.85	879	1,038	0.00	0	879
Keep Unused Used by Participant				1.8%	1,038	0.00	0	1,038	0.00	0	0
Transferred	Destroyed by Discarder			12.6%	1,038	0.85	879	395	0.85	335	544
Transferred	Peer-to-Peer		Replaced by similar free unit	0.0%	1,038	0.85	879	787	0.85	666	213
Transferred	Peer-to-Peer		Replaced by similar purchased unit	5.6%	1,038	0.85	879	749	0.85	634	245
Transferred	Peer-to-Peer		Replaced by new unit	4.5%	1,038	0.85	879	443	0.85	375	504
Transferred	Peer-to-Peer		Not replaced	24.0%	1,038	0.85	879	0	0.85	0	879
Transferred	Retail	Individual	Replaced by similar purchased unit	5.2%	1,038	0.85	879	749	0.85	634	245
Transferred	Retail	Individual	Replaced by new unit	3.6%	1,038	0.85	879	443	0.85	375	504
Transferred	Retail	Individual	Not replaced	12.5%	1,038	0.85	879	0	0.85	0	879
Transferred	Retail	Primary Unit	Units purchased to install in rental units	1.3%	1,038	0.85	879	749	0.85	634	245
Transferred	Retail	Primary Unit	Commercial spaces	0.7%	1,038	0.85	879	749	0.85	634	245
Transferred	Retail	Primary Unit	Other	0.8%	1,038	0.85	879	749	0.85	634	245
Transferred	Retail	Destroyed by secondary market actors		13.2%	1,038	0.85	879	395	0.85	335	544
Totals**				100.0%	1,038	0.83	863	406	0.71	203	660

* Statewide proportion values sourced from 2010-2012 CA ARP evaluation.

** Totals are a sum of the product of statewide proportion percentages and values in each row.

[21] Table formatting taken directly from the 2010-2012 CA ARP evaluation report.

Table A-205 RETIRE FY 19/20 Freezer Counterfactual Action[22]

Counterfactual Action				Statewide Proportions (%)*	Program Unit Consumption under the Counterfactual			Alternative Unit Consumption under the Counterfactual			Gross Unit Energy Savings, kWh
					Full UEC	Usage	Adj. UEC	Full UEC	Usage	Adj. UEC	
				(A)	(B)	(C)	(D=(B*C))	(E)	(F)	(G=(E*F))	(H=(D-G))
Keep in Use by Participant				14.2%	1,064	0.89	949	1,064	0.00	0	949
Keep Unused Used by Participant				1.8%	1,064	0.00	0	1,064	0.00	0	0
Transferred	Destroyed by Discarder			12.6%	1,064	0.89	949	405	0.89	361	588
Transferred	Peer-to-Peer		Replaced by similar free unit	0.0%	1,064	0.89	949	806	0.89	719	230
Transferred	Peer-to-Peer		Replaced by similar purchased unit	5.6%	1,064	0.89	949	767	0.89	684	265
Transferred	Peer-to-Peer		Replaced by new unit	4.5%	1,064	0.89	949	443	0.89	395	554
Transferred	Peer-to-Peer		Not replaced	24.0%	1,064	0.89	949	0	0.89	0	949
Transferred	Retail	Individual	Replaced by similar purchased unit	5.2%	1,064	0.89	949	767	0.89	684	265
Transferred	Retail	Individual	Replaced by new unit	3.6%	1,064	0.89	949	443	0.89	395	554
Transferred	Retail	Individual	Not replaced	12.5%	1,064	0.89	949	0	0.89	0	949
Transferred	Retail	Primary Unit	Units purchased to install in rental units	1.3%	1,064	0.89	949	767	0.89	684	265
Transferred	Retail	Primary Unit	Commercial spaces	0.7%	1,064	0.89	949	767	0.89	684	265
Transferred	Retail	Primary Unit	Other	0.8%	1,064	0.89	949	767	0.89	684	265
Transferred	Retail	Destroyed by secondary market actors		13.2%	1,064	0.89	949	405	0.89	361	588
Totals**				100.0%	1,064	0.88	932	415	0.75	218	714
* Statewide proportion values sourced from 2010-2012 CA ARP evaluation.											
** Totals are a sum of the product of statewide proportion percentages and values in each row.											

Based on the full year UEC estimation and part-use estimation, the part-use adjusted UEC values for refrigerators and freezers recycled through the program are presented below in Table A-206.

Table A-206 RETIRE Part-use Adjusted UEC Estimates

Fiscal Year	Appliance Type	Number of Units	Part-use Adjusted UEC
15/16	Freezer	129	652
	Refrigerator	2,432	499
16/17	Freezer	304	665
	Refrigerator	4,250	533

[22] Table formatting taken directly from the 2010-2012 CA ARP evaluation report.

Fiscal Year	Appliance Type	Number of Units	Part-use Adjusted UEC
17/18	Freezer	134	639
	Refrigerator	2,704	522
18/19	Freezer	282	660
	Refrigerator	5,102	536
19/20	Freezer	114	714
	Refrigerator	2,533	538

A.15.2.4. Per-Unit Gross Peak Demand Reduction

Appliance load shapes for refrigerators and freezers were used to estimate the average kW reduction occurring during LADWP's defined on-peak period. These load shapes were normalized versions of load shapes originally developed as part of the End-Use Load and Consumer Assessment program (ELCAP). Using these normalized ELCAP load shapes, the Evaluator determined that approximately 3.8% of the annual gross kWh savings attributable to a recycled refrigerator occurs during the on-peak period. Per-unit gross peak demand reduction for refrigerators and freezers by fiscal year is presented in Table A-207.

Table A-207 RETIRE Per-Unit kW Reduction

Fiscal Year	Appliance Type	Number of Units	Per-unit kW Reduction
15/16	Freezer	129	0.077
	Refrigerator	2,432	0.060
16/17	Freezer	304	0.078
	Refrigerator	4,250	0.061
17/18	Freezer	134	0.077
	Refrigerator	2,704	0.062
18/19	Freezer	282	0.079
	Refrigerator	5,102	0.062
19/20	Freezer	114	0.083
	Refrigerator	2,533	0.063

A.15.2.5. Description of Factors Affecting Gross Realized Savings

This section describes factors that affected gross realized savings for the RETIRE Retrospective Period evaluation. Figure A-37 through Figure A-41 show the factors and the impact they had on overall program savings.

Figure A-37 FY 15/16 Ex-Post kWh Impact Factors

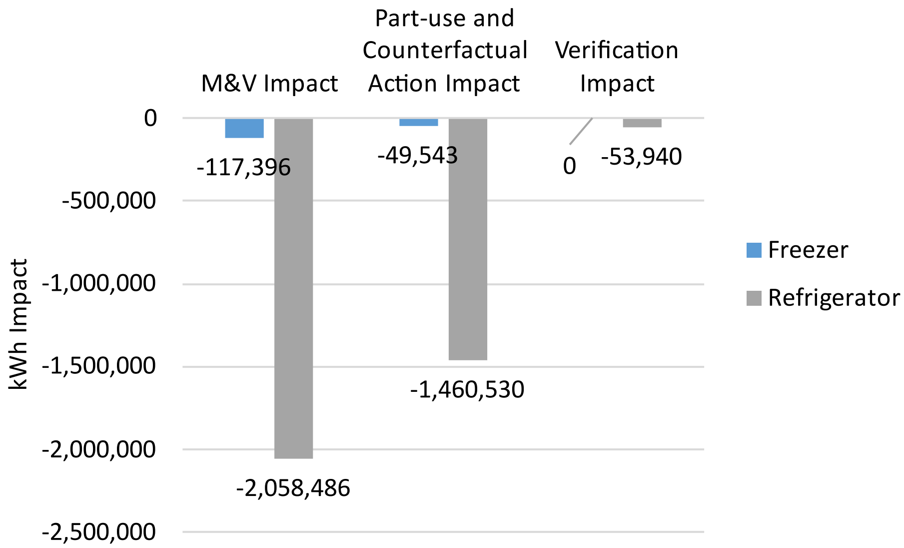


Figure A-38 FY 16/17 Ex-Post kWh Impact Factors

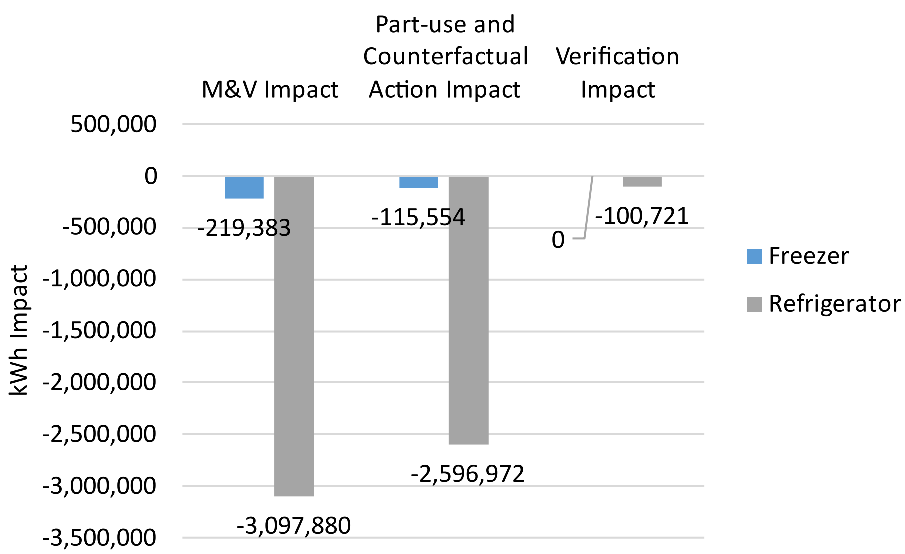


Figure A-39 FY 17/18 Ex-Post kWh Impact Factors

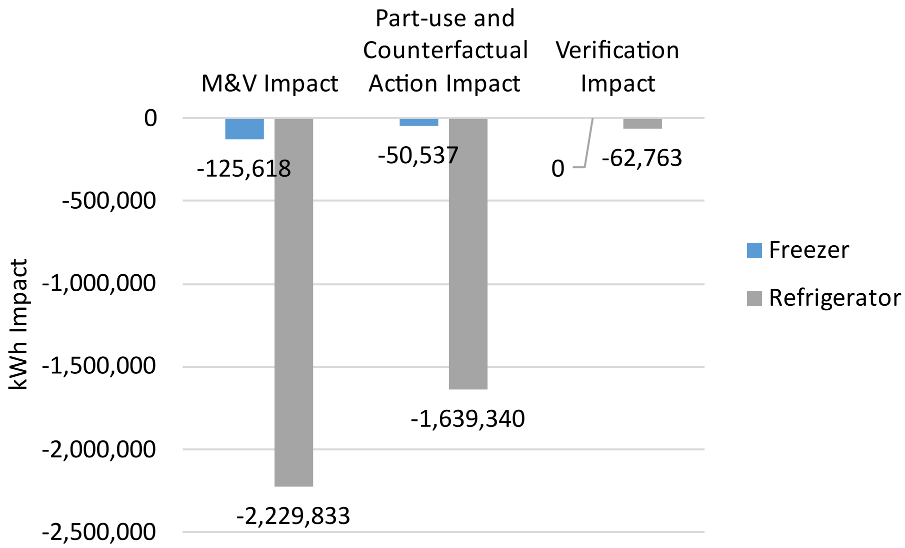


Figure A-40 FY 18/19 Ex-Post kWh Impact Factors

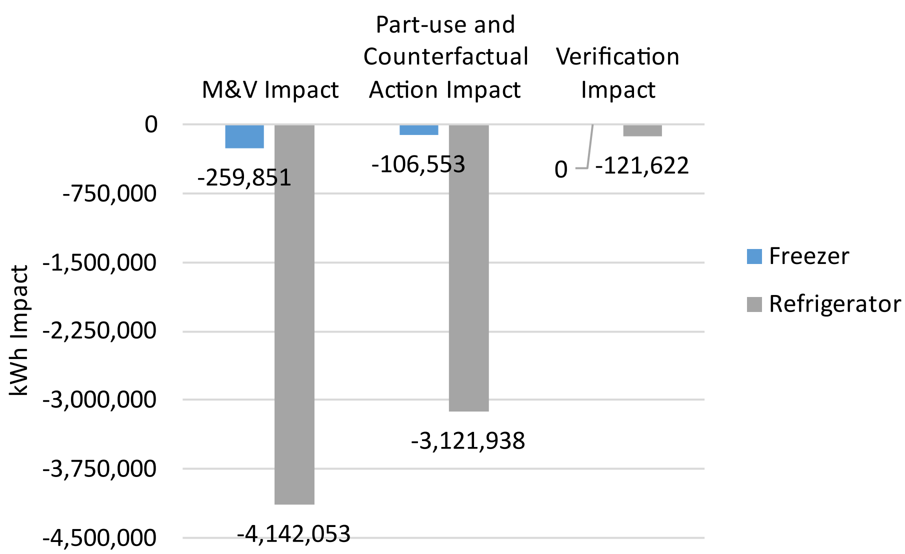
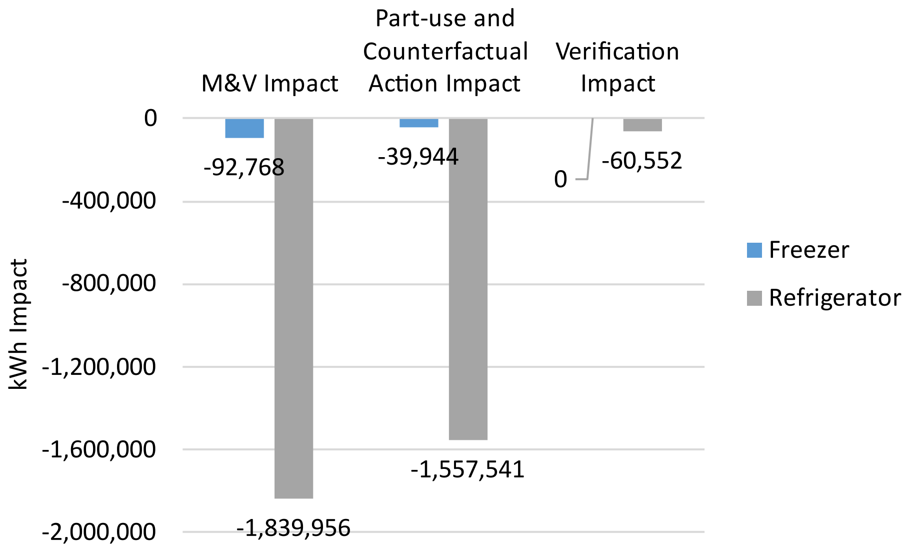


Figure A-41 FY 19/20 Ex-Post kWh Impact Factors



The Evaluator made several types of adjustments to program savings. They include:

- **M&V Impact:** The primary component of this adjustment is the calculation of full year UEC and comparing that to ESP Ex-Ante savings.
- **Part-use Impact:** The primary component of this adjustment is the calculation of part-use UEC employing the CA ARP evaluation methodology.
- **Verification Impact:** The primary component of this adjustment is the calculation of verified working units upon recycling pickup using survey response data.

A.16. RLEP

This section details the impact evaluation for the Residential Lighting Efficiency Program that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation is to calculate energy savings and peak demand impacts attributable to the Program.

A.16.1. Evaluation Methodology

The Evaluator completed the following types of data collection:

Table A-208 RLEP Program Evaluation Data Collection

Source	Data Types
Program tracking data	Data requests to LADWP for all measure level program tracking data
General population surveys	Survey administered to a sample of residential customers via account email contact information
DEER Workpapers	Determination of baseline lamp wattage by fiscal year

Tracking data was reviewed to ensure that the data provided sufficient information to verify program participation and to calculate energy and peak demand impacts.

Field data collection consisted of collecting general population survey responses. In home data collection did not occur for the Retrospective Period due to the COVID-19 pandemic. Savings were evaluated via the efficient product specifications, referenced workpapers for base case wattages, interactive factors and survey data for lamp usage in the household.

A.16.1.1. Tracking Data Review

Program data aggregated at the measure level was obtained from the ESP platform. Additional tracking data from the kit distributions was sourced from spreadsheet data in Excel format that was provided to the Evaluator securely by LADWP.

The tracking data was sourced from the document “Res Lighting Calculated Savings Sept 2016-2018.xlsx” listed in Table A-209 along with other data sources. This document listed the distribution event dates for door-to-door deliveries, as well as LED lamps distributed along with refrigerator deliveries and other outreach program events. The additional documents corresponded to the phases of the program and contract documents for the program implementer.

Table A-209 RLEP Tracking Data Document List

File Name	Dates
Res Lighting Calculated Savings Sept 2016-2018.xlsx	2018
Residential Lighting Efficiency FY 18/19 Pre QAQC.xlsx	2020
Exhibit A.doc; Lamp specification documents	July 28, 2016
Task Order LADWP01 documents	July 28, 2016
Task Order LADWP02 documents	November 3, 2016
Task Order LADWP03 documents	March 20, 2017
Task Order LADWP04 documents	December 18, 2017
Task Order LADWP05 documents	October 10, 2018
Task Order LADWP06 documents	December 18, 2018
Task Order Phase II Owens Valley documents	July 13, 2019

The energy savings from the tracking data aligned with the ESP reported program energy savings for FY 16/17, through FY 18/19. Program activity for FY 19/20 was not included in the ESP database, program costs from FY 15/16 were also not included. The tracking data review found the inputs used for the energy savings algorithm with baseline wattage, efficient wattage, hours of operation and an estimated realization rate. A heating-cooling interactive factor was not included as a factor in the Ex-Ante energy savings estimate. The per unit energy and demand savings remained the same for all the program years.

A.16.1.2. M&V Sample Design

The general population was all residential accounts in the LADWP service territory. The contact information for a sample of accounts was obtained and filtered for those customers who were agreeable for email contact. A general population survey was selected with 14,716 email addresses randomly sampled as shown in Table A-210.

Table A-210 RLEP General Population Survey

Strata	Number of LED Kits	Ex-Ante kWh Savings	Survey Sample Deployed
General Population Survey	4,333,552	146,321,218	14,716

A.16.1.3. Ex-Ante Savings Review

The Ex-Ante data review had three objectives. The first was to compare the tracking data energy savings to the aggregate measure level energy savings in ESP. Second, to compare the number of units and incentive cost to the ESP data. Finally, to review the available measure data used by the program to estimate energy and peak demand impacts.

The Ex-Ante energy savings were determined by Equation A-47 for all fiscal years.

$$kWh = \#LED\ kits\ x\ 2\frac{lamps}{kit}x\frac{(Watts_{base} - Watts_{LED})}{1000W/kW}x\ HOU\ xRR \qquad \textit{Equation A-47}$$

And Equation A-48 for peak demand follows.

$$kW = kWh_{savings}\ x\ CDF \qquad \textit{Equation A-48}$$

Table A-211 RLEP Ex-Ante Energy Savings Algorithm

Factor	Description
kWh	Annual energy savings
#LED kits	Kit quantity
$Watts_{Base}$	Base case, 36 Watts
$Watts_{LED}$	LED, 12 Watts
HOU	Annual hours if use, 1095 hours
RR	Realization Rate, 0.66
CDF	Coincident demand factor; 0.000105355

Table A-212 summarizes the review of the Ex-Ante savings sourced from the ESP report and tracking data spreadsheets. There was no participant level data in the tracking spreadsheets, but instead the lighting distribution periods were listed. For FY 16/17, the tracking data included 100% of the savings in the ESP reports. Peak demand reduction was not listed in the ESP report.

Table A-212 RLEP FY 16/17 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Initial LED Direct-to-Door Delivery	48,382,070	48,343,392	0.0%	N/A	5,093.24	N/A
LED Deliveries – Ref. Exchange		38,678			4.08	
Total	48,382,070	48,382,070	0.0%	N/A	5,097.31	N/A

Table A-213 summarizes the same data types for FY 17/18 with 99.98% of the savings in the tracking data captured in the ESP report. Again, there was no peak demand reduction listed in the ESP report. The savings for FY 17/18 included a customer type bin for low income (LI).

Table A-213 RLEP FY 17/18 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Phase II Direct-to-Door Delivery	32,744,935 LI 16,372,468	48,702,915	0.0%	N/A	5,131.11	N/A
LED Deliveries – Ref. Exchange		392,860			41.39	
Outreach Programs		10,129			1.07	
Total	49,117,403	49,105,904	0.0%	N/A	5,173.57	N/A

Table A-214 summarizes the FY 18/19 data, with 100% of the energy and peak demand impacts from the tracking data captured in the ESP report.

Table A-214 RLEP FY 18/19 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Phase III LED Direct-to-Door	31,384,784 LI 13,450,622	44,615,578	0.0%	3,307.56 LI 1,417.10	4,700.49	0.0%
LED Deliveries – Ref. Exchange		169,042			17.81	
Outreach Programs		50,786			5.35	
Total	44,835,406	44,835,406	0.0%	4,723.65	4,723.65	0.0%

Lastly, Table A-215 summarizes the FY 18/19 data, with 100% of the energy and peak demand impacts from the tracking data captured in the ESP report.

Table A-215 RLEP FY 19/20 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Phase III LED Direct-to-Door	4,147,835	3,871,567	-3.4%	422.26	407.89	0.0%
LED Deliveries – Ref. Exchange		73,126			7.70	
Outreach Programs		63,274			6.67	
Total	4,147,835	4,007,967	-3.4%	422.26	422.26	0.0%

A.16.1.4. M&V Approach

The method to estimate the energy savings for the RLEP program utilizes the same algorithm as the Ex-Ante method, but with differences in the source of the inputs. The savings algorithms for the Retrospective Period are listed below.

$$kWh = Qty_{ver} x\ HOU\ x\left(Watts_{base} - Watts_{efficient}\right) x \frac{IE_{kWh}}{1000\,\frac{Watt}{kW}} x\ ISR$$ *Equation A-49*

$$kW = kWh\ x\ \ CDF$$ *Equation A-50*

Table A-216 RLEP ENERGY STAR Lighting Savings Algorithm Inputs

Variable Name	Input	Source	Value Range
kWh, kW	Measure savings per program year		
Qty_{ver}	Quantity verified in tracking data to ESP data	RLEP tracking data	99.9% - 100%
HOU	Annual hours of use	RLEP General Population Survey, 2021	Interior: 716 hours Exterior: 2,884 hours
$Watts_{base}$	$Watts_{efficient}$ x WRR or $Watts_{efficient}$ + $Watts_{delta}$	2015 Workpaper Guidance-Lighting Retrofits, March 13,2015 2017 Screw in Lamp Disposition, revised May 26, 2017 2018 Screw in Lamp Disposition, March 2018	FY 16/17 WRR: 2.96 Delta watts: 23.52 FY 17/18 Delta watts: 12.77 FY 18/19 Delta watts: 1.53
$Watts_{efficient}$	LED Lamp wattage	RLEP Program	12 W
IE	Interactive Effects Factor by climate zone	LA Assessor Data & DEER Lighting Interactive Factors	Varies by climate zone
ISR	In Service Rate	RLEP General Population Survey, 2021	14,716 Surveys Deployed

Variable Name	Input	Source	Value Range
CDF	Coincident Demand Factor	LA Assessor Data & DEER Lighting Interactive Factors	Varies by climate zone

A.16.1.5. Online Survey Data Collection

An online survey was deployed to a sample of LADWP residential customers through email using the accountholder email addresses on file; the survey responses were collected in February and March 2021.The goal of the survey was to establish the ISR and to estimate the lighting hours of use.

A.16.2. Impact Evaluation

The impact evaluation utilized the survey response data to calculate the ISR value and the estimate of lighting hours of use. The efficient LED A-Lamp wattage was obtained from equipment specification documents and the CPUC Lighting Disposition papers were referenced for the baseline wattage and Interactive Effects, in order to determine the energy savings. The peak demand reduction calculation utilized the same CDF value as the Ex-Ante estimation.

A.16.2.1. Description of Factors Affecting Gross Realized Savings

The factors that affected energy savings for FY 16/17 are shown in Figure A-42. The number of units were not indicated in the ESP data but stated as having zero MWh impact in the figure, as the energy savings were equal to the tracking data. The Ex-Post hours were an aggregation of exterior lighting hours and interior lighting hours of use. The figure shows the HOU factor as the product of the ratio of Ex-Post aggregated hours of 1032 to the Ex-Ante hours of 1095 and total energy savings. The Ex-Post delta watts were determined from the CPUC 2016 LED WRR Disposition using the WRR factor of 2.96. The Ex-Post delta watts was 23.52 W compared to the Ex-Ante of 24.0 W. The Ex-Post determined an aggregated Interactive Effects factor for all residential properties in the city of Los Angeles from the Assessor Open Portal database, by building type (single family, multifamily, mobile home) and by climate zone. The Ex-Ante IE was assumed to be equal to 1.0. The Ex-Ante included a "gross realization rate" factor in the savings estimate, which was similar in application to the Ex-Post ISR value determined from the General Population Survey. The Ex-Ante value was 0.66 compared to the Ex-Post ISR of 0.75 and was the largest contributor to the realization rate for energy savings.

Figure A-42 FY 16/17 Ex-Post MWh Impact Factors

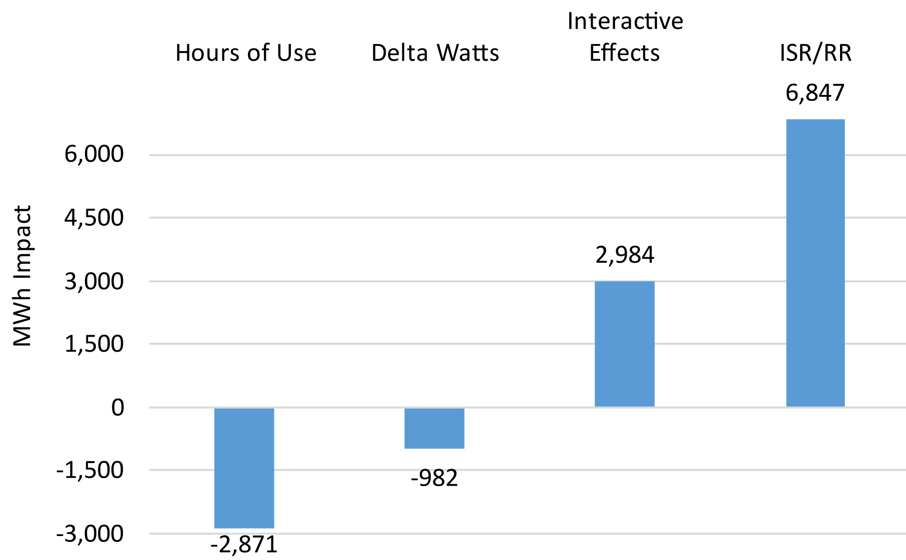


Figure A-43 presents the same factors for the FY 17/18. The HOU, IE and ISR/RR remained the same, but the revised delta watts significantly lowered the energy savings realization rate. The CPUC 2017 Screw in Lamp Disposition was referenced for the A-lamp delta watt table for the 75W EISA bin and lumens per watt (lpw) of 90 to 100. The A-lamp delta watts table had been determined by a base case of 55% CFL, 20% LED and 25% halogen lamps. The delta watts were interpolated between the two lpw bins at 12.77 W. The ratio of the Ex-Post value of 12.77 W to the Ex-Ante delta watts of 24.0 and the product of the total energy savings resulted in 22,983 MWh less for the realized energy savings.

Figure A-43 FY 17/18 Ex-Post MWh Impact Factors

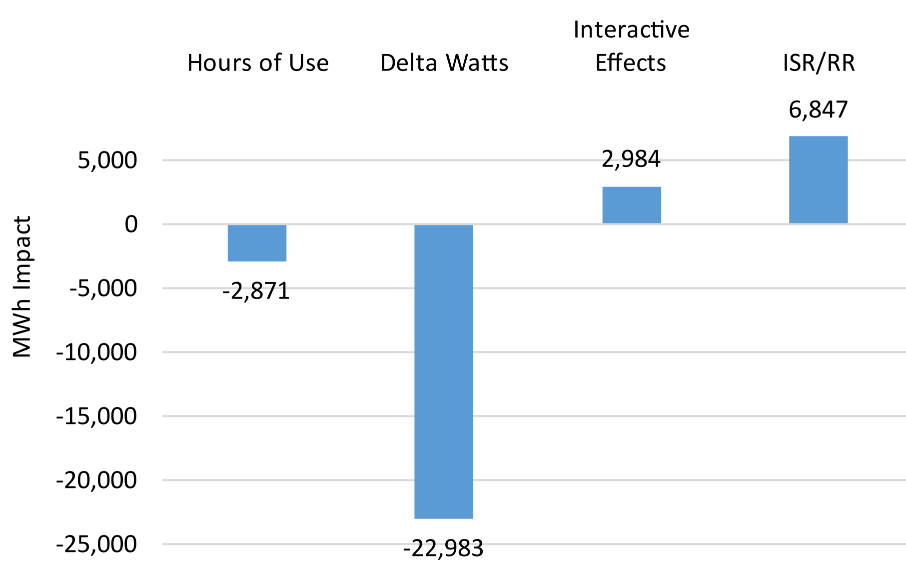
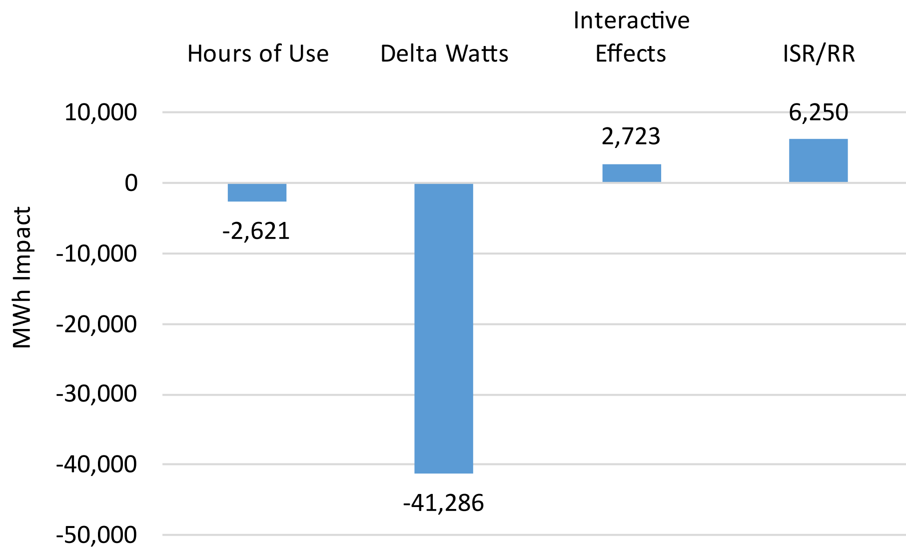


Figure A-44 illustrates the same data as the previous figures, with another revision to the delta watts used for the Ex-Post energy savings. The CA Title 20 became effective on January 1,2018 and required that General Service A-Lamps sold in the state, to have a minimum efficiency of 80 lumens per watt, or a tradeoff with a higher Color Rendering Index (CRI) value. The CPUC 2018 Screw-In Lamps Savings Method Disposition also considered the Title 20 baseline case and set the baseline mix for A-lamps to 25% compact fluorescent (CFL) and 75% LED. The delta watts for the 12 Watt efficient LED lamps were 1.90 Watts for FY 18/19, which was the largest contributor to the low realization rate.

Figure A-44 FY 18/19 Ex-Post MWh Impact Factors



A.17. ACOP

This section details the impact evaluation for the AC Optimization (ACOP) Program that LADWP offered customers during the Retrospective Period. The primary objective of this evaluation is to calculate energy savings and peak demand impacts attributable to the Program.

A.17.1. Methodology and Impact Evaluation

This section presents the findings of the tracking data review, and the methodology used to calculate verified Ex-Post energy savings and peak demand reduction for the program.

A.17.1.1. Tracking Data Review

LADWP provided the Evaluator with the available program tracking data for measures installed between August 9, 2016, through June 17, 2020. LADWP provided the following datasets:

- Quarterly billable amounts by measure.

- Measure-level tracking data including customer accounts, premise address, measures installed, quantity of measures installed, contractor name, measure cost, and install date; and,
- Monthly measure count summaries with associated measure-level Ex-Ante kWh savings.

The Evaluator reviewed available program data and counted the total number of unique measures completed in each fiscal year. These measure counts were used to extrapolate measure-level regression analysis to program-level savings for each Retrospective fiscal year.

A.17.1.2. Ex-Ante Savings Review

The following tables summarize discrepancies the Evaluator found comparing the reported ESP Ex-Ante kWh savings and peak kW reduction with the Ex-Ante kWh savings and peak kW reduction presented in the tracking data delivered by LADWP. For FY 16/17, the data provided by CLEAResult did not contain Ex-Ante kWh and peak kW savings, as exhibited in Table A-217. The remaining program years had sufficiently detailed tracking data, which was categorized by building type. During FY 16/17 and 17/18, The ESP data did not provide a granular level of detail, so ESP energy savings had to be disaggregated using proportions from the program tracking data. Beginning in FY 18/19, ESP data provided a greater level of detail, categorizing savings by building type. The results are tabled below.

Table A-217 ACOP FY 16/17 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Commercial	112,643	N/A	N/A	N/A	N/A	N/A
Multi-Residential	54,504					
Single Family	5,377,777					
Undetermined	975,631					
Total	6,520,555	N/A	N/A	N/A	N/A	N/A

Table A-218 ACOP FY 17/18 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Commercial	344,537	324,569	-5.8%	N/A	319.78	N/A
Multi-Residential	1,564,512	1,473,839	-5.8%		1,691.72	
Single Family	7,085,377	6,677,384	-5.8%		9,095.93	

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Undetermined	79,315	72,074	-9.1%		98.08	
Total	9,073,741	8,547,867	-5.8%	N/A	11,205.51	N/A

Table A-219 ACOP FY 18/19 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Commercial	269,799	495,119	83.5%	260.76	487.75	87.0%
Multi-Residential	4,482,714	3,762,134	-16.1%	4,332.59	4,330.46	0.0%
Single Family	11,468,220	12,021,839	4.8%	11,084.16	16,384.05	47.8%
Undetermined	234,244	168,007	-28.3%	226.40	228.55	0.9%
Total	16,454,977	16,447,098	0.0%	15,903.91	21,430.81	34.8%

Table A-220 ACOP FY 19/20 Ex-Ante Savings Source Comparison

Measure	ESP Data Ex-Ante kWh	Program Data Ex-Ante kWh	Ex-Ante kWh Percent Change	ESP Data Ex-Ante Peak kW	Program Data Ex-Ante Peak kW	Ex-Ante Peak kW Percent Change
Commercial	375,725	352,355	-6.2%	97.83	343.23	250.8%
Multi-Residential	4,058,951	4,082,321	0.6%	1,056.89	4,868.77	360.7%
Single Family	4,857,440	4,822,157	-0.7%	5,840.76	6,773.48	16.0%
Undetermined	46,927	82,210	75.2%	12.22	114.68	838.5%
Total	9,339,043	9,339,043	0.0%	7,007.70	12,100.16	72.7%

The largest discrepancy in energy savings is displayed in FY 17/18. In addition, the ESP data did not provide peak kW reduction for measures in FY 16/17 and FY 17/18, and program tracking data did not provide energy savings and peak kW reduction for FY 16/17. Otherwise, energy savings had a tendency to be closely aligned between program tracking data and ESP data. peak kW reduction amounts were generally very different between the two data sources for every fiscal year.

A.17.1.3. M&V Approach

Table A-221 summarizes the data sources used in the ACOP impact evaluation.

Table A-221 ACOP Data Sources

Data	Source
Program tracking data	Data requested for all data tracking program participation, rebate applications, and measure details
Recipient billing data	Monthly billing data provided by LADWP for customers that have participated in ESAP in the study periods
Nonparticipant billing data	Monthly billing data provided by LADWP for customers that have not participated in ESAP in the study periods
Participation in other LADWP programs	Data provided by LADWP for all residential program participation in the study periods

The database review process started with a review of tracking data to ensure that sufficient information was provided to calculate energy and demand impacts.

Field data collection was not completed for ACOP. Savings were evaluated via billing analysis for the program. In addition, no sampling plan was required for this program, as savings were evaluated via billing analysis with a census of participants.

The approach the Evaluator used to determine Ex-Post kWh savings and peak kW reduction for ACOP was based on statistical analysis of billing data. The Evaluator took the following steps during the evaluation approach:

- First, the Evaluator conducted an exploratory data analysis that made use of all provided participant billing data.
- Second, the Evaluator used regression models to make longitudinal and cross-sectional comparisons of energy consumption before and after installation of energy efficiency measures to determine how electricity use changed after a measure was installed at a household or business.
- Third, the Evaluator quantified whole home or building savings by extrapolating regression model outputs with weather and number of participants in each study period.

Ex-Post savings were determined using the regression coefficients. Further details of the billing analysis approach are summarized in Section A.17.1.4.

A.17.1.4. Billing Analysis Approach

The Evaluator performed a billing analysis to evaluate the energy savings for the Commercial, Multi-Residential, Single Family, and Undetermined measures for ACOP. A pooled billing data regression was used to evaluate the Commercial measure while a billing data retrofit isolation was used to evaluate Multi-Residential, Single Family, and Undetermined.

A.17.1.4.1. Billing Data Regression Analysis

A pre/post pooled mixed effects billing data regression was selected to evaluate the Commercial measure. Although a PSM model was used to evaluate residential measures throughout this evaluation, PSM is often unsuited to commercial billing data analysis due to the increased variability in commercial billing data and lack of homogeneity in commercial processes. Similarly, a billing data retrofit isolation is inappropriate for the evaluation of commercial buildings as changes that appear weather-dependent in nature can be driven due to operational changes that reoccur on an annual basis. For example, extended store hours in the summer can appear like increased HVAC load for commercial buildings. Additionally, municipal code regarding commercial ventilation may require certain commercial buildings to have HVAC operating year-round, thus rendering a baseload period difficult to isolate. Thus, the most appropriate choice for a comparable baseline to the post-retrofit period is a commercial customer's own historic usage.

The remainder of Section A.17.1.4.1 describes the billing data regression method for ACOP Commercial.

A.17.1.4.2. Billing Data Preparation

Billing data was prepared in a similar manner to the steps described in Section A.10.1.5.2 with the following exceptions:

- Billing data was prepared for participants only—a comparison group comprised of non-participants was not developed.
- Billing data was not filtered for customers with pools.

Table A-222 presents the final sample size for all four fiscal years. Because fiscal year 16/17 had an insufficient number of participants to perform an independent billing analysis (n=43), an analysis combining participants from FY 16/17, through FY 18/19—collectively known as fiscal year 16/19—was performed in its place. FY 19/20 was not included in the combined analysis due to the overlap of the customer post-period with the COVID-19 pandemic.

Table A-222 ACOP Commercial Participant Count

Fiscal Year	Number of Participants	Final Sample Size
16/19	500	284
17/18	150	105
18/19	312	199
19/20	394	263

A.17.1.4.3. Degree Day Base Optimization

Degree day bases for ACOP Commercial participants were optimized using the method described in Section A.10.1.5.4.

A.17.1.4.4. Regression Model

To estimate participant savings for ACOP Commercial, the Evaluator used a treatment-only pre/post regression model with customer fixed effects. The regression equation is specified in Equation A-51. The Evaluator used the LFE 2.8-6 package in R 3.6.3 to perform the mixed effects regression model.

$$\begin{aligned} Average\ Daily\ kWh_i &= \alpha_i + \beta_1 \cdot post + \beta_2 \cdot CDD_i + \beta_3 \cdot HDD_i + \beta_4 \cdot CDD_i \cdot post \\ &+ \beta_5 \cdot HDD_i \cdot post + \beta_6 \cdot month_1 + \cdots + \beta_n \cdot month_{12} + \varepsilon \end{aligned}$$

Equation A-51

Where:

- i represents each individual customer for each month,
- $post$ is an indicator variable indicating whether the observation is in the pre-treatment period or post-treatment period,
- CDD_i is the CDD calculated for customer *i,*
- HDD_i is the HDD calculated for customer *i,*
- $month_1$ through $month_{12}$ are indicator variables indicating if the month is January through December,
- α_i is the customer-specific intercept term,
- β_1 is the main effect of program participation,
- β_2 is the main effect of CDD,
- β_3 is the main effect of HDD,
- β_4 is the CDD-dependent effect of program participation,
- β_5 is the HDD-dependent effect of program participation,
- β_6 through β_n are the main effects of month,
- ε is the error term.

Table A-223 through Table A-226 present the regression coefficients of interest by fiscal year as well as information pertaining to model fit.

Table A-223 ACOP Commercial Regression Coefficients (FY 16/19)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Post	-8.755	1.360	-6.439	0.000	0.912
Post x HDD	0.666	0.298	2.238	0.025	0.912
Post x CDD	0.523	0.235	2.230	0.026	0.912

Table A-224 ACOP Commercial Regression Coefficients (FY 17/18)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Post	-4.068	1.920	-2.118	0.034	0.938
Post x HDD	0.234	0.396	0.590	0.555	0.938
Post x CDD	-0.036	0.310	-0.116	0.908	0.938

Table A-225 ACOP Commercial Regression Coefficients (FY 18/19)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Post	-5.488	1.226	-4.478	0.000	0.925
Post x HDD	0.527	0.273	1.929	0.054	0.925
Post x CDD	-0.078	0.213	-0.367	0.714	0.925

Table A-226 ACOP Commercial Regression Coefficients (FY 19/20)

Term	Regression Coefficient	Standard Error	T-value	P-value	Adjusted R-squared
Post	-10.694	1.126	-9.497	0.000	0.914
Post x HDD	0.668	0.245	2.721	0.007	0.914
Post x CDD	0.142	0.187	0.763	0.446	0.914

The savings for each fiscal year were then calculated using the formula presented in Equation A-52.

$$\begin{aligned} Annual\ Savings &= [Post\ Coefficient + (Post\ x\ CDD\ Coefficient\ \cdot \overline{CDD}) \\ &+ (Post\ x\ HDD\ Coefficient\ \cdot \overline{HDD})] \cdot -1 \cdot 365.25 \end{aligned} \qquad \textit{Equation A-52}$$

Where:

- $\overline{CDD}$ is the average daily CDD for a typical weather year, and
- $\overline{HDD}$ is the average daily HDD for a typical weather year.

HDDs and CDDs were weighted relative to the nearest weather stations for the participants in each program year using TMY3. These weighted values are presented in Table A-227.

Table A-227 ACOP Commercial Weighted Average TMY3 HDD and CDD

Fiscal Year	Average Daily HDD	Average Daily CDD
16/19	2.621	2.025
17/18	2.983	1.953
18/19	2.396	2.173
19/20	2.243	1.976

The average savings per household, 90% confidence intervals, and relative precision are presented in Table A-228.

Table A-228 ACOP Commercial Average Savings per Household

Fiscal Year	Annual kWh Savings	90% Confidence Interval (Lower Bound)	90% Confidence Interval (Upper Bound)	Relative Precision (90% CL)
16/19	2,173	1,605	2,742	26%
17/18	1,257	447	2,067	64%
18/19	1,606	1,098	2,113	32%
19/20	3,256	2,803	3,709	14%

A.17.1.4.5. Billing Data Retrofit Isolation

The billing analysis approach for ACOP Multi-Residential, Single Family, and Undetermined largely follows the billing data retrofit isolation approach for CRP Cool Roofs documented in Section A.10.1.5.6. The remainder of Section A.17.1.4.5 will describe any key differences in the analysis approach and provide an overview of key metrics.

A.17.1.4.6. Billing Data Preparation

Billing data was prepared using the method detailed in Section A.10.1.5.7. The number of participants included in the analysis are presented in Table *A-229*.

Table A-229 ACOP Non-Commercial Participant Count

Strata	Number of Participants	Final Sample Size
Multi-Residential	16,684	5,089
Single Family	33,650	12,945
Undetermined	701	281

A.17.1.4.7. Weather Normalization

Participant billing data was normalized to TMY3 using the method described in Section A.10.1.5.8.

A.17.1.4.8. Isolation of Weather-Dependent Load

Weather-dependent loads were isolated using the method described in Section A.10.1.5.9.

A.17.1.4.9. Savings Calculations

The savings calculation method is described in Section A.10.1.5.11. Table A-230 presents the annual per premise savings with 90% confidence intervals and relative precision.

Table A-230 ACOP Non-Commercial Per Premise Savings

Strata	Annual kWh Savings	90% Confidence Interval (Lower Bound)	90% Confidence Interval (Upper Bound)	Relative Precision (90% CL)
Multi-Residential	447.094	409.674	484.515	8%
Single Family	769.946	718.940	820.953	7%
Undetermined	424.756	264.357	585.154	38%

A.17.1.4.10.Peak Demand Reduction Estimation

The peak demand reduction estimation followed the method described in Section A.10.1.5.12. The ETDFs for ACOP are presented in Table A-231.

Table A-231 ACOP ETDFs

Strata	ETDF
Commercial	0.000279
Multi-Residential	0.000551
Single Family	0.000476
Undetermined	0.000516

Appendix B Cost Effectiveness Measure Level Results

This appendix presents cost effectiveness results at the measure level for each of the LADWP Energy Efficiency Programs during the Retrospective Period.

B.1. Non-Residential Sector Programs

Table B-1 CDI Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC	TRC	PCT	RIM	MTRC
		Ratio	Ratio	Ratio	Ratio	Ratio
15/16	Lighting	1.12	36.22	0.00	0.31	36.22
	Retrofit Plumbing	1.12	36.22	0.00	0.31	36.22
16/17	Lighting	0.93	28.80	0.00	0.27	28.80
	Retrofit Plumbing	0.93	28.80	0.00	0.27	28.80
17/18	Lighting	0.77	0.77	217.35	0.26	0.77
	Retrofit Plumbing	0.77	0.77	217.35	0.26	0.77
18/19	Lighting	0.74	3.36	347.27	0.22	3.36
	Retrofit Plumbing	0.74	3.36	347.27	0.22	3.36
19/20	Lighting	0.46	1.65	384.40	0.16	1.65
	Retrofit Plumbing	0.46	1.65	384.40	0.16	1.65

Table B-2 CLIP Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC	TRC	PCT	RIM	MTRC
		Ratio	Ratio	Ratio	Ratio	Ratio
15/16	Lighting	1.95	3.52	0.00	0.37	3.52
16/17	Lighting	2.37	5.20	0.00	0.32	5.20
17/18	Lighting	5.07	3.55	35.07	0.38	3.55
18/19	Lighting	1.80	4.65	51.79	0.29	4.65
19/20	Lighting	1.23	2.80	55.34	0.20	2.80

Table B-3 CPP Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC	TRC	PCT	RIM	MTRC
		Ratio	Ratio	Ratio	Ratio	Ratio
15/16	Building Envelope	2.69	8.46	0.00	0.35	8.46
	Controls	2.69	8.46	0.00	0.35	8.46
	HVAC	2.69	8.46	0.00	0.35	8.46
	Lighting	2.69	8.46	0.00	0.35	8.46
	Process	2.69	8.46	0.00	0.35	8.46
	VFD	2.69	8.46	0.00	0.35	8.46

Fiscal Year	Measure	PAC	TRC	PCT	RIM	MTRC
		Ratio	Ratio	Ratio	Ratio	Ratio
16/17	Building Envelope	2.45	6.48	0.00	0.31	6.48
	Controls	2.45	6.48	0.00	0.31	6.48
	HVAC	2.45	6.48	0.00	0.31	6.48
	Lighting	2.45	6.48	0.00	0.31	6.48
	Other	2.45	6.48	0.00	0.31	6.48
	Process	2.45	6.48	0.00	0.31	6.48
	VFD	2.45	6.48	0.00	0.31	6.48
17/18	Building Envelope	5.79	5.79	0.00	0.37	5.79
	Controls	5.79	5.79	0.00	0.37	5.79
	HVAC	5.79	5.79	0.00	0.37	5.79
	Lighting	5.79	5.79	0.00	0.37	5.79
	Other	5.79	5.79	0.00	0.37	5.79
	Process	5.79	5.79	0.00	0.37	5.79
	VFD	5.79	5.79	0.00	0.37	5.79
18/19	Building Envelope	2.92	2.05	5.54	0.43	2.05
	Controls	5.49	3.94	17.15	0.33	3.94
	HVAC	2.90	3.24	8.96	0.47	3.24
	Lighting	1.28	6.58	55.07	0.25	6.58
	Other	0.90	1.68	7.66	0.25	1.68
	Process	3.84	1.58	3.98	0.44	1.58
	VFD	2.71	1.35	3.24	0.45	1.35
19/20	Building Envelope	1.69	1.18	5.27	0.29	1.18
	Controls	2.05	2.76	25.90	0.27	2.76
	HVAC	1.92	2.01	10.28	0.33	2.01
	Lighting	1.70	3.43	66.27	0.22	3.43
	Other	0.57	1.01	7.40	0.17	1.01
	Process	2.99	3.04	34.71	0.26	3.04
	VFD	2.01	2.37	14.95	0.33	2.37

Table B-4 FSPC Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC	TRC	PCT	RIM	MTRC
		Ratio	Ratio	Ratio	Ratio	Ratio
15/16	Refrigerators/Freezers	1.29	5.99	0.00	0.30	5.99
	Evap. Fan Motors	4.53	5.99	0.00	0.35	5.99
	Ice Machines	2.33	5.99	0.00	0.35	5.99
	Anti-Sweat Heat Controls	3.92	5.99	0.00	0.36	5.99
	Night Covers	2.24	5.99	0.00	0.46	5.99
16/17	Refrigerators/Freezers	0.88	1.27	0.00	0.24	1.27

Fiscal Year	Measure	PAC	TRC	PCT	RIM	MTRC
		Ratio	Ratio	Ratio	Ratio	Ratio
	Kitchen Hood DVC	1.06	1.27	0.00	0.33	1.27
	Ice Machines	0.94	1.27	0.00	0.26	1.27
	Combi Oven	1.09	1.27	0.00	0.26	1.27
	Deck Oven	0.30	1.27	0.00	0.16	1.27
	Hot Food Cabinets	1.03	1.27	0.00	0.26	1.27
	Steamers	1.09	1.27	0.00	0.26	1.27
	On Demand Hand Wrapper	1.00	1.27	0.00	0.26	1.27
17/18	Refrigerators/Freezers	0.79	0.43	1.55	0.24	0.43
	Kitchen Hood DVC	0.81	0.59	2.17	0.26	0.59
	Ice Machines	1.12	1.05	6.10	0.27	1.05
	Combi Oven	1.48	2.00	0.00	0.29	2.00
	Deck Oven	1.30	2.00	0.00	0.28	2.00
	Hot Food Cabinets	1.35	2.00	0.00	0.29	2.00
	Steamers	1.47	2.00	0.00	0.19	2.00
18/19	Refrigerators/Freezers	0.12	0.24	7.70	0.09	0.24
	Ice Machines	0.24	0.30	16.76	0.14	0.30
	Combi Oven	0.32	0.30	16.00	0.16	0.30
	Convection Oven	0.29	0.08	0.34	0.15	0.08
	Hot Food Cabinets	0.31	0.27	5.42	0.16	0.27
	Steamers	0.32	0.31	25.33	0.16	0.31
19/20	Refrigerators/Freezers	0.19	0.21	0.00	0.11	0.21
	Kitchen Hood DVC	0.16	0.21	68.44	0.10	0.21
	Ice Machines	0.20	0.21	62.17	0.11	0.21
	Combi Oven	0.20	0.21	0.00	0.11	0.21
	Convection Oven	0.18	0.21	0.00	0.10	0.21
	Fryer	0.19	0.21	0.00	0.10	0.21
	Hot Food Cabinets	0.20	0.21	59.93	0.11	0.21
	Steamers	0.21	0.21	0.00	0.11	0.21

Table B-5 FSP POS Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC	TRC	PCT	RIM	MTRC
		Ratio	Ratio	Ratio	Ratio	Ratio
19/20	Convection Oven	0.21	0.21	9.00	0.11	0.21
	Hot Food Cabinets	0.19	0.24	0.00	0.10	0.24
	Ice Machines	0.21	0.24	0.00	0.11	0.24
	Refrigerators/Freezers	0.19	0.24	0.00	0.10	0.24

Table B-6 LADWP Facilities Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC	TRC	PCT	RIM	MTRC
		Ratio	Ratio	Ratio	Ratio	Ratio
15/16	Lighting	0.12	36.22	0.00	0.09	36.22
16/17	Lighting	0.11	0.32	0.00	0.08	0.32
17/18	Lighting	0.34	0.39	15.72	0.19	0.39
18/19	Lighting	0.00	0.00	214.30	0.00	0.00
19/20	Lighting	0.08	0.10	42.15	0.06	0.10

Table B-7 LAUSD DI Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC	TRC	PCT	RIM	MTRC
		Ratio	Ratio	Ratio	Ratio	Ratio
16/17	Lighting	0.33	13.50	53.69	0.17	13.50
17/18	Lighting	0.25	3.93	47.33	0.15	3.93
18/19	Lighting	0.38	0.61	70.37	0.18	0.61
19/20	Lighting	0.19	0.76	103.28	0.10	0.76

Table B-8 SBD Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC	TRC	PCT	RIM	MTRC
		Ratio	Ratio	Ratio	Ratio	Ratio
15/16	New Construction	0.48	0.48	0.00	0.22	0.48
	Modernization	0.48	0.48	0.00	0.22	0.48
16/17	New Construction	1.86	33.85	0.00	0.31	33.85
	Modernization	1.86	33.85	0.00	0.31	33.85
17/18	New Construction	1.25	2.90	8.69	0.31	2.90
	Modernization	1.25	2.90	8.69	0.31	2.90
18/19	New Construction	1.55	1.93	11.10	0.30	1.93
	Modernization	1.55	1.93	11.10	0.30	1.93
19/20	New Construction	1.22	1.38	9.89	0.25	1.38
	Modernization	1.22	1.38	9.89	0.25	1.38

Table B-9 Upstream HVAC Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC	TRC	PCT	RIM	MTRC
		Ratio	Ratio	Ratio	Ratio	Ratio
16/17	AC	3.04	16.26	0.00	0.42	16.26
	HP	3.04	16.26	0.00	0.42	16.26
	VRF	3.04	16.26	0.00	0.42	16.26
	Not Id.	3.04	16.26	0.00	0.42	16.26
17/18	AC	2.47	11.45	0.00	0.44	11.45

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
	HP	2.47	11.45	0.00	0.44	11.45
	VRF	2.47	11.45	0.00	0.44	11.45
18/19	AC	2.58	1.50	4.27	0.42	1.50
	HP	2.58	1.50	4.27	0.42	1.50
	VRF	2.58	1.50	4.27	0.42	1.50
19/20	AC	1.52	3.61	0.00	0.37	3.61
	HP	1.52	3.61	0.00	0.37	3.61
	VRF	1.52	3.61	0.00	0.37	3.61

B.2. Residential Sector Programs

Table B-10 CRP Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
15/16	Central Air Conditioner	0.95	3.52	0.00	0.52	3.52
	Central Heat Pump	1.62	3.52	0.00	0.67	3.52
	Certified Install Pool Pump	1.73	3.52	0.00	0.34	3.52
	Cool Roof	0.37	3.52	0.00	0.28	3.52
	CRP Pool Pump	0.18	3.52	0.00	0.13	3.52
	Dual Pane Skylights & Windows	2.14	3.52	0.00	0.75	3.52
	Refrigerator	0.68	3.52	0.00	0.26	3.52
	Room Air Conditioner	0.84	3.52	0.00	0.46	3.52
	Whole House Fan	1.89	3.52	0.00	0.74	3.52
16/17	Central Air Conditioner	1.03	4.97	0.00	0.55	4.97
	Central Heat Pump	1.41	4.97	0.00	0.64	4.97
	Certified Install Pool Pump	1.73	4.97	0.00	0.32	4.97
	Cool Roof	0.37	4.97	0.00	0.27	4.97
	CRP Pool Pump	0.19	4.97	0.00	0.13	4.97
	Dual Pane Skylights & Windows	2.44	4.97	0.00	0.79	4.97
	Refrigerator	0.62	4.97	0.00	0.23	4.97
	Room Air Conditioner	0.75	4.97	0.00	0.43	4.97
	Whole House Fan	2.83	4.97	0.00	0.86	4.97
17/18	Central Air Conditioner	4.29	1.19	2.38	1.05	1.19
	Central Heat Pump	4.29	4.29	0.00	0.87	4.29
	Certified Install Pool Pump	4.29	4.29	0.00	0.39	4.29
	Cool Roof	4.29	0.14	0.43	1.03	0.14
	CRP Pool Pump	4.29	1.66	24.02	0.37	1.66
	Dual Pane Skylights & Windows	4.29	0.46	0.72	0.74	0.46
	Refrigerator	0.00	0.00	0.00	0.00	0.00
	Room Air Conditioner	0.00	0.00	0.00	0.00	0.00

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
	Whole House Fan	4.29	1.09	1.32	1.06	1.09
18/19	Attic Insulation	0.56	5.01	0.00	0.40	5.01
	Central Air Conditioner	1.18	5.01	0.00	0.63	5.01
	Central Heat Pump	1.51	5.01	0.00	0.72	5.01
	Certified Install Pool Pump	1.70	5.01	0.00	0.33	5.01
	Cool Roof	0.51	0.18	0.46	0.37	0.18
	CRP Pool Pump	0.10	1.54	29.07	0.08	1.54
	Dual Pane Skylights & Windows	2.82	0.80	0.84	0.92	0.80
	Whole House Fan	2.74	5.01	0.00	0.92	5.01
19/20	Attic Insulation	0.42	3.37	0.00	0.30	3.37
	Central Air Conditioner	0.93	3.37	0.00	0.50	3.37
	Central Heat Pump	1.04	3.37	0.00	0.47	3.37
	Certified Install Pool Pump	1.05	3.37	0.00	0.21	3.37
	Cool Roof	0.42	0.15	0.46	0.30	0.15
	CRP Pool Pump	0.09	1.13	24.24	0.07	1.13
	Dual Pane Skylights & Windows	2.04	0.62	0.86	0.70	0.62
	Whole House Fan	1.11	2.24	27.48	0.23	2.24

Table B-11 EPM Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
16/17	Advanced Power Strips Tier 1	0.13	0.72	0.00	0.10	0.72
	Advanced Power Strips Tier 2	0.65	0.72	0.00	0.26	0.72
	ENERGY STAR Lighting	0.65	0.72	0.00	0.22	0.72
	ENERGY STAR Refrigerator	0.37	0.72	0.00	0.19	0.72
	ENERGY STAR Refrigerator Most Eff.	0.35	0.72	0.00	0.18	0.72
	ENERGY STAR Room Air Conditioner	0.46	0.72	0.00	0.32	0.72
	ENERGY STAR Television	0.44	0.72	0.00	0.21	0.72
	ENERGY STAR Television Most Eff.	0.17	0.72	0.00	0.12	0.72
	Smart Program Thermostats	0.64	0.72	0.00	0.39	0.72
	Web Enabled Program Thermostats	0.66	0.72	0.00	0.40	0.72
17/18	Advanced Power Strips Tier 1	1.93	1.93	0.00	0.39	1.93
	Advanced Power Strips Tier 2	1.93	1.93	0.00	0.33	1.93
	ENERGY STAR Lighting	1.93	1.93	0.00	0.29	1.93
	ENERGY STAR Refrigerator	1.93	0.88	6.16	0.33	0.88
	ENERGY STAR Refrigerator Most Eff.	1.93	1.02	8.32	0.33	1.02
	ENERGY STAR Room Air Conditioner	1.93	1.13	4.24	0.80	1.13
	ENERGY STAR Television	1.93	1.93	0.00	0.37	1.93
	ENERGY STAR Television Most Eff.	0.00	0.00	0.00	0.00	0.00
	Smart Programmable Thermostats	1.93	1.17	3.02	0.74	1.17

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
	Web Enabled Prog. Thermostats	1.93	1.50	6.38	0.74	1.50
18/19	Advanced Power Strips Tier 1	0.00	0.00	0.00	0.00	0.00
	Advanced Power Strips Tier 2	1.73	1.78	32.63	0.26	1.78
	ENERGY STAR Lighting	1.23	2.18	0.00	0.23	2.18
	ENERGY STAR Refrigerator	0.57	0.96	7.33	0.21	0.96
	ENERGY STAR Refrigerator Most Eff.	0.17	2.18	0.00	0.12	2.18
	ENERGY STAR Room Air Conditioner	1.00	2.18	0.00	0.53	2.18
	ENERGY STAR Television	0.89	0.28	1.28	0.22	0.28
	Smart Programmable Thermostats	1.43	1.44	4.65	0.64	1.44
	Web Enabled Prog. Thermostats	0.28	1.72	32.48	0.22	1.72
	Washer	0.00	2.18	0.00	0.00	2.18
19/20	Advanced Power Strips Tier 2	1.37	1.70	0.00	0.24	1.70
	ENERGY STAR Lighting	1.01	1.70	0.00	0.20	1.70
	ENERGY STAR Refrigerator	0.46	0.77	7.14	0.18	0.77
	ENERGY STAR Refrigerator Most Eff.	0.33	0.78	8.53	0.15	0.78
	ENERGY STAR Room Air Conditioner	0.83	1.20	6.09	0.48	1.20
	ENERGY STAR Television	0.33	0.21	1.41	0.16	0.21
	ENERGY STAR Television Most Eff.	0.78	1.00	9.85	0.21	1.00
	Smart Programmable Thermostats	1.37	1.20	4.16	0.63	1.20
	Web Enabled Prog. Thermostats	1.46	1.19	3.83	0.65	1.19

Table B-12 ESAP Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
15/16	Whole House	5.25	36.22	0.00	0.40	36.22
16/17	Whole House	1.25	46.07	0.00	0.28	46.07
17/18	Whole House	1.03	1.03	0.00	0.27	1.03
18/19	Whole House	0.64	0.64	4.60	0.20	0.64
19/20	Whole House	0.69	0.69	4.30	0.20	0.69

Table B-13 HEIP Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
15/16	AC Window Unit	0.38	36.22	0.00	0.19	36.22
	Aerator	0.38	36.22	0.00	0.19	36.22
	Air Sealing	0.38	36.22	0.00	0.19	36.22
	Attic Insulation	0.38	36.22	0.00	0.19	36.22
	CFL	0.38	36.22	0.00	0.19	36.22
	Duct Sealing	0.38	36.22	0.00	0.19	36.22

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
	LED	0.38	36.22	0.00	0.19	36.22
	Pipe wrap	0.38	36.22	0.00	0.19	36.22
	Showerhead	0.38	36.22	0.00	0.19	36.22
	Toilet Gasket	0.38	36.22	0.00	0.19	36.22
	Toilet	0.38	36.22	0.00	0.19	36.22
16/17	AC Window Unit	0.53	0.95	0.00	0.21	0.95
	Aerator	0.53	0.95	0.00	0.21	0.95
	Air Sealing	0.53	0.95	0.00	0.21	0.95
	Attic Insulation	0.53	0.95	0.00	0.21	0.95
	CFL	0.53	0.95	0.00	0.21	0.95
	Duct Sealing	0.53	0.95	0.00	0.21	0.95
	LED	0.53	0.95	0.00	0.21	0.95
	Pipe wrap	0.53	0.95	0.00	0.21	0.95
	Showerhead	0.53	0.95	0.00	0.21	0.95
	Toilet Gasket	0.53	0.95	0.00	0.21	0.95
	Toilet	0.53	0.95	0.00	0.21	0.95
17/18	AC Window Unit	0.44	0.85	12.12	0.19	0.85
	Aerator	0.44	0.85	12.12	0.19	0.85
	Air Sealing	0.44	0.85	12.12	0.19	0.85
	Attic Insulation	0.44	0.85	12.12	0.19	0.85
	CFL	0.44	0.85	12.12	0.19	0.85
	Duct Sealing	0.44	0.85	12.12	0.19	0.85
	LED	0.44	0.85	12.12	0.19	0.85
	Pipe wrap	0.44	0.85	12.12	0.19	0.85
	Showerhead	0.44	0.85	12.12	0.19	0.85
	Toilet Gasket	0.44	0.85	12.12	0.19	0.85
	Toilet	0.44	0.85	12.12	0.19	0.85
18/19	AC Window Unit	0.48	0.52	3.22	0.35	0.52
	Aerator	0.51	0.67	0.00	0.24	0.67
	Air Sealing	0.65	0.67	0.00	0.44	0.67
	Attic Insulation	0.60	0.67	0.00	0.42	0.67
	CFL	0.59	0.63	33.30	0.20	0.63
	Duct Sealing	0.63	0.67	0.00	0.36	0.67
	LED	0.58	0.63	30.83	0.20	0.63
	Pipe wrap	0.58	0.63	39.70	0.18	0.63
	Showerhead	0.58	0.61	17.33	0.24	0.61
	Toilet	0.24	0.67	0.00	0.16	0.67
	Toilet Gasket	0.01	0.67	0.00	0.01	0.67
19/20	AC Window Unit	0.25	0.27	3.20	0.20	0.27

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
	Aerator	0.03	0.28	128.39	0.03	0.28
	Air Sealing	0.30	0.31	0.00	0.23	0.31
	Attic Insulation	0.28	0.31	0.00	0.22	0.31
	CFL	0.29	0.29	30.16	0.13	0.29
	Duct Sealing	0.30	0.31	0.00	0.23	0.31
	LED	0.29	0.31	0.00	0.13	0.31
	Pipe wrap	0.29	0.30	45.02	0.13	0.30
	Showerhead	0.28	0.29	18.83	0.15	0.29
	Toilet	0.20	0.31	0.00	0.13	0.31
	Toilet Gasket	0.00	0.31	0.00	0.00	0.31

Table B-14 REP Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
15/16	Refrigerator	0.83	36.22	0.00	0.28	36.22
16/17	Refrigerator	0.78	8.41	0.00	0.25	8.41
17/18	Refrigerator	0.70	0.68	54.67	0.25	0.68
18/19	Refrigerator	0.92	3.23	128.06	0.31	3.23
19/20	Refrigerator	0.40	0.66	127.62	0.19	0.66

Table B-15 RETIRE Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
15/16	Freezer	2.58	36.22	0.00	0.47	36.22
	Refrigerator	2.58	36.22	0.00	0.47	36.22
16/17	Freezer	2.69	7.09	0.00	0.39	7.09
	Refrigerator	2.41	7.09	0.00	0.36	7.09
17/18	Air Conditioner	0.69	0.89	2.73	0.29	0.89
	Freezer	0.69	0.89	2.73	0.29	0.89
	Refrigerator	0.69	0.89	2.73	0.29	0.89
18/19	Air Conditioner	1.05	1.11	0.00	0.56	1.11
	Freezer	1.14	2.48	0.00	0.33	2.48
	Refrigerator	1.58	2.48	0.00	0.35	2.48
19/20	Air Conditioner	1.14	1.19	0.00	0.57	1.19
	Freezer	0.92	1.19	0.00	0.27	1.19
	Refrigerator	0.89	1.19	0.00	0.26	1.19

Table B-16 RLEP Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
16/17	LED Kit	1.91	24.51	0.00	0.28	24.51
17/18	LED Kit	1.93	17.15	0.00	0.29	17.15
18/19	LED Kit	0.40	0.53	0.00	0.17	0.53
19/20	LED Kit	0.47	0.48	0.00	0.17	0.48

B.3. Cross-Sector Programs

Table B-17 ACOP Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
16/17	Commercial	0.64	0.74	0.00	0.37	0.74
	Multifamily	0.64	0.74	0.00	0.37	0.74
	Single Family	0.64	0.74	0.00	0.37	0.74
	Undetermined	0.64	0.74	0.00	0.37	0.74
17/18	Commercial	0.49	0.54	0.52	0.36	0.54
	Multifamily	0.49	0.54	0.52	0.36	0.54
	Single Family	0.49	0.54	0.52	0.36	0.54
	Undetermined	0.49	0.54	0.52	0.36	0.54
18/19	Commercial	0.07	0.93	16.34	0.06	0.93
	Multifamily	0.21	0.60	3.47	0.18	0.60
	Single Family	1.93	8.16	0.00	0.78	8.16
	Undetermined	0.07	0.93	16.34	0.06	0.93
19/20	Commercial	1.36	2.42	0.00	0.28	2.42
	Multifamily	0.26	2.42	0.00	0.15	2.42
	Single Family	0.93	2.42	0.00	0.54	2.42
	Undetermined	0.41	2.42	0.00	0.19	2.42

Table B-18 CSO Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
15/16	Title 20/24	33.99	33.99	0.00	0.42	33.99
	Cool Roof - Retrofit	33.99	33.99	0.00	0.42	33.99
	Cool Roof -NC	33.99	33.99	0.00	0.42	33.99
	Plumbing	33.59	33.59	0.00	0.41	33.59
16/17	Title 20/24	37.26	37.27	0.00	0.37	37.27
	Cool Roof - Retrofit	37.26	37.27	0.00	0.37	37.27
	Cool Roof -NC	37.26	37.27	0.00	0.37	37.27
	Plumbing	32.38	32.38	0.00	0.37	32.38

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
17/18	Title 20/24	20.53	20.53	0.00	0.38	20.53
	Cool Roof - Retrofit	20.53	20.53	0.00	0.38	20.53
	Cool Roof -NC	20.53	20.53	0.00	0.38	20.53
	Plumbing	31.62	31.62	0.00	0.34	31.62
18/19	Title 20/24	165.36	165.36	0.00	0.36	165.36
	Cool Roof - Retrofit	165.36	165.36	0.00	1.30	165.36
	Cool Roof -NC	165.36	165.36	0.00	1.30	165.36
	Plumbing	165.36	165.36	0.00	0.36	165.36
19/20	Title 20/24	14.79	14.79	0.00	0.32	14.79
	Cool Roof - Retrofit	14.79	14.79	0.00	0.32	14.79
	Cool Roof -NC	14.79	14.79	0.00	0.32	14.79
	Plumbing	14.79	14.79	0.00	0.32	14.79

Table B-19 MFWB Measure Level Cost Effectiveness Results

Fiscal Year	Measure	PAC Ratio	TRC Ratio	PCT Ratio	RIM Ratio	MTRC Ratio
17/18	Whole Building	1.84	2.13	9.05	0.25	2.13
19/20	Whole Building	1.27	1.50	9.73	0.21	1.50

Appendix C Home and Demographic Characteristics

The participant surveys included questions on respondent home characteristics and demographic characteristics. The following tables summarize the findings from the surveys. For select characteristics, data is presented for the population of the City of Los Angeles and is based on the 2019 American Community Survey 5-year estimates.

C.1. Home Characteristics

Table C-1 Home Ownership

Home Ownership	Population Estimate	RLEP (n = 373)	CRP (n = 178)	EPM (n = 429)	HEIP (n = 315)	REP (n = 832)	RETIRE (n = 680)
Own	37%	45%	96%	89%	91%	23%	76%
Rent	63%	54%	4%	9%	7%	76%	22%
Own and rent to someone else	NA	1%	1%	2%	2%	1%	2%

Table C-2 Space Heating Fuel Type

Space Heating Fuel Type	RLEP (n = 374)	CRP (n = 178)	EPM (n = 430)	HEIP (n = 320)	REP (n = 839)	RETIRE (n = 688)
Electricity	45%	14%	22%	22%	46%	26%
Natural gas	47%	85%	77%	75%	40%	70%
Propane	0%	0%	0%	0%	0%	0%
Other	1%	0%	0%	1%	1%	1%
Don’t heat home	7%	1%	1%	3%	12%	3%

Table C-3 Water Heating Fuel Type

Water Heating Fuel Type	RLEP (n = 372)	CRP (n = 177)	EPM (n = 428)	HEIP (n = 318)	REP (n = 825)	RETIRE (n = 685)
Natural gas	73%	92%	88%	88%	73%	87%
Electricity	22%	8%	10%	10%	22%	11%
Propane	2%	1%	1%	0%	2%	0%
Other	3%	0%	1%	1%	3%	1%
Do not have hot water	1%	0%	0%	0%	1%	1%

C.2. Demographic Characteristics

Table C-4 Number of People in Household

Household size	RLEP (n = 373)	CRP (n = 176)	EPM (n = 430)	HEIP (n = 319)	REP (n = 833)	RETIRE (n = 685)
1 person	20%	13%	13%	19%	21%	17%
2 people	34%	34%	36%	30%	20%	31%
3 people	16%	21%	21%	19%	17%	17%
4 people	16%	18%	20%	16%	18%	17%
5 people	5%	6%	5%	5%	11%	7%
6 people	3%	3%	2%	3%	6%	3%
7 people	1%	1%	0%	1%	2%	2%
8 or more people	1%	0%	1%	2%	2%	0%
Prefer not to state	4%	5%	3%	5%	3%	7%

Table C-5 Age of Respondents

Age	Population Estimate	RLEP (n = 374)	CRP (n = 176)	EPM (n = 430)	HEIP (n = 319)	REP (n = 837)	RETIRE (n = 684)
18 - 24	13%	2%	0%	0%	0%	1%	1%
25 - 34	23%	19%	1%	11%	5%	8%	7%
35 - 44	18%	29%	19%	30%	14%	23%	15%
45 - 54	17%	20%	24%	23%	21%	24%	21%
55 - 64	14%	15%	25%	18%	21%	21%	22%
65 - 74	9%	11%	22%	14%	21%	15%	24%
75+	7%	5%	10%	4%	18%	8%	10%

Table C-6 Race/Ethnicity of Respondents

Race/Ethnicity	Population Estimate	RLEP (n = 372)	CRP (n = 175)	EPM (n = 430)	HEIP (n = 319)	REP (n = 835)	RETIRE (n = 682)
American Indian/Alaska Native	-	0%	0%	0%	0%	1%	0%
East Asian	11%	17%	13%	17%	9%	7%	13%
South Asian	-	2%	3%	3%	1%	2%	4%
Black	9%	6%	1%	2%	13%	16%	6%
Latino	49%	28%	9%	12%	26%	50%	18%
Native Hawaiian or Other Pacific Islander	-	0%	0%	0%	0%	0%	0%
Middle Eastern or North African	-	3%	2%	3%	1%	1%	2%
White	55%	36%	68%	55%	42%	17%	51%
Some other race	-	1%	1%	1%	2%	1%	1%
More than one race	4%	5%	5%	8%	5%	5%	5%

*Note that comparisons with census data are limited because the census defines demographic groups differently from the survey. Most notably, the question on Latino or Hispanic identity is asked separately of questions on racial group identification. This difference may account for the higher percentage of Latino participants in most programs than is found in the population.

Table C-7 Household Income

Annual Household Income	Population Estimate	RLEP (n = 372)	CRP (n = 175)	EPM (n = 429)	HEIP (n = 318)	REP (n = 833)	RETIRE (n = 683)
Under $15,000	12%	8%	2%	3%	6%	25%	4%
$15,000 to less than $25,000	9%	17%	2%	2%	8%	31%	9%
$25,000 to less than $35,000	9%	9%	5%	2%	9%	22%	9%
$35,000 to less than $50,000	12%	11%	4%	5%	15%	13%	13%
$50,000 to less than $75,000	15%	18%	9%	9%	16%	6%	17%
$75,000 to less than $100,000	11%	11%	17%	13%	14%	2%	15%
$100,000 to less than $150,000	14%	15%	28%	28%	16%	0%	14%
$150,000 or over	17%	10%	34%	38%	16%	0%	17%