2009 Energy Efficiency Program Evaluation Plan

Pasadena Water and Power

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SUMMIT BLUE
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1 UTILITY OVERVIEW

Two legislative bills (SB1037 and AB2021) were signed into law a year apart. SB1037 requires that the Publically Owned Utilities (POUs), similar to the Investor Owned Utilities (IOUs), place cost effective, reliable, and feasible energy efficiency and demand reduction resources at the top of the loading order. They must now procure 'negawatts' first. Additionally, SB1037 (signed September 29, 2005) requires an annual report that describes the programs, expenditures, expected energy savings, and actual energy savings.

Assembly Bill 2021, signed by the Governor a year later (September 29, 2006), reiterated the loading order and annual report stated in SB1037 as well as expanding on the annual report requirements. The expanded report must include 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. AB2021 additionally requires a report every three years that highlights cost-effective electrical and natural gas potential savings from energy efficiency and established annual targets for energy efficiency and demand reduction over 10 years.

The legislative reports require both an on-going assessment of what is occurring within the programs along with a comparison of how much possible savings are left within the POU service territory. The goal of this 2009 energy efficiency program plan is to assist Pasadena Water and Power (PWP), to meet these requirements. This plan provides guidance and recommends evaluation, measurement, and verification (M&V) activities that will help PWP standardize and streamline the reporting process in order to meet the legislative requirements.

This plan identifies recommended M&V actions based on information gathered from staff interviews, a review of existing utility records, databases, and marketing materials. Based on this review, it is recommended that Pasadena Water and Power conduct the following M&V activities for its non-residential sector and further review the following:

- Current cost-effectiveness incentive calculations,
- Program tracking methods,
- The program process flow, and
- Engineering calculations and assumptions used to calculate program savings.

1.1 General Utility Background Information

In 1880, the population of Pasadena was 391. One hundred years later, in 1980, the population was 118,072. According to the 2000 Census, Pasadena's population increased to 133,936.The California Finance Department estimates the Pasadena population to be 148,126 in 2008. Pasadena covers approximately 22.5 square miles, with an average of ten residents per acre.

Pasadena is located 10 miles northeast of downtown Los Angeles. The city is bordered by the San Gabriel Mountains to the north and seven cities; La Canada Flintridge, South Pasadena, Arcadia, Sierra Madre, San Marino, Glendale, Los Angeles and unincorporated Altadena. The elevation is 864 feet above sea level.

The climate is sub-tropical and semi-arid. The average daytime temperature is 78 Fahrenheit. The overall average temperature is 65 F. The average yearly rainfall is 20 inches. During the winter months of December through March, it is sunny or partly sunny 75% of the time. Both coastal and interior weather influences the Southern Californian inland valley climate zone. The inland winds bring hot and dry air, and marine air brings cool and moist air. This area was famous for growing citrus because the summers are warm and winters never frost. According to Pasadena Weather Station records, this area has about 10% more CDD as HDD.

Table 1: Pasadena Weather Station Typical Meteorological Year Data

Base Temp: 65F	Pasadena
Heating Degree Days (HDD)	1,398
Cooling Degree Days (CDD)	1,558

1.2 Key Customer Markets

The 2005-2007 American Community Survey 3-Year Estimates show there are 51,973 occupied housing units in Pasadena and approximately 6,500 non-commercial establishments in its service territory.

1.3 Efficiency Programs Offered

PWP offers a variety of energy efficiency programs to its residential, commercial and industrial customers. Although the focus of this evaluation is on the commercial and industrial energy efficiency programs, brief descriptions of all energy efficiency programs are summarized in the next sections.

1.3.1 Residential Program Summaries

- **Pool Pump Rebate Program:** Available to all electric customers who replace their old pool pump with a new energy efficient dual-speed, four-speed or variable-speed pool pump. This program also offers additional incentives for customers who run their pool pump before noon and after 6 p.m. weekdays and running it no more than 4 hours per day.

Table 2: Rebate Amounts for Pool Pump Program

Purchased Outside Pasadena	Purchased Within Pasadena
$200	$250

- **Energy-Savings Light Bulbs:** ***CFLs :*** PWP wants you to replace your old incandescent light bulbs with energy-efficient compact fluorescent light bulbs (CFLs) .
    - **THE GOAL:** If all 53,000 Pasadena households switch to at least 10 energy-saving bulbs, the city will eliminate over **10,000 tons** of carbon dioxide emissions annually.

- **THE PLEDGE:** Make a pledge to switch to **10 energy-saving bulbs**, tell **10 Pasadena friends** to do the same, and help Pasadena eliminate over **10,000 tons** of carbon emissions every year.
  THE KIT: Between August and September 2008, every household in Pasadena received a **Power of 10 Challenge** energy-saving starter kit from PWP. Inside the kit was two free CFLs, a recycling pouch for **safe disposal of CFLs**, plus an order form for $75 worth of free CFLs.

PWP Cool Trees Program: PWP offers residential electric customers a rebate for planting any one of 37 species of shade trees. Estimates are that well-placed trees around a home can reduce air conditioning or cooling costs by as much as 20 percent. Residential electric customers who purchase an eligible "Cool Tree" will qualify for the following rebate amounts.

Table 3: Rebate Amounts for the Cool Trees Program

Your PWP rebate if trees are purchased from a Non-Pasadena vendor:	Your PWP rebate if trees are purchased from a Pasadena vendor:	Your "Greening Pasadena Rewards Program" bonus amount:**
up to $40*	up to $50*	up to $10*

- **PWP's Energy Star® Rebate Program:** PWP offers all residential electric customers rebates on certain ENERGY STAR® products. The ENERGY STAR label certifies that the product exceeds federal energy-efficiency standards. The following rebates apply to qualifying equipment.

Table 4: Rebate Appliance Amounts Energy Star® Rebate Program

Product Type	Limits	Your PWP rebate if the item was purchased from a Non-Pasadena retailer:	Your PWP rebate if the item was purchased from a Pasadena retailer:	"Greening Pasadena Rewards Program" bonus amount:* (green power customers only)
Energy Star® Refrigerator	Must be	$100/unit	$150/unit	$15
Refrigerator and Freezer Recycling Bonus	Limit 2 units recycled of any combination	Refrigerator -$25 incentive plus one 3-pack of CFL's Freezer - $35 incentive plus one 3-pack of CFL's	To schedule an appointment or to get more information call PWP's AnswerLine (626) 744-6970	N/A
Energy Star® Ceiling Fan with Compact Fluorescent (CFL) Bulbs*	Limit 2 units every 5 years	$40/unit	$50/unit	$5/unit
Energy Star® qualified CFL Bulbs 3-Pack	Limit one 3-pack per year	To receive a free 3-pack of CFL's take the online Home Energy Calculation survey or call the PWP AnswerLine (626) 744-6970	The Interactive Home Energy calculator can be found here.	N/A
Energy Star® qualified CFL lighting fixtures		$25/unit (May not exceed price of fixture)	$30/unit (May not exceed price of fixture)	$5/unit

PWP's Efficient Cooling Home Incentive Program: is providing rebates to its residential electric customers for the purchase and installation of energy efficient items to cool their home. Specifically, rebates are provided for central air conditioners (minimum 14.0 SEER), ENERGY STAR® room air conditioners, ENERGY STAR® dual-glazed windows and doors, ENERGY STAR® skylights and light tubes, window sun shade screens and solar or roof attic fans.

Table 5: Rebate Amounts for PWP's Efficient Cooling Home Incentive Program

Energy Efficient Cooling Item:	Your PWP rebate if the item was purchased from a Non-Pasadena retailer:	Your PWP rebate if the item was purchased from a Pasadena retailer:	Your "Green Power Rewards Program" bonus amount:
Central air conditioner - Tier 1 (≥14 SEER) TXV** required	$100/ton	$110/ton	$10/ton
Central air conditioner - Tier 2 (≥15 SEER) TXV** required	$110/ton	$120/ton	$10/ton
Central air conditioner - Tier 3 (≥16 SEER) TXV** required	$120/ton	$130/ton	$15/ton
Central air conditioner - Tier 4 (≥17 SEER) TXV** required	$130/ton	$140/ton	$15/ton
Central air conditioner - Tier 5 (≥18 SEER) TXV** required	$140/ton	$150/ton	$20/ton
ENERGY STAR® Room Air Conditioner	$50/unit - limit 2 units every 10 years	$75/unit	$10/unit
Solar Powered Attic or Roof Fan	$90/unit - limit 2 units every 10 years	$100/unit	$10/unit
Window Sun Shade Screens	$0.60/sq.ft. - installation must be made to windows on south, west or east walls. Screens must reflect 70% of the sun's heat and glare.	$0.75/sq.ft.	$0.10/sq.ft.
Energy Star® skylights or Light Tubes	$175/unit - limit 1 unit per room every 20 years	$200/unit	$20/unit
Energy Star® Dual-glazed windows & doors	$1.50 per square foot - every 25 years	$2.00 per square foot	$0.15 per square foot
**TXV=Thermal Expansion Valve To be eligible for the Green Power Rewards Program bonus amount you must be enrolled in the PWP Green Power program.			

PWP's All-electric Household Rebate Program: PWP is offering residential electric customers who live in all-electric homes rebates on certain energy efficient products. All-electric households use electricity, rather than natural gas, for heating. PWP is offering residential electric customers rebates on the following energy efficient products:

Table 6: Rebate Amounts for PWP's All-Electric Household Rebate Program

Product Type	Your PWP rebate if the item was purchased from a Non-Pasadena retailer:	Your PWP rebate if the item was purchased from a Pasadena retailer:	Your "Greening Pasadena Rewards Program" bonus amount:**
Energy Efficient Heat Pump (tier 1)*	$100/ton	$115/ton	$15
Energy Efficient Heat Pump (tier 2)*	$125/ton	$140/ton	$20
Energy Efficient Heat Pump (tier 3)*	$150/ton	$160/ton	$15
ENERGY STAR® Dishwasher	$60/unit	$75/unit	$15
ENERGY STAR® Clothes Washer	$80/unit	$100/unit	$20
ENERGY STAR® Programmable Thermostat	$20/unit	$25/unit	$5

Refrigerator Recycling Rebate: PWP provides a ***$***25 rebate for refrigerators or a $35 rebate for freezers, and a coupon redeemable for three compact fluorescent light bulbs to its residential electric customers who recycle their old, inefficient refrigerator. To be eligible, you must be a PWP residential electric customer. The refrigerator must be in working order to qualify. There is a two-unit limit per household.

1.3.2 Non-residential Program Summaries

PWP also offers a variety of energy efficient programs to its commercial and multi-family customers. Brief program descriptions follow:

- **Energy Efficiency Partnering (EEP) Program:** Pasadena Water & Power offer non-residential customers one a flexible energy efficiency incentive in which any permanently installed energy-saving retrofit project may qualify for a rebate incentive.

  The total standard rebate received may not exceed 50% of the project's cost. The incentive levels are:

  - *For Energy Efficiency Savings (kWh:* For each kWh that the new project saves in comparison to the existing equipment's kWh usage, you will receive $0.11 (for a minimum of six months, and up to 48 months).

  - *For Energy Demand Reduction (kW):* If your project also reduces your coincidental summer or winter peak load by 20 kW or more, you will receive an additional $100 for each peak kW that has been reduced (for a maximum of four years).

  Currently, this program is fully subscribed and new applications are put on the waiting list. All applications expire after 6 months.

- **High-Performance Building Program:** PWP offers incentives to encourage owners and developers to explore higher levels of energy efficiency and to ensure the inclusion of energy-efficiency features in a new construction or large retrofit project. The program offers participating customers:
    - An energy efficiency matching rebate and lower energy costs.
    - Free technical assistance to provide additional resources, new technologies, and other financial incentives that may be available.

  Financial incentives are available to customers when the efficiency of the new building or large retrofit exceeds the minimum threshold (12% above California's 2005 Title 24 Energy Efficiency Standards). These incentives encourage owners to make energy efficiency a major goal in their projects, and recognize the extra effort required to achieve these higher levels of efficiency.

  Rebates are capped at a maximum of $100,000 per freestanding building or individual electric meter. The program matches one month's electricity savings for each percentage better than code that the building performs.

- **Pasadena LEED Certification Program:** The goal of the Pasadena LEED Certification Program is to encourage private sector builders to construct sustainable buildings and receive LEED certification from the U.S. Green Building Council. LEED certification provides independent, third-party verification that a building meets the highest performance standards. Green Building Incentives will be awarded to successful applicants as follow:
    - LEED™ Certified $15,000
    - LEED™ Silver $20,000
    - LEED™ Gold $25,000
    - LEED™ Platinum $30,000

Incentives are approved on a first-come, first-served basis. Applicants will be required to provide verification of LEED registration and receive their City building permit before any funds are reserved. Incentives will be awarded upon showing proof of LEED certification.

- **Direct Install Emerging Technologies (DIET) Program:** PWP is providing special funding of up to 100% of the cost of projects under this program. The program consists of the following components:
    - No-cost review of facilities to identify comprehensive and emerging savings opportunities.
    - Report of recommendations and energy savings potential, which can often represent up to 30% energy saving.
    - Completion of installation and arrangement, when requested, for special vendor-financing to eliminate any cash outlay.

    - Eligible equipment includes:
        - **Daylight Harvesting Ballast** reduces fluorescent lighting cost up to 70% in areas that receive daylight via windows or skylights. When the ballast photosensor senses light, power is automatically reduced to a level that maintains lighting quality while achieving major savings.
        - **HVAC Cycle Management (CMU)** reduces energy cost of single-zone packaged HVAC, typically by 12-18%. CMU analyzes demand every cycle to determine when,

and for how long, during each cycle, the HVAC can "coast" with the fan running, while maintaining temperature.

- **CO2 Sensor System** for demand-control ventilation eliminates high cost of excessive outside air use for building ventilation. Outside air is pre-set for maximum expected occupancy. When occupancy is below maximum, there is up to 500% over-ventilation, wasting energy to heat or cool outside air. Sensors detect CO2 exhaled by occupants and adjust outside air to match the needs of real-time occupancy.
- **Delta P Pressure Independent Water Flow Control Valve** maintains optimum coil performance in chilled water systems by stabilizing water flow through the coils regardless of demand level.
- **HVAC Ultraviolet (UVC)** install at HVAC coils to reduce energy cost, eliminate coil and drain pan cleaning, and greatly improve I.A.Q. to reduce absenteeism and improve productivity.
- **Hotel Room Key Card Energy System** reduces hotel/motel room energy costs 20% to 45% by controlling energy use when a room is unoccupied. When entering rooms, guests place the key card in an entry-area energy slot to turn on HVAC, selected lighting and power outlets. When a guest leaves a room and removes the keycard, HVAC, lighting and power outlets revert to energy saving levels set by management, which always maintains guest comfort.
- **Diesel Emergency Generator Heat Pump** takes over the function of block heaters to maintain stand-by temperatures of diesel generators, typically at 90 to 120 degrees F, saving 70% to 80% of the energy cost. The heat pump's efficiency level is four times greater than that of a block heater.

- **Commercial Customer Educational Offerings**

PWP also offers a variety of commercial energy efficiency workshops in partnership with Burbank Water & Power and Glendale Water & Power. These free workshops addressed the following topics:

- Workshop 1: Save Energy, Save Money: Introduction to Energy Efficiency and Rebates
- Workshop 2: Adjustable Speed Drives
- Workshop 3: Air Handling System Efficiency
- Workshop 4: Chilled Water System Efficiency
- Workshop 5: Cooling Tower Efficiency
- Workshop 6: Energy Management Systems (EMS)

2 PROCESS EVALUATION

The focus of these activities were to gain a better understanding of current nonresidential program operations, assess the overall effectiveness of program operations, and identify areas for program improvement. The key elements in this process evaluation were to:

- Task 1 – Review current program tracking methods
- Task 2 - Assess program flow
- Task 3 - Conduct interviews with key program staff and third-party vendors

2.1 Task 1 – Review Current Program Tracking Methods

PWP currently uses the E3 calculator to track program results. The E3 calculator is the primary reporting tool used by the public electric utilities in California to report their annual energy efficiency program accomplishments to the CEC. The tool includes a significant amount of data, including energy and peak demand for a large number of measures, associated measure costs, avoided cost data, and rates data, among other data. PWP utilizes the E3 calculator algorithms to identify appropriate cost effective incentive levels.

The Summit Blue team reviewed the methods used by PWP to develop their incentive levels. PWP created a spreadsheet with information extracted from the E3 calculator to assist them in identifying appropriate cost effective incentive levels. This spreadsheet duplicates the subset of calculations performed within E3 that help identify the appropriate cost effective incentive levels with the convenience of being much easier to use. The SB team reviewed each of the formulas within the PWP calculator and found them to be properly formulated and pointing to proper input values. In addition to formulas, the PWP calculator depends on a set of avoided cost ratios extracted from the E3 calculator. The ratios depend in part on the length of measure life. SB was able to replicate these ratios from the E3 data. In summary, the PWP calculator properly replicates the functions of the E3 calculator and is a useful and appropriate tool to use to help identify appropriate cost effective incentive levels.

Table 7: Comparisons of Residential and Non Residential Energy Efficiency Program Metrics for FY 2007-08

	Units Installed	Net Demand Savings (kW)	Net Peak kW Savings	Gross Annual kWh Savings	Net Annual kWh Savings	Net Lifecycle kWh savings	Utility Incentives Cost ($)	Utility Mktg, EM&V, and Admin Cost ($)	Total Utility Cost ($)
Residential	125,612	6,555	1,390	6,883,895	6,759,684	75,000,124	758,710	114,898	873,608
% of Total	**99.32%**	97.06%	87.51%	82.44%	82.80%	81.45%	64.32%	64.81%	64.39%
Non-Residential	866	198	198	1,466,657	1,403,933	17,081,699	420,800	62,391	483,192
% of Total	**0.68%**	2.94%	12.49%	17.56%	17.20%	18.55%	35.68%	35.19%	35.61%

Total	126,477	6,753	1,589	8,350,552	8,163,616	92,081,823	$1,179,510	$177,289	$1,356,799

Source: E 3 calculator results for PWP

As Table 7 shows, the majority of PWP's energy efficiency past activities during the 2007-08 budget cycle have been focused on residential programs, primarily due to budget constraints. This finding is highlighted further by the comparison of units installed through these programs, as shown in Figures 1 and 2. To date, the majority of PWP's energy savings are from the installation of energy efficiency lighting products, specifically CFLs and LEDs. These savings appear to be based on the assumption that all 10 light bulbs were installed. This assumption should be reviewed though an independent M&V process. On the commercial side, most of the rebates are either for HVAC or lighting installations.

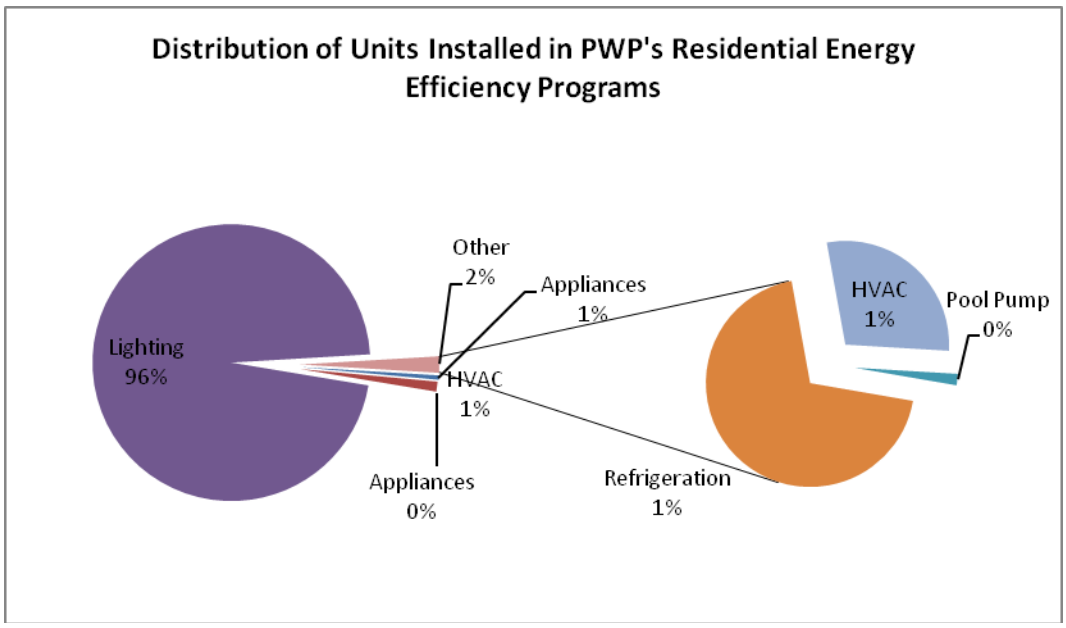


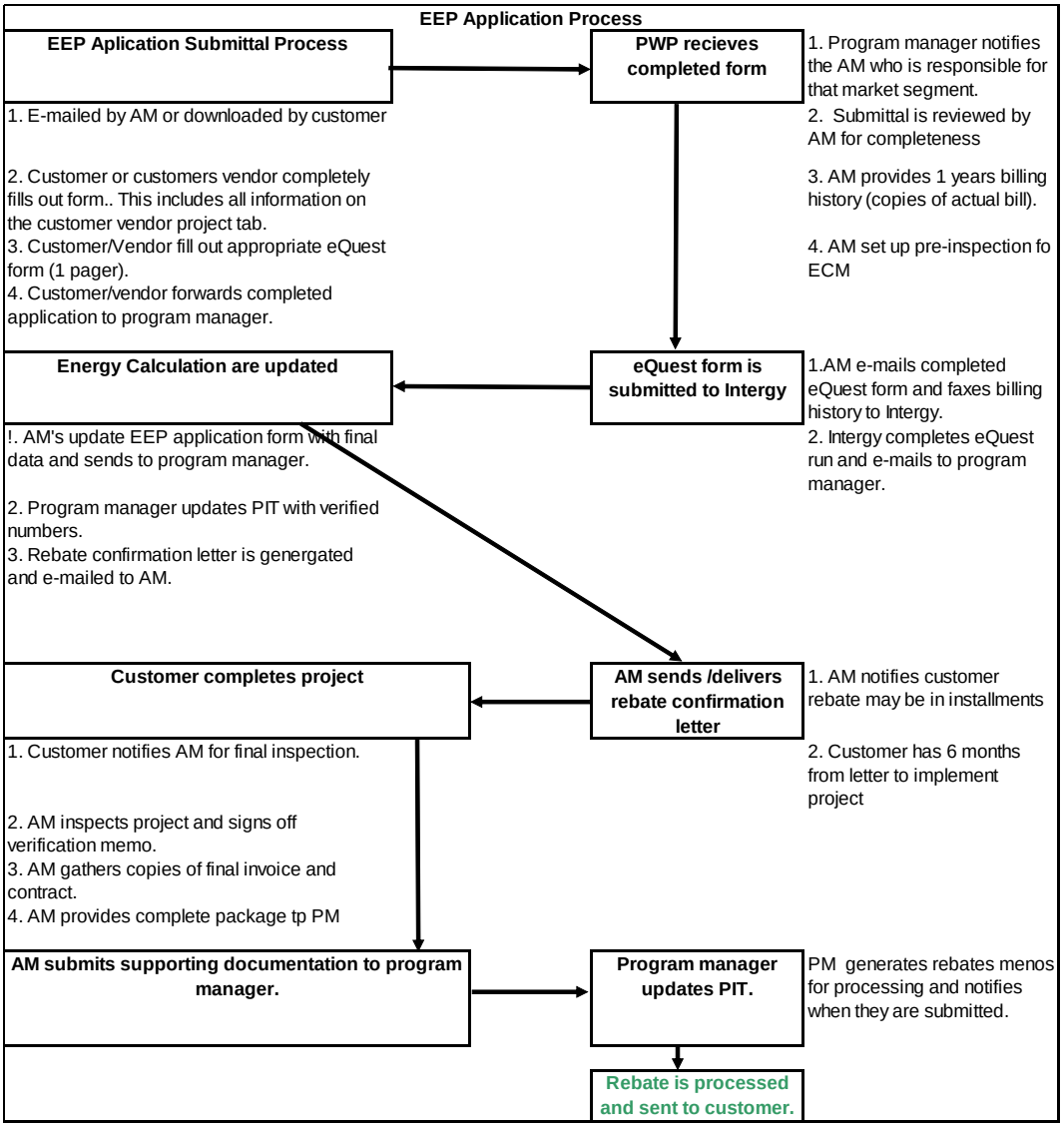
Figure 1: Distribution of Units Installed in PWP's Residential Energy Efficiency Programs

Historically, PWP has relied on achieving most of its energy savings from the installation of residential lighting products. To date, the residential program accounts for nearly all energy efficiency activities at PWP, and therefore should be included in future EM&V plans. Future PWP program emphasis is shifting to the commercial sector, which will provide a more balanced energy efficiency portfolio.

2.2 Task 2 - Assess Program Flow

The Summit Blue reviewed the flow on interactions and information between the various parties involved in PWPs non-residential energy efficiency programs. The program flow, illustrated in Figure 3, was a major area of discussion among the staff and third-party vendors. Overall, the program flow meets the appropriate needs for the documentation and approval of rebates.

Figure 2: Process flow for its commercial programs



2.3 Summary of Staff and Vendor Interviews

This section summarizes the key findings from interviews conducted with program staff and the vendors who are responsible for providing analytical support for PWP's commercial and industrial programs.

Staff Interview Findings

The staff interviews focused primarily on program operations, particularly as it pertained to the tracking and calculation of estimated savings from energy efficiency projects.

Program Operations: The staff reported that they were pleased, overall, with program operations. The commercial programs are the EEP, HPBP, DIET and the Pasadena LEED Certification Program, are all

designed to provide customers with a "holistic approach" to making energy efficiency investments that not only comply with the minimum Title 24 codes (such as in the HPBP), but also provide even larger energy savings. While the focus of n the programs is not to just push for LEED certification but rather, PWP wants to encourage LEED certification if the building is close to meeting those standards. PWP's focus in its LEED program is its emphasis on energy efficiency improvements in coordination with the LEED standards.

Overall, the staff is pleased with the integrated nature of the PWP's program designs and believes that this program provides consistent guidance to building owners and developers.

Program Enrollment: The EEP Program had a waiting list for customers to participate. After six months, the customers must reapply in order to be considered for program funding, as a way to ensure that proposed projects are still "in the pipeline." There are currently about 54 customers in this program, and there is a group of relatively large customers including educational facilities such as school districts and Cal Tech's 60 buildings.

Program Database and Tracking: The program database is a combination of MS Excel and MS Access databases. Although the intention is to have the database completely integrated with the other energy efficiency programs, that has not been completed. The staff is trying to make the tracking system run as seamlessly as possible, although they admit there have been some difficulties with getting the database up and running within a reasonable timeframe (specifically the financial constraints requiring an RFP to continue work on the database delayed the implementation.) . They are pleased with the current set up for the data audit forms and are not interested in incorporating the text comments captured in the current spreadsheet into a numerical format. The staff requires eQuest runs on every project.

Areas for Improvement:

- **Program Design:** The HPBP program design may have to be adjusted to meet the new code requirements that buildings must be 20 to 25% more efficient, so that may make it more difficult for some customers to become eligible for rebate funding. The program is designed to be able to make adjustment as necessary based upon quarterly evaluations. In fact the program was adjusted with lower incentive rate in May. Minimum "early replacement" equipment eligibility and incentives are based on cost-effectiveness of energy savings. HPBP only: new construction equipment eligibility and incentives are based on a percentage of energy savings above T-24 standards)

- **Program Tracking:** The database is still "under construction" and will require some additional work in order to fully meet the program needs. This is still a labor-intensive activity that should be more automated as the program continues.

Vendor Interview Findings

The Summit Blue team also interviewed the vendor responsible for calculating the savings estimates for its commercial and industrial energy efficiency programs. These interviews focused primarily on how the program operations were affected by program database and tracking activities.

Program Operations: This firm provides the third party verification and savings estimates for the commercial programs. They perform the initial assessment of energy savings and then provides more calculations to determine the estimated savings from proposed energy efficiency projects.

Program Database and Tracking: The vendor reports that significant improvements to application processing has been made since implementation of some internal staffing changes. The vendor also reports that the delays experienced earlier in the program have been eliminated. The vendor also indicated that "PWP has been extremely patient" as they worked to establish the proper workflows, applications, and database tracking.

These programs involved managing a significant amount of paperwork from the audit forms, and energy calculations. However, the program is now running smoothly and application processing is generally completed with a one-week timeframe.

The program vendor also provides additional information to help with program management including weekly status reports, monthly budget recaps, and energy analysis in addition to billing support.

Areas for Improvement:

The vendor is concerned that PWP may be relying too heavily on the vendor to provide engineering analysis beyond the current program offerings. As a way to ensure that new technologies are properly reviewed for inclusion in the commercial programs, the vendor believes PWP would benefit from having an internal engineering review process as well.

2.4 Key Findings and Recommendations from the Process Evaluation

A key objective for the process evaluation component of this plan was to determine the overall effectiveness of the current data tracking for program operations. The key findings include:

- The EEP program has been well-received among PWP customers and participation rates are likely to increase once all the programs have become fully operational.
- The commercial programs appear to be well-designed and focus on helping customers achieve maximum energy efficiency savings through a variety of approaches.
- Overall, program operations have improved significantly in the past few months and the programs are operating efficiently.
- PWP continues to look for ways to expand the programs' focus, especially with the DIET program. However, there is a risk on relying on the implementation contractor to perform energy analysis on future programs or technologies. Instead, new program technologies should be reviewed internally by PWP staff to ensure that they will are appropriate in PWP's service territory.

3 METHODOLOGY EVALUATION OF THE NON-RESIDENTIAL CUSTOM PROGRAM

Pasadena Water & Power uses two main evaluation consultants for projects in the Custom program. The project reports provided for review were hard-copy evaluations that did not include details of the algorithms used for calculations. However since eQuest is used by the program, this should not be necessary.

3.1 Methodology Evaluation Overview

The methodologies used to calculate savings for the Non-Residential Custom Program included the following:

1. eQuest models to be used for all savings calculations
2. Actual rather than Title 24 baselines used for project savings

The reporting details are discussed in detail in the following sections. Additional detailed information may be found in the appendices.

3.2 Methodology Review

The objective of the methodology review was to review one site level retrofit report by each of the two main consultants used by PWP for the custom program. Although the two used different reporting formats, both were expected to use DOE-2 based models for their savings calculations. The original consultant did not use eQuest but rather the basic DOE-2 model. The eQuest requirement has been the standard for the last 8 months.

It should be noted that although eQuest is an industry standard DOE 2.2 modeling tool, its results can be very sensitive to certain inputs. This is less of an issue with the PWP application of modeling savings on a single system rather than for a full building model. Because of this, the primary focus of our review was on the choice of input parameters for the models.

3.2.1 Methodology Review Sample

The two projects reviewed for this study involved custom HVAC retrofits. They were provided to Summit Blue by Pasadena Water & Power and represent reporting by the two major program consultants used by the utility.

Table 8. Program Installations and Savings

Customer	Retrofit Measures	kW	kWh
Site 1	Retrofit of Water Cooled Direct Expansion to Variable Flow Chilled Water	247	825,780
Site 2	Packaged HVAC Units	108.98	297,300
Evaluation Total		355.98	1,123,080

Both sites planned efficiency improvements to their cooling systems. The retrofits involved replacement of HVAC equipment at both sites, as shown in Table 8, above.

3.2.2 Review Activities

Review activities involved a review of the site level reports. Since eQuest is a standard tool, a full review of its algorithms was not required. The focus of this review is on inputs and assumptions used for the models. Summit Blue looked for several items in the reports during the review including:

1. Clear statement of baseline and calculation assumptions
2. Explanation of the project as a whole
3. Key equipment parameters, such as EER or COP
4. Other inputs to the eQuest model, such as airflow and area of the conditioned space
5. Confirmation that eQuest was used for calculations

3.2.3 Methodology Review Results

Review work and an analysis of the site reports showed that the overall methodology was sound, but better documentation and justification of certain assumptions would be helpful.

Site 1

Site 1 converted its central plant from a water cooled direct expansion air conditioning system with reciprocating compressors to two new 290-ton centrifugal chillers with variable speed, oil-free compressors. The thirteen existing direct expansion units were to be replaced with chilled water coils for the air handlers on each floor of the building. Additionally, the basement was to be equipped with a chilled water fan coil and two-way valves were to be installed at each of the fourteen coils. Additionally a new 700 ton cooling tower with variable frequency drives on its fans was to be installed along with variable flow condenser water pumping. One of the two existing 40 horsepower condenser pumps will be removed.

Engineering consultant 1 was hired to conduct a pre-installation study of this project to determine the savings for this project prior to installation. The consultant provided Pasadena Water & Power with a nineteen page report evaluating the proposed project. This report included a short summary of the project, analyses of the existing and proposed load profiles, operation schedules for the building, airflow data by floor, and summaries of usage by component.

The documentation provided DOE-2 model outputs and inputs. Billing calibration was provided for the analysis along with actual data logging of the system to establish the baseline kW per ton of the HVAC system. However, the time and expense involved in this is not justified for a simple replacement of a single system, such as in this case.

The cooling tower was apparently switched from a forced draft to an induced draft model. This is not explicitly stated in the project summary, however the replacement of two 40 HP fans with two 10 HP units as listed in the project summary strongly indicates that this is the case. One of the two 40 HP water pumps was also removed and the new system included variable frequency drives on all three motors.

The baseline of the existing Carrier water cooled, direct expansion units was calculated at 1.56 kW/ton. This is significantly higher than a typical new direct expansion, water cooled unit, which would probably

be less than 0.9 kW/ton. However, this value was established by data loggers and is a measured value. Title 24 based savings are not included in this estimate. However, since the entire cooling scheme has been changed, and no direct comparison is applicable, use of "as-is" energy for the baseline is not an uncommon way of treating savings. Nevertheless, a Title 24 comparison would be informative in this report. Appendix A shows the Title 24 efficiency requirements for new units.

As shown in Table 9, the calculated annual energy savings for the site amount to 70% of the cooling baseline, but only 40% demand savings. This is an unusually high percentage, however based upon the provided documentation it appears to be feasible. The savings include a 100 HP reduction at the cooling tower, along with a reduction in the cooling tower temperature setpoint from 80 °F to 72 °F. The temperature reduction should allow a reduction in use of the main compressors, particularly at off-peak hours. Additionally, the replacement of the old reciprocating system with using 1.56 kW/ton with a new variable speed centrifugal chillers using only 0.47 kW/ton will definitely produce significant savings. These factors should allow for the claimed 70% savings. The cooling tower temperature setpoint reduction and addition of variable speed drives is consistent with the lesser reduction in demand savings of 40%.

Table 9. Site 1 Baseline and Savings

	kW	Annual kWh
Baseline Cooling Usage	625	1,177,343
Retrofit Cooling Usage	378	351,563
Cooling Savings	247	825,780

Site 2

Site 2 retrofitted 311 packaged terminal air conditioning units totaling 389 tons of cooling. The rebate justification noted that eQuest building modeling was the validation method. The building at the site was a 190,000 square foot, four floor hotel with 136,840 square feet of conditioned space. Air conditioning operates continuously, twenty-four hours a day, 365 days per year. In addition to the eQuest model, a SPC estimation software savings calculation was included.

The units to be replaced were listed as being only one year old in the PWP application, although this may be a default value, as the old EER was stated as degraded to 7 from an original 8.8 along with a COP degraded from 2.6 to 2. The new EER was significantly higher at 9.8 with a standard COP of 2.6. A static pressure of two inches and airflow of 400 cfm/ton are included in the listed inputs to the SPC software.

This report included a summary of usage for different systems in the building based upon the eQuest model. The summary sheet showed ventilation fan, miscellaneous equipment, and area light usage in addition to space cooling requirements. The non-cooling numbers may have been based on default settings in eQuest, although this was not explicitly stated, and were not changed between the base and retrofit cases. The savings is the sum of cooling and heating savings for the new equipment.

There are two separate values given for rebatable savings. The eQuest output sheet shows 20.8 kW and 55,800 kWh. However there is also a summary table that lists SPC estimation software AC&R cooling unit savings as "rebatable savings" separately from eQuest rebatable savings. These SPC values show 25 kW and 72,228 kWh/year savings.

The site 2 eQuest summary included savings based both upon the degraded values of the old air conditioning units and savings based upon a Title 24 baseline. A month-by-month savings output is included, along with outputs showing that only May, June, July, August, September, and October savings were used in calculating demand savings.

The most notable issue is that the standard rebate estimate is based upon the degraded savings rather than the Title 24 or SPC savings. The PWP incentive check processing request and EEP rebate estimate form both list 297,300 kWh and 108.98 kW savings, which is the savings shown in the tables as actual, rather rebatable savings. This amounts to 23% savings relative to the baseline. Although non-IOUs in California are permitted to use actual savings for rebate and reporting purposes, it would be advisable to provide justification for the degraded EER value of the existing system when making this savings claim.

Table 10. Site 2 Baseline and Savings

	HVAC kW	Annual HVAC kWh	SPC HVAC kW	SPC HVAC kWh	Title 24 HVAC kW	Title 24 HVAC kWh
Baseline Cooling Usage		1,265,900		826,332		1,024,400
Retrofit Cooling Usage		968,600		754,104		968,600
Cooling Savings	108.98	297,300	25	72,228	20.8	55,800

3.3 Evaluation Observations

There were two items of note when comparing both reports:

1. *Use of actual rather than Title 24 savings for rebate applications.* Both studies use savings based on actual, degraded HVAC equipment. Non IOUs in California are not required to use Title 24 baselines, however this is the accepted standard practice and provides conservative savings values. Additionally, it is difficult to verify that free-ridership is not an issue when older equipment is replaced and degraded efficiencies do not appear to have been verified through measurements prior to the studies.
2. *Lack of detail in reporting in the first report.* eQuest is currently the standard modeling framework used by PWP and it does have a standard reporting format. However, eQuest was not used in the first report and this resulted in very different selections of included tables and graphs for the two consultants. Now that eQuest is the standard reporting tool, there should be consistency in the future.

4 IMPACT EVALUATION PLAN

A process evaluation has already been developed within Section 2 of this report and does not need to be repeated this fiscal year. As noted in Section 2, most of PWP's claimed energy savings in the last fiscal year accrued from its residential programs; primarily its CFL program efforts. It is our understanding that a telephone survey evaluation of this residential CFL program is currently being undertaken. The results from this effort should be included in PWPs next annual report to the CEC.

Much of the emphasis for the current fiscal year is shifting to the non-residential custom program. Section 3 of this Report provided our review of the methodology for implementing and tracking results for the non-residential custom program. Summit Blue believes that PWP has developed a strong framework for program implementation and the program effort should be successful. The program has been very successful and the CMUA gave it an award for the best public benefits rebate program for a utility of their size. What follows are our recommendations for measurement and verification of the results from PWPs non-residential efficiency program.

4.1 Impact Evaluation Research Issues and Objectives

The primary objectives of an impact analysis are:

1. Review engineering assumptions or deemed savings assumptions currently used.
2. Perform metering as needed.
3. Develop an analysis approach designed to minimize uncertainty of reported savings.
4. Independently (non-utility, non-program implementer) verify measure installations.
5. Calculate verified gross demand and energy savings and develop program realization rates.

4.2 Methods and Data Sources

A useful construct for thinking about the range of efficiency measures covered by the Program is the International Performance Measurement and Verification Protocol (IPMVP). Table 11 presents a listing of the IPMVP protocols, the nature of the performance characteristics of the measures to which M&V options typically apply, and an overview of the data requirements to support each option. Our approach to selecting M&V strategies follows these guidelines.

Table 11: Overview of M&V Options

IPMVP M&V Option	Measure Performance Characteristics	Data Requirements
Option A: Engineering calculations using spot or short-term measurements, and/or historical data	Constant performance	• Verified installation • Nameplate or stipulated performance parameters • Spot measurements • Run-time hour measurements
Option B: Engineering calculations using metered data.	Constant or variable performance	• Verified installation • Nameplate or stipulated performance parameters • End-use metered data
Option C: Analysis of utility meter (or sub-meter) data using techniques from simple comparison to multi-variate regression analysis.	Variable performance	• Verified installation • Utility metered or end-use metered data • Engineering estimate of savings input to SAE model
Option D: Calibrated energy simulation/modeling; calibrated with hourly or monthly utility billing data and/or end-use metering	Variable performance	• Verified installation • Spot measurements, run-time hour monitoring, and/or end-use metering to prepare inputs to models • Utility billing records, end-use metering, or other indices to calibrate models

Evaluation priorities should be based on a combination of relative size of the savings achieved, the degree of uncertainty with *ex ante* estimates of the savings, and where future program growth is expected. Based on the large share of *ex ante* estimates of claimed savings, priority should be given to evaluating the residential CFL program. This effort is currently underway. Of equal importance, both from the perspective of anticipated future growth as well as higher levels of *ex ante* uncertainty in regards to claimed savings is the non-residential custom program. How this program is evaluated will vary from site to site depending of the measures implemented.

For non-residential lighting measures, it is our recommendation that M&V Option "A" is the most appropriate methodology. The methodology recommended is a review of the engineering estimates used to develop the *ex ante* estimates. These engineering estimates may be deemed savings, where the evaluation insures that the proper savings value is used, or a review of the engineering calculations, generally provided in a spreadsheet.

For process measures, motors, air compressor measures, and other custom measures, the savings may be based either on deemed estimates or calculated with spot load measurements (by the original installer), manufacturer's data, and estimated hours of operation. In either case, the underlying assumptions need to be reviewed, especially the assumed hours of operation. Spot metering may also be needed (Option B).

In all cases, on-site verification of installation should be performed.

4.3 Identify Impact Evaluation Sample

Once the population of program participants has been identified, a weighted sample should be drawn with the weight based on the level of claimed energy savings by site. It is suggested that the sample have a

level of precision and confidence of 90% +/- 10%. It is uncertain how many sites would be needed to meet this level of precision and confidence until the full population of participants are known. It should be remembered that small participant population sizes leads to greater shares of sampled sites to maintain statistical validity.

4.4 Installation Verification

Verification that measures have actually been installed is an important part of an impact evaluation. M&V efforts of custom program participants nearly always require on site visits. During these on-site visits, the characteristics of the measures installed will be verified.

4.5 Calculate Gross Energy and Demand Impacts

It is expected that the same methodology used to develop the *ex ante* estimates of savings will be used for the *ex post* estimates. What may change are some of the input variables into the methodology, such as hours of operation, or specific equipment sizing. If sampling is employed, a weighting factor will be used to normalize the results to the full participant population. Demand impacts will be based on the kW/kWh ratio currently used in the *ex ante* estimates.

4.6 Prepare an EM&V Report for PWP's Non-Residential Efficiency Program

The evaluation consultant should issue a final report to the utility summarizing the results from the evaluation and describing any recommendations that come from the evaluation. These recommendations will assist PWP in meeting the requirements with the AB2021 requirements and will be submitted to the California Energy Commission (CEC).

The final report should include:

E: Executive Summary

1. Introduction and Selected Evaluation Issues

1.1. Program Overview

1.2. Program Objectives

2. Impact Evaluation Plan

2.1. Research Issues and Objectives

2.2. Methods & Data Sources

2.3. Sample Design

3. Data Collection Plan

4. Impact Evaluation Results

4.1. Findings

4.2. Recommendations

5. Evaluation Based Recommendations

5 ESTIMATED BUDGET

The actual budget cannot be determined until the sample population is known and the sample draw made. The evaluation efforts may vary significantly from project to project, depending on the measures installed. However, based on our experience with other California Municipal utilities, it is expected that this effort would need a budget of between $40,000 to $60,000.

APPENDIX A: TITLE 24 COOLING EFFICIENCY REQUIREMENTS

Table A-1. Unitary Air Conditioner Efficiency Requirements

TABLE 112-A ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Efficiency [a]		Test Procedure
		Before 1/1/2010	After 1/1/2010	
Air Conditioners, Air Cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	10.3 EER[b]	11.2 EER[b]	ARI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	9.7 EER[b]	11.0 EER[b]	ARI 340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	9.5 EER[b] and 9.7 IPLV[b]	10.0 EER[b] and 9.7 IPLV[b]	
	≥ 760,000 Btu/h	9.2 EER[b] and 9.4 IPLV[b]	9.7 EER[b] and 9.4 IPLV[b]	
Air Conditioners, Water and Evaporatively Cooled				ARI 210/240
	> 240,000 Btu/h	11.0 EER[b] and 10.3 IPLV[b]		ARI 340/360
Condensing Units, Air Cooled	≥ 135,000 Btu/h	10.1 EER and 11.2 IPLV		ARI 365
Condensing Units, Water or Evaporatively Cooled	≥ 135,000 Btu/h	13.1 EER and 13.1 IPLV		

[a] IPLVs are only applicable to equipment with capacity modulation.

[b] Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

Source: 2008 Building Efficiency Standards for Residential and Non-Residential Buildings

Table A-2. Title 24 Heat Pump Efficiency Requirements

TABLE 112-B UNITARY AND APPLIED HEAT PUMPS, MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Subcategory or Rating Condition	Efficiency [a]		Test Procedure
			Before 1/1/2010	After 1/1/2010	
Air Cooled (Cooling Mode)	≥65,000 Btu/h and <135,000 Btu/h	Split System and Single Package	10.1 EER[b]	11.0	ARI 340/360
	≥135,000 Btu/h and <240,000 Btu/h		9.3 EER[b]	10.6	
	≥240,000 Btu/h		9.0 EER[b] and 9.2 IPLV[b]	9.5 EER[b] and 9.2 IPLV[b]	
Air Cooled (Heating Mode)	≥65,000 Btu/h and <135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.2 COP	3.3 COP	ARI 210/240
	≥135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.1 COP	3.2 COP	ARI 340/360

[a] IPLVs and Part load rating conditions are applicable only to equipment with capacity modulation.

[b] Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

Source: 2008 Building Efficiency Standards for Residential and Non-Residential Buildings

Table A-3. Title 24 Water Chiller Efficiency Requirements

TABLE 112-D WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Efficiency	Test Procedure
Air Cooled, With Condenser, Electrically Operated	< 150 Tons	2.80 COP 3.05 IPLV	ARI 550/590
	≥ 150 Tons		
Air Cooled, Without Condenser, Electrically Operated	All Capacities	3.10 COP 3.45 IPLV	
Water Cooled, Electrically Operated, Positive Displacement (Reciprocating)	All Capacities	4.20 COP 5.05 IPLV	ARI 550/590
Water Cooled, Electrically Operated, Positive Displacement (Rotary Screw and Scroll)	< 150 Tons	4.45 COP 5.20 IPLV	ARI 550/590
	≥ 150 Tons and < 300 Tons	4.90 COP 5.60 IPLV	
	≥ 300 Tons	5.50 COP 6.15 IPLV	
Water Cooled, Electrically Operated, Centrifugal	< 150 Tons	5.00 COP 5.25 IPLV	ARI 550/590
	≥ 150 Tons and < 300 Tons	5.55 COP 5.90 IPLV	
	≥ 300 Tons	6.10 COP 6.40 IPLV	
Air Cooled Absorption Single Effect	All Capacities	0.60 COP	ARI 560
Water Cooled Absorption Single Effect	All Capacities	0.70 COP	
Absorption Double Effect, Indirect-Fired	All Capacities	1.00 COP 1.05 IPLV	
Absorption Double Effect, Direct-Fired	All Capacities	1.00 COP 1.00 IPLV	
Water Cooled Gas Engine Driven Chiller	All Capacities	1.2 COP 2.0 IPLV	ANSI Z21.40.4

Source: 2008 Building Efficiency Standards for Residential and Non-Residential Buildings