|  |
| --- |
| HVAC  Unitary Air-Cooled AC or Heat Pump,  ≥ 65 kBtuh, Commercial  SWHC013-02 |

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Measure Name

Unitary Air-Cooled Air Conditioner or Heat Pump, ≥ 65 kBtuh, Commercial

Statewide Measure ID

SWHC013-02

Technology Summary

A single-package air conditioning (AC) or heat pump (HP) unit consists of a single package (or cabinet housing) that includes a condensing unit, a compressor, and an indoor fan/coil. A single-package unit is typically installed on the roof of a building and will sit on a "roof-curb" or supporting beams. A down-flow unit has the benefit of concealed ducting, which minimizes the chances of water leaking through a roof penetration. An additional benefit of a package unit is that there is no need for field-installed refrigerant piping, which minimizes labor costs and the possibility of contaminating the system with dirt, metal, oxides or noncondensing gases.

A split system consists of two major parts in separate housings: a remote condensing unit and an indoor fan/coil. These system components are connected by a set of refrigerant lines. The fan/coil includes a furnace section for a gas-fired heating system. Typical locations for the fan/coil are the attic space, under-floor, or in a closet or mechanical room. Locating the fan/coil in a conditioned or semi-conditioned space will help the system operate more efficiently by cutting down the thermal gains and losses to the unit and ducting.

There are two different indicators of energy efficiency of air conditioners with capacity > 65 kBtuh: the energy efficiency ratio (EER) and the integrated energy efficiency ratio (IEER). The EER represents the energy efficiency corresponding to peak loading (kW) and the IEER corresponds to a weighted average of ratings at different loads, considering part-load performance. The heating function of commercial heat pumps is rated using coefficient of performance (COP), which is tested at 47 °F ambient conditions.

Single-package AC/HPs are common in the commercial sector; the ratio of split-system versus single-package AC/HP in the commercial market sector is approximately 1:20. Split-system AC/HPs are more common in the residential construction.

Air-source single-package and split-system AC/HP units ≥ to 5.4 tons (65 kBtuh) and < 11.3 tons (135 kBtuh) are installed in a variety of building types: convenience markets, fast-food stores, office complexes, and strip malls. Air-source single-package and split-system AC/HP units ≥ 11.3 tons are commonly used to condition larger commercial open spaces as would be found in large chain outlet stores.

Manufacturers continue to design new equipment to achieve increasingly higher part-load efficiency (IEER). Building owners, engineers, and regulatory bodies such as the U.S. Department of Energy have added to this momentum. Building certification programs such as LEED reward annual energy savings, which is enhanced by part-load equipment efficiency. In 2012, DOE issued the “RTU Challenge” which encouraged manufacturers to produce 18 IEER equipment. In 2016, DOE finalized a regulation that would shift unitary AC/HP ratings from EER to IEER on January 1, 2018. These activities underscore the increasing emphasis on part-load efficiency by industry and regulators.

Measure Case Description

The measure case is defined as an air-cooled air conditioner or heat pump with a cooling capacity ≥ 65 kBtuh, installed in a nonresidential building. The minimum efficiency requirements of measure offerings are specified below.

Air Conditioning Measure Case Specification

| **Capacity Range (kBtuh)** | **EER** | **IEER** |
| --- | --- | --- |
| 65 - 134 kBTUh | 11.5 | 13.0 |
| 12.0 | 13.5 |
| 12.5 | 14.0 |
| 13.0 | 15.0 |
| 135 - 240 kBTUh | 11.5 | 13.0 |
| 12.0 | 13.5 |
| 12.5 | 14.0 |
| 240 - 760 kBTUh | 10.8 | 12.2 |
| 11.5 | 12.7 |
| 12.5 | 15.5 |
| > 760 kBTUh | 10.2 | 11.6 |
| 11.0 | 12.3 |
| 12.0 | 13.8 |

Heat Pump Measure Case Specification

| **Capacity Range (kBtuh)** | **EER** | **COP** |
| --- | --- | --- |
| 65 - 134 kBTUh | 11.5 | 3.4 |
| 12.0 | 3.4 |
| 135 - 240 kBTUh | 11.5 | 3.2 |
| 12.0 | 3.2 |
| 240 - 760 kBTUh | 10.5 | 3.2 |
| 10.8 | 3.2 |

Base Case Description

The base case is defined as an existing air-cooled air conditioner or heat pump with cooling capacity > 65 kBtuh in a nonresidential building that meets the minimum efficiency standards (See Code Requirements).

Code Requirements

The minimum energy efficiency requirements for this measure are stipulated by the U.S. Department of Energy (DOE) appliance standards program and the California Building Energy Efficiency Standards (Title 24), as noted below. Commercial unitary air conditioners and heat pumps are federally pre-empted, meaning California Title 20 follows the federal standards. The California building code includes an EER requirement in addition to IEER, making it more stringent than the federal requirements.

Applicable State and Federal Codes and Standards

|  |  |  |
| --- | --- | --- |
| **Code** | **Applicable Code Reference** | **Effective Date** |
| CA Appliance Efficiency Regulations – Title 20 (2018) | Section 1605.1(c)(1) Table C-4 | January 1, 2018 |
| CA Building Energy Efficiency Standards – Title 24 (2019) | Section 110.2(a) Table 110.2-A | January 1, 2020 |
| Federal Standards | 10 CFR §431.97, Table 3 | January 1, 2018 |

**2018 DOE Appliance Efficiency Regulations.** The efficiency requirements for air-cooled air conditioning and heat pump units over 5.4 tons (65 kBtuh) stipulated by the DOE are shown below.

DOE Requirements for Large Unitary Equipment

|  |  |  |
| --- | --- | --- |
| **Equipment Type** | **Minimum IEER a** | **Minimum COP** |
| Air-cooled unitary air conditioners  ≥ 65 and < 135 kBtuh | 12.7 | N/A |
| Air-cooled unitary air conditioners  ≥ 135 and < 240 kBtuh | 12.2 | N/A |
| Air-cooled unitary air conditioners  ≥ 240 and < 760 kBtuh | 11.4 | N/A |
| Air-cooled unitary heat pumps in cooling mode  ≥ 65 and < 135 kBtuh | 12.0 | 3.3 |
| Air-cooled unitary heat pumps in cooling mode  ≥ 135 and < 240 kBtuh | 11.4 | 3.2 |
| Air-cooled unitary heat pumps in cooling mode  ≥ 240 kBtuh and < 760 kBtuh | 10.4 | 3.2 |

a All IEER values shown are for “all other types of heating” (i.e., gas packs), as opposed to “electric resistance heating or no heating.”

**California Building Energy Efficiency Standards (Title 24).** These measure offerings fall under Title 24 of the California Building Energy Efficiency Standards, which establishes the minimum efficiency ratings in both EER and IEER, as specified below.

Title 24 Requirements for Large Unitary Equipment

|  |  |  |  |
| --- | --- | --- | --- |
| **Equipment Description (Capacity Range)** | **Minimum EER a** | **Minimum IEER a** | **Minimum COP** |
| Air-cooled unitary air conditioners  ≥ 65 and < 135 kBtuh | 11.0 | 12.7 | N/A |
| Air-cooled unitary air conditioners  ≥ 135 and < 240 kBtuh | 10.8 | 12.2 | N/A |
| Air-cooled unitary air conditioners  ≥ 240 and < 760 kBtuh | 9.8 | 11.4 | N/A |
| Air-cooled unitary air conditioners  ≥ 760 kBtuh | 9.5 | 11.0 | N/A |
| Air-cooled unitary heat pumps in cooling mode ≥ 65 and < 135 kBtuh | 10.8 | 12.0 | 3.3 |
| Air-cooled unitary heat pumps in cooling mode  ≥ 135 and < 240 kBtuh | 10.4 | 11.4 | 3.2 |
| Air-cooled unitary heat pumps in cooling mode  ≥ 240 kBtuh and < 760 kBtuh | 9.3 | 10.4 | 3.2 |

a All IEER values shown are for “all other types of heating” (i.e., gas packs), as opposed to “electric resistance heating or no heating.”

Normalizing Unit

Per cooling ton.

Program Requirements

Measure Implementation Eligibility

All combinations of measure application type, delivery type, and sector that are established for this measure are specified in the table below. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements.  Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. The table below also designates the broad market sector(s) that are applicable for this measure.

*Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.*

Implementation Eligibility

|  |  |  |
| --- | --- | --- |
| **Measure Application Type** | **Delivery Type** | **Sector** |
| Normal replacement (NR) | UpDeemed | Com |
| New construction (NC) | UpDeemed | Com |

Additional eligibility requirements include:

* All unitary direct expansion (DX) equipment is eligible.
* The replacement must be “like for like” (e.g., a heat pump for a heat pump)
* Retrofitted equipment must have cooling capacity (e.g., Btu/h) within +/- 5% of existing equipment OR the contractor must provide a load calculation verifying that the new unit is sized correctly for the load.

Eligible Products

Eligible equipment must meet the measure case specifications in the Measure Case Description.

The model number is used to ascertain the equipment efficiency of a package system. The equipment efficiency of a split system will be based on a combination of the condenser and evaporator model numbers provided by a distributor. The efficiency rating will then be verified according to the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) or Consortium for Energy Efficiency (CEE) database or manufacturers specification sheets.

Field inspections should be performed to verify the condenser/unit model number for quality assurance purposes.

Because of the large number of evaporator/condenser combinations available for split systems (several thousand combinations) some averages and/or minimum efficiencies may be used for certain groups of equipment.

Eligible Building Types and Vintages

This measure is applicable for all nonresidential building types and vintages.

Eligible Climate Zones

This measure is applicable to any California climate zones.

Program Exclusions

Central systems and domestic hot water systems are not eligible.

Package terminal air conditioning units, which are units manufactured for installation through a wall or window and are usually ≤ 2 tons, are not eligible.

Data Collection Requirements

Data collection requirements for midstream and upstream deliveries, when possible, the program administrator (PA) shall claim the “specific building type savings” in which the equipment will be installed and submit that information at claims level on CEDARS website. In cases where there is no “building type” information available for a given project, program administrator shall claim the weighted savings of “Com” building type.”

Use Category

HVAC

Electric Savings (kWh)

The electric energy savings of a unitary air-cooled ACs and HPs ≥ 65 kBtu/hr were drawn directly from the Database of Energy Efficient Resources (DEER). The version used to calculate savings for these measures is DEER2020. The results were reported in the Remote Ex-Ante Database Interface (READI) tool; the results have not been modified.

Electric savings values vary by building type, building vintage, and climate zone. All DEER “Com” building types as well as the “existing” vintage (“Ex”, weighted DEER vintages) and all climate zones were used.

The DEER Energy Impact IDs and the associated Measure Offering IDs and description are provided in Table 5.

Measure Offering IDs and DEER Measure IDs

| **Statewide Measure Offering ID** | **DEER Energy Impact ID** | **Measure Offering Description** |
| --- | --- | --- |
| SWHC013A | NE-HVAC-airAC-SpltPkg-65to134kBtuh-11p5eer-woutPreEcono | Unitary Air-Cooled A/C, Commercial, 65 - 134 kBTU/h, 11.5 EER and 13 IEER |
| SWHC013B | NE-HVAC-airAC-SpltPkg-65to134kBtuh-12p0eer-woutPreEcono | Unitary Air-Cooled A/C, Commercial, 65 - 134 kBTU/h, 12 EER and 13.5 IEER |
| SWHC013C | NE-HVAC-airAC-SpltPkg-65to134kBtuh-12p5eer-woutPreEcono | Unitary Air-Cooled A/C, Commercial, 65 - 134 kBTU/h, 12.5 EER and 14 IEER |
| SWHC013D | NE-HVAC-airAC-SpltPkg-65to134kBtuh-13p0eer-woutPreEcono | Unitary Air-Cooled A/C, Commercial, 65 - 134 kBTU/h, 13 EER and 15 IEER |
| SWHC013E | NE-HVAC-airAC-SpltPkg-135to239kBtuh-11p5eer | Unitary Air-Cooled A/C, Commercial, 135 - 239 kBTU/h, 11.5 EER and 13 IEER |
| SWHC013F | NE-HVAC-airAC-SpltPkg-135to239kBtuh-12p0eer | Unitary Air-Cooled A/C, Commercial, 135 - 239 kBTU/h, 12 EER and 13.5 IEER |
| SWHC013G | NE-HVAC-airAC-SpltPkg-135to239kBtuh-12p5eer | Unitary Air-Cooled A/C, Commercial, 135 - 239 kBTU/h, 12.5 EER and 14 IEER |
| SWHC013H | NE-HVAC-airAC-SpltPkg-240to759kBtuh-10p8eer | Unitary Air-Cooled A/C, Commercial, 240 - 759 kBTU/h, 10.8 EER and 12.2 IEER |
| SWHC013I | NE-HVAC-airAC-SpltPkg-240to759kBtuh-11p5eer | Unitary Air-Cooled A/C, Commercial, 240 - 759 kBTU/h, 11.5 EER and 12.7 IEER |
| SWHC013J | NE-HVAC-airAC-SpltPkg-240to759kBtuh-12p5eer | Unitary Air-Cooled A/C, Commercial, 240 - 759 kBTU/h, 12.5 EER and 15.5 IEER |
| SWHC013K | NE-HVAC-airAC-SpltPkg-gte760kBtuh-10p2eer | Unitary Air-Cooled A/C, Commercial, > 760 kBTU/h, 10.2 EER and 11.6 IEER |
| SWHC013L | NE-HVAC-airAC-SpltPkg-gte760kBtuh-11p0eer | Unitary Air-Cooled A/C, Commercial, > 760 kBTU/h, 11 EER and 12.3 IEER |
| SWHC013M | NE-HVAC-airAC-SpltPkg-gte760kBtuh-12p0eer | Unitary Air-Cooled A/C, Commercial, > 760 kBTU/h, 12 EER and 13.8 IEER |
| SWHC013N | NE-HVAC-airHP-SpltPkg-65to134kBtuh-11p5eer-3p4cop | Unitary Air-Source H/P, Commercial, 65-134 kBTU/h, 11.5 EER and 3.4 COP |
| SWHC013O | NE-HVAC-airHP-SpltPkg-65to134kBtuh-12p0eer-3p4cop | Unitary Air-Source H/P, Commercial, 65-134 kBTU/h, 12.0 EER and 3.4 COP |
| SWHC013P | NE-HVAC-airHP-SpltPkg-135to239kBtuh-11p5eer-3p2cop | Unitary Air-Source H/P, Commercial, 135-239 kBTU/h, 11.5 EER and 3.2 COP |
| SWHC013Q | NE-HVAC-airHP-SpltPkg-135to239kBtuh-12p0eer-3p2cop | Unitary Air-Source H/P, Commercial, 135-239 kBTU/h, 12.0 EER and 3.2 COP |
| SWHC013R | NE-HVAC-airHP-SpltPkg-240to759kBtuh-10p5eer-3p2cop | Unitary Air-Source H/P, Commercial, 240-759 kBTU/h, 10.5 EER and 3.2 COP |
| SWHC013S | NE-HVAC-airHP-SpltPkg-240to759kBtuh-10p8eer-3p2cop | Unitary Air-Source H/P, Commercial, 240-759 kBTU/h, 10.5 EER and 3.2 COP |

**To-code Savings Portion Measures.** The to-code savings portion measure offerings designated for this measure represent the energy savings that result from retrofitting existing equipment to code-compliant equipment. The to-code savings were determined by subtracting the “AStdWB” savings from the “APreWB” savings for the above-code ACs and HPs. The result was the difference between customer existing equipment and above-code equipment.

**Hours of Operation.** The hours of operation are not applicable for this type of measure. The savings values used were downloaded from DEER2020 directly. All measure offerings designated for this measure have a wide range of equivalent full load hours (EFLH) that vary by climate zone, building type, and building vintage. Since DEER data was used for the calculation of energy impacts, the hours of operation are embedded in those values. DEER simulations calculate the values based on the use of building vintages for each climate zone that are then weighted by the climate zone specific distribution of the vintages to get values for Existing (Ex).

**IEER Rating Update.** The IEER values published in the Technology Definitions for the DEER2016 Update were calculated based on typical expected operation. These values did not always correspond with the rated IEER values published by the equipment manufacturers. For the DEER2017 update, manufacturer rated IEER values were collected and applied to the Technology Definitions. Those same definitions were included in the DEER2020 update

**Impact of fan control on IEER.** The type of fan control installed on a system affects the IEER rating. Most manufacturers now provide a description of the fan control that was used in the development of each IEER value. For some units where different fan control options are available, multiple IEER values are listed. In the IEER versus EER data that was collected for the DEER2017 update, the fan control strategy was either constant volume or two-speed. For each unit size range, relationships were established between rated IEER and rated EER for both of these fan control strategies. Both values are now listed in the Measure and Technology tables.

Peak Electric Demand Reduction (kW)

The peak demand reduction of a unitary air-cooled ACs and HPs ≥ 65 kBtuh were drawn directly from the Database of Energy Efficient Resources (DEER). The version used to calculate savings for these measures is DEER2020. The results were reported in the Remote Ex-Ante Database Interface (READI) tool; the results have not been modified.

Electric savings values vary by building type, building vintage, and climate zone. All DEER “Com” building types as well as the “existing” vintage (“Ex”, weighted DEER vintages) and all climate zones were used.

See Electric Savings for additional details.

Gas Savings (Therms)

The gas unit energy savings of a unitary air-cooled ACs and HPs ≥ 65 kBtuh were drawn directly from the Database of Energy Efficient Resources (DEER). The version used to calculate savings for these measures is DEER2020. The results were reported in the Remote Ex-Ante Database Interface (READI) tool; the results have not been modified.

Therm savings values vary by building type, building vintage, and climate zone. All DEER “Com” building types as well as the “existing” vintage (“Ex”, weighted DEER vintages) and all climate zones were used.

Life Cycle

Effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining useful life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

The EUL and RUL specified for this measure are specified below. Note that RUL is only applicable for add-on and accelerated replacement installations and is not applicable for this measure.

Effective Useful Life and Remaining Useful Life

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| EUL – Rated years | 15.0 | California Public Utilities Commission (CPUC), Energy Division.  2003. Energy Efficiency Policy Manual v 2.0. Page 17. |
| RUL - Rated years | n/a | n/a |

Base Case Material Cost ($/unit)

The base case material costs derived from data collected through a survey of equipment distributors. Data were based upon the 2016 efficiency tiers and interpolated to the DEER 2020 tiers.[[1]](#footnote-2)

Measure Case Material Cost ($/unit)

The measure case material costs derived from data collected through a survey of equipment distributors. Data were based upon the 2016 efficiency tiers and interpolated to the DEER2020 tiers.[[2]](#footnote-3)

Base Case Labor Cost ($/unit)

Labor hours and labor hourly rates were obtained from the *2010–2012 WO017 Ex Ante Measure Cost Study* conducted by Itron, Inc.[[3]](#footnote-4) The values adopted for this measure are the recommended values for Large Packaged DX (> 5 tons).

Measure Case Labor Cost ($/unit)

Labor hours and labor hourly rates were obtained from the *2010–2012 WO017 Ex Ante Measure Cost Study* conducted by Itron, Inc.[[4]](#footnote-5) The values adopted for this measure are the recommended values for Large Packaged DX (> 5 tons).

Net-to-Gross (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. The relevant NTG values for all packaged and split system air conditioner and heat pump replacements are specified below. The NTG for this measure was stipulated by the California Public Utilities Commission (CPUC) Energy Division in Resolution E-4952, which approved the Database for Energy Efficient Resources (DEER) for 2020. This NTG value is based upon results presented in the 2015 Upstream HVAC Programs.[[5]](#footnote-6)

Net-to-Gross Ratios

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| NTG - Nonresidential rooftop and split system HVAC upgrades  (*NonRes-sAll-mHVAC-RTU-SplitSys*) | 0.5 (Electric)  0.6 (Gas) | California Public Utilities Commission (CPUC). 2020. Resolution E-5082. August 27. Page A-49, Table A-2. READI tool v2.5.1 NTG Ratio (2020) |

Gross Savings Installation Adjustment (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method. This GSIA rate is the current “default” rate specified for measures for which an alternative GSIA has not been estimated and approved.

Gross Savings Installation Adjustment Rates

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| GSIA | 1.0 | California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 31. |

Non-Energy Impacts

Non-energy impacts for this measure have not been quantified.

DEER Differences Analysis

This section provides a summary of inputs and methods from the Database of Energy Efficient Resources (DEER), and the rationale for inputs and methods that are not DEER-based.

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Comment / Used for Workpaper** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | Yes |
| DEER Measure Case | Yes |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | No |
| DEER Version | DEER2020 |
| Reason for Deviation from DEER | n/a |
| DEER Measure IDs Used |  |
| NTG | Source: DEER2022 and READI tool v2.5.1. The NTG values for electric/gas of 0.5/0.6 associated with NTG ID: *NonRes-sAll-mHVAC-RTU-SplitSys* |
| GSIA | Source: DEER. The GSIA of 1.0 is associated with GSIA ID: *Def-GSIA* |
| EUL/RUL | Source: DEER. The value of 15 years is associated with EUL ID: *HVAC-airAC, HVAC-airHP* |

Revision History

Measure Characterization Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision Number** | **Revision Complete Date** | **Primary Author, Title, Organization** | **Revision Summary and Rationale for Revision** |
| 01 | 06/30/2018 | Jennifer Holmes  Cal TF Staff | Draft of consolidated text for this statewide measure is based upon:  PGECOHVC128, Revision 9 (July 1, 2017)  WPSDGENRHC0025, Revision 0 (January 2, 2018) – short form  SCE17HC035, Revision 5 (October 13, 2015)  Consensus reached among Cal TF members. |
| 01 | 10/14/2019 | Henry Liu  PG&E,  Bryan Boyce and Garrett Hedberg  Energy Solutions | Updated energy impacts with DEER2020 values.  Separated out heat pump measures from air conditioners (using DEER values).  Updated NTG.  Finalized workpaper document in statewide format and created MeasureDataSpec and EAD Tables. |
| 01 | 11/14/2019 | Henry Liu  PG&E,  Bryan Boyce and Garrett Hedberg  Energy Solutions | Additional QC of EAD and MeasureDataSpec workbooks, minor editorial/references adjusted. No changes to savings. |
| 02 | 4/9/2021 | Ed Reynoso  SDG&E,  Keith Valenzuela  AESC Inc | Updated ex-ante data (EAD) associated with DEER NTG and energy impacts records for DEER2022 and adopting all commercial DEER building types to align with 2022 DEER Resolution E5082 data collection per section “ 4.1 Add program tracking data and evaluation requirements to the deemed workpaper template”. Removed the MeasureDataSpec, from this submission. |

1. Pacific Gas & Electric Company (PG&E). 2017. “SWHC013-01 Distributor Survey of IMC.xlsx.” [↑](#footnote-ref-2)
2. Pacific Gas & Electric Company (PG&E). 2017. “SWHC013-01 Distributor Survey of IMC.xlsx.” [↑](#footnote-ref-3)
3. Itron, Inc. 2014. 2010-2012 WO017 Ex Ante Measure Cost Study Final Report. Prepared for the California Public Utilities Commission.  [↑](#footnote-ref-4)
4. Itron, Inc. 2014. 2010-2012 WO017 Ex Ante Measure Cost Study Final Report. Prepared for the California Public Utilities Commission.  [↑](#footnote-ref-5)
5. DNV GL. 2020. *Impact Evaluation of 2018 HVAC Programs (Group A HVAC).* Prepared for the California Public Utilities Commission (CPUC). April 20, 2020. [↑](#footnote-ref-6)