|  |
| --- |
| HVAC  SEER Rated AC and HP equipment, Residential  SWHC049-01 |

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Measure Name

HVAC - SEER Rated AC and HP Equipment, Residential

Statewide Measure ID

SWHC049-01

Technology Summary

**Packaged HVAC.** A single-package Air Conditioner (AC) or Heat Pump (HP) system consists of a single cabinet housing containing a condensing unit, a compressor, and an indoor fan/coil. The heating section (if one is included) may be either gas-fired or incorporated into the refrigeration circuit as a heat pump. Single-package units are typically installed on the rooftop or on the ground outside of the house. A benefit of package units is that there is no need for field-installed refrigerant piping, minimizing labor costs and the possibility of contaminating the system with dirt, metal, oxides or non-condensing gases.

**Split-System HVAC.** A split system consists of two major parts in separate housings: a remote compressor/condenser unit, and an indoor air handler. The two system components are connected by a pair of refrigerant lines. The air handler consists of a fan, filter(s), gas-fired furnace, and evaporator coil.. In the case of a heat pump, the air handler has no furnace, and the coil is used in condensing mode for heating and in evaporator mode for cooling. Typical locations for the indoor section are in the attic, a closet with either inside or outside access, or in the garage. The outdoor compressor/condenser unit is usually located on the ground outside of the house.

Both these systems are central systems, meaning cooled and heated air is distributed throughout the house through ductwork. The efficiency of a central air-conditioner is represented by a seasonal energy efficiency ratio (SEER) rating for cooling mode and annual fuel utilization efficiency (AFUE) for heating mode provided by forced air furnace. The efficiency of a central heat pump is represented by a seasonal energy efficiency ratio (SEER) rating for cooling mode and a heating seasonal performance factor (HSPF) rating for the heating mode. The technologies typically associated with high efficiency systems are related to fans and compressors. ACs and HPs with SEER rating 15 and above typically have two speed fans, and ACs and HPs with SEER rating 16 and above have two stage compressors. These trends are noted as informational, but not as requirements for efficient equipment. Equipment is determined to be efficient based on its SEER rating alone, and energy impacts are modeled based on SEER ratings.

Measure Case Description

The measure case is defined as one of the following pieces of equipment, of the same type as the base case equipment. The measure case exceeds the code requirements and is defined by the efficiency tiers specified below. A central system should meet or exceed both the SEER and HSPF rating listed below.

Measure Case Specification

| **Statewide Offering ID** | **Split AC or HP** | **Size Range kBTU/h** | **SEER Rating** | **HSPF Rating** | **Measure Application Type** |
| --- | --- | --- | --- | --- | --- |
| SWHC049A | AC | 45 - 65 | 15 | N/A | AR |
| SWHC049B | AC | 45 - 65 | 16 | N/A | AR |
| SWHC049C | AC | 45 - 65 | 17 | N/A | AR |
| SWHC049D | AC | 45 - 65 | 18 | N/A | AR |
| SWHC049E | AC | 45 - 65 | 19 | N/A | AR |
| SWHC049F | AC | 45 - 65 | 20 | N/A | AR |
| SWHC049G | AC | 45 - 65 | 21 | N/A | AR |
| SWHC049H | AC | <45 | 15 | N/A | AR |
| SWHC049I | AC | <45 | 16 | N/A | AR |
| SWHC049J | AC | <45 | 17 | N/A | AR |
| SWHC049K | AC | <45 | 18 | N/A | AR |
| SWHC049L | AC | <45 | 19 | N/A | AR |
| SWHC049M | AC | <45 | 20 | N/A | AR |
| SWHC049N | AC | <45 | 21 | N/A | AR |
| SWHC049O | HP | 18 - 65 | 15 | 8.7 | AR |
| SWHC049P | HP | 18 - 65 | 16 | 9 | AR |
| SWHC049Q | HP | 18 - 65 | 17 | 9.4 | AR |
| SWHC049R | HP | 18 - 65 | 18 | 9.7 | AR |
| SWHC049S | AC | 45 - 65 | 15 | N/A | NR |
| SWHC049T | AC | 45 - 65 | 16 | N/A | NR |
| SWHC049U | AC | 45 - 65 | 17 | N/A | NR |
| SWHC049V | AC | 45 - 65 | 18 | N/A | NR |
| SWHC049W | AC | 45 - 65 | 19 | N/A | NR |
| SWHC049X | AC | 45 - 65 | 20 | N/A | NR |
| SWHC049Y | AC | 45 - 65 | 21 | N/A | NR |
| SWHC049Z | AC | <45 | 15 | N/A | NR |
| SWHC049AA | AC | <45 | 16 | N/A | NR |
| SWHC049AB | AC | <45 | 17 | N/A | NR |
| SWHC049AC | AC | <45 | 18 | N/A | NR |
| SWHC049AD | AC | <45 | 19 | N/A | NR |
| SWHC049AE | AC | <45 | 20 | N/A | NR |
| SWHC049AF | AC | <45 | 21 | N/A | NR |
| SWHC049AG | HP | 18 - 65 | 15 | 8.7 | NR |
| SWHC049AH | HP | 18 - 65 | 16 | 9 | NR |
| SWHC049AI | HP | 18 - 65 | 17 | 9.4 | NR |
| SWHC049AJ | HP | 18 - 65 | 18 | 9.7 | NR |
| SWHC049AK | AC | 45 - 65 | 15 | N/A | NC |
| SWHC049AL | AC | 45 - 65 | 16 | N/A | NC |
| SWHC049AM | AC | 45 - 65 | 17 | N/A | NC |
| SWHC049AN | AC | 45 - 65 | 18 | N/A | NC |
| SWHC049AO | AC | 45 - 65 | 19 | N/A | NC |
| SWHC049AP | AC | 45 - 65 | 20 | N/A | NC |
| SWHC049AQ | AC | 45 - 65 | 21 | N/A | NC |
| SWHC049AR | AC | <45 | 15 | N/A | NC |
| SWHC049AS | AC | <45 | 16 | N/A | NC |
| SWHC049AT | AC | <45 | 17 | N/A | NC |
| SWHC049AU | AC | <45 | 18 | N/A | NC |
| SWHC049AV | AC | <45 | 19 | N/A | NC |
| SWHC049AW | AC | <45 | 20 | N/A | NC |
| SWHC049AX | AC | <45 | 21 | N/A | NC |
| SWHC049AY | HP | 18 - 65 | 15 | 8.7 | NC |
| SWHC049AZ | HP | 18 - 65 | 16 | 9 | NC |
| SWHC049BA | HP | 18 - 65 | 17 | 9.4 | NC |
| SWHC049BB | HP | 18 - 65 | 18 | 9.7 | NC |

Base Case Description

The code/ standard base case is defined as a residential central air conditioning unit for cooling and gas furnace for space heating or central heat pump that meets the California Appliance Efficiency Regulations (Title 20) code requirements prevailing in 2020 (see Code Requirements).

For non-new-construction applications: The existing (in-situ) base case is defined as a residential central air conditioning unit for cooling and gas furnace for space heating or central heat pump as defined by DEER and listed in the table below.

Please note that unit type (AC or heat pump) will remain the same in the base and measure case. Replacing an AC unit and gas furnace with a heat pump is considered fuel substitution and is outside the scope of this workpaper. Please refer to SWHC045-01 for the residential HVAC fuel substitution measures.

**Base, Standard, and Measure Cases**

| **Case** | **Description of Typical Scenario** |
| --- | --- |
| Measure | Residential central AC with SEER>=15  Residential central HP with SEER>=15 and HSPF >=8.7 |
| Existing Condition | Residential central AC 18-65 kBTU/h:  pre-2001: mix of SEER 10 and SEER 13 units with an average SEER = 11.4, one-speed fan;  post-2001: SEER = 13 (EER = 11.08), one-speed fan;  2014: SEER = 14 (EER = 12.17), one-speed fan  Residential central HP:  pre-2001: SEER = 10 (HSPF = 7.1), one-speed fan;  post-2001: SEER = 13 (HSPF = 8.2), one-speed fan;2014: SEER = 14 (HSPF = 8.2), one-speed fan |
| Code/Standard | Residential central AC with SEER=14  Residential central HP with SEER=14 & HSPF = 8.2 |

Code Requirements

The residential HVAC equipment designated for this measure must comply with both state and federal efficiency standards. Applicable state and federal codes and standards for air-cooled air-conditioners and heat pumps are specified below.

Applicable State and Federal Codes and Standards

|  |  |  |
| --- | --- | --- |
| **Code** | **Applicable Code Reference** | **Effective Date** |
| CA Appliance Efficiency Regulations – Title 20 | Section 1605.1(c)(1) Table C-3 and  Section 1605.1 (e)(1) Table E-6  Section 1605.1 (e)(1) Table E-7 | January 1, 2019 |
| CA Building Energy Efficiency Standards – Title 24 (2019) | N/A | N/A |
| Federal Standards (Title 10) | Section 430.32(c) | January 1, 2015 for AC and HP |

**California Appliance Efficiency Regulations (Title 20)**[[1]](#footnote-1) Section 1605.1(c)1 Table C-3 (portions replicated below) established standards for single phase air-cooled air conditioners and heat pumps for capacities < 65,000 Btu/hr.

Table C-3: Standards for Single Phase Air-Cooled Conditioners with Cooling Capacity Less than 65,000 Btu per Hour and Single Phase Air-Source Heat Pumps with Cooling Capacity Less than 65,000 Btu per Hour, Not subject to EPAct[[2]](#footnote-2)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Product Class*** | ***Minimum Efficiency Effective January 1, 2015*** | | | |
| ***Minimum SEER*** | ***Minimum HSPF*** | ***Minimum EER*** | ***Average Off-Mode Power Consumption Pw. pff (watts)*** |
| Split system air conditioners with rated cooling capacity < 45,000 Btu/hour | 14 | - | 12.2 | 30 |
| Split system air conditioners with rated cooling capacity >= 45,000 Btu/hour | 14 | - | 11.7 | 30 |
| Split system heat pumps with rated cooling capacity < 45,000 Btu/hour | 14 | 8.2 | 12.2 | 33 |
| Split system heat pumps with rated cooling capacity >= 45,000 Btu/hour | 11.7 | 33 |
| Single package air conditioners | 14 | - | 11.0 | 30 |
| Single package heat pumps | 14 | 8.0 | - | 33 |

Title 10 of the Code for Federal Regulations, section 430.32(c)[[3]](#footnote-3) has standards for split system and packaged unit air conditioners and heat pumps that are equivalent to California Title 20. Hence, the Title 20 standards govern the definition of the base case for this measure.

**Existing baseline efficiency.** To determine the existing baseline efficiency, previous editions of Title 20 codes were consulted. Since the remaining useful life (RUL) for an accelerated replacement (AR) measure application for this measure is five years (see Life Cycle), the equipment should have been installed around 2010 to have a five-year RUL in 2020. Hence, the Title 20 standards that were applicable in year 2010 was considered.[[4]](#footnote-4) Section 1605.1(c)1 Table C-2 of the 2010 standards for single phase air-cooled air conditioners and heat pumps for capacities < 65,000 Btu/hr and Section 1605.1 (e) (1) Table E-4 provides standards for central furnaces. The minimum efficient requirement for air conditioners is SEER 13 and the minimum requirements for central furnaces are same as the Title 20 2019 requirements.

Normalizing Unit

Tons of cooling capacity (Cap-tons).

Program Requirements

Measure Implementation Eligibility

All combinations of measure application type, delivery type, and sector that are established for this measure are specified 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. This table 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** |
| Accelerated replacement | DnDeemDI | Res |
| Accelerated replacement | DnDeemed | Res |
| Normal replacement | UpDeemed | Res |
| Normal replacement | DnDeemDI | Res |
| Normal replacement | DnDeemed | Res |
| New construction | UpDeemed | Res |
| New construction | DnDeemDI | Res |
| New construction | DnDeemed | Res |

For upstream/mid-stream deliveries, the implementer should provide the retailer or distribution location where the product was sold and the product’s rated capacity (e.g., tons) and cooling and heating rated efficiencies (SEER/HSPF). Additionally, the implementer is encouraged to document and track the Residential building type where the product will be installed.

Eligible Products

The efficiency specification for eligible air conditioners and heat pumps are included in Measure Case Description section.

Only those air conditioning and heat pump systems covered by AHRI 210/240 2008 are eligible. Efficiency values must be certified by Air-conditioning Heating and Refrigeration Institute (AHRI) as verified by the AHRI certification number.

For split systems the certification will specify an evaporator coil model and may specify additional components. In some cases, a furnace is specified in the certificate. In this case since the furnace is specified as part of the AC system it will not be eligible for a separate incentive.

**General Eligibility Requirements**

Installed equipment must be electric fueled to qualify for EE incentives.

Eligible Building Types and Vintages

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

Eligible Climate Zones

This measure is applicable in all California climate zones.

*Required Documentation for Accelerated Replacement*

Preponderance of evidence (POE) must be documented. Notably, programs shall document if measure was replaced as a direct result of information, recommendations, and support provided by the Program Administrator, and programs shall require the collection and submission of documentation to ensure proper conformance to eligibility and implementation requirements. The following are the types of information that will be required for all projects:

1. Customer/site information
2. Specifications of existing equipment
3. Proof that the existing air conditioner and gas furnace are still operating as intended
4. Existing air conditioner and gas furnace nameplate data with manufacturer date to confirm remaining useful life
5. Replacement central heat pump information

To document POE, the provided Preponderance of evidence (POE) survey[[5]](#footnote-5), or similar, should be completed.

Program Exclusions

Fuel substitution measures are not eligible. Please refer to SWHC045-01 for fuel substitution measures.

Data Collection Requirements

This section discusses the limitations of data used to analyze the measure described in this workpaper, and the potential need for future data or timeline for updates, so that energy efficiency incentive program administrators can incorporate those requirements into their program designs.

Experience with residential HVAC workpapers suggests that one of the most significant limitations for analysis is the availability of a cost dataset that is up to date and reflects the market. This workpaper recommends sampling a fraction of installations, to record material cost and installation costs. This information can be anonymized. Such a dataset would be representative of customer costs and would be used to measure price variations between installations of similar products. In turn, the amount of variation can be used to determine the confidence associated with cost data collection, for instance, to decide whether additional survey data is needed at the time of the next workpaper update. However, this recommendation is not a general requirement for programs or implementers following this workpaper.

Use Category

HVAC

Electric Savings (kWh)

The unit energy savings (UES) of these measures were obtained directly from Database for Energy Efficient Resources (DEER) remote ex-ante database interface (READi) v2.5.1. for update year 2020.

For new construction (NC) measure application, savings corresponding to “New” building vintage were used. Please note NC only has 1st baseline savings (above-code savings) and no 2nd baseline savings (above-existing savings).

For normal replacement (NR) measure application, savings corresponding to “Ex” building vintage were used. Like NC, NR only has 1st baseline savings (above-code savings) and no 2nd baseline savings (above-existing savings).

For accelerated replacement (AR) measure application, savings corresponding to “Ex” building vintage were used. AR measures have both 1st and 2nd baseline savings and were available from READi.

UES corresponding to “Any” program administrator (PA) were used. There are a few climate zones where “Any” PA savings were not available, in which case, savings for the primary IOU for the climate zone were used, as determined by the DEER 2020 residential weights table.[[6]](#footnote-6)

Peak Electric Demand Reduction (kW)

Like kWh savings, peak kW savings were obtained from DEER via READi. 2020 updates for DEER consider the new DEER peak hours of 4-9PM.

Gas Savings (Therms)

The AC replacement measures include only the cooling mode savings powered by electricity. The heating mode usage which is typically powered by natural gas was not in the scope of this workpaper. However, the heating mode penalty because of less heat added to the air steam from the efficient supply fan in high SEER AC unit was considered and was derived from READi like kWh savings.

For HP replacement there are only electric savings since cooling and heating mode are powered by electricity.

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 RUL is only applicable to the first baseline period for a retrofit or accelerated replacement measure with an applicable code baseline. The methodology to calculate the RUL conforms with Version 5 of the Energy Efficiency Policy Manual, which recommends “one-third of the effective useful life in DEER as the remaining useful life until further study results are available to establish more accurate values.”[[7]](#footnote-7) This approach provides an RUL estimate without the requiring any a priori knowledge about the age of the equipment being replaced.[[8]](#footnote-8)

The EUL and RUL specified for this measure are presented below. The estimated lifetime can be traced to values adopted for the California PY 2001 programs and was adopted for commercial AC measures for DEER 2005.

Effective Useful Life and Remaining Useful Life

| **Parameter** | **Value** | **Source** |
| --- | --- | --- |
| EUL (yrs)  *HV-ResHP* for Heat Pumps  *HV-ResAC* for ACs | 15.0 | Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric (SDG&E), Southern California Edison (SCE), Southern California Gas Company (SCG), California Energy Commission (CEC), Office of Ratepayer Advocates (CPUC ORA), and Natural Resources Defense Council (NRDC). 1998. Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand-Side Management Programs. Revised March 1998 and March 1999. Appendix F.  Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric (SDG&E), Southern California Edison (SCE), Southern California Gas Company (SCG). 2000. “Proposed Effective Useful Life for Measures for PY2001 Program Elements. Report Issued Prior to Public Meeting. Response to Ordering Paragraph #8, Discussion Paper 2.” September 5.  Itron, Inc. 2005. 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study - Final Report. Prepared for Southern California Edison. Table 11-1.  California Public Utilities Commission (CPUC), Energy Division. 2008. “EUL\_Summary\_10-1-08.xls.” |
| RUL (yrs)  *HV-ResHP*  *HV-ResAC* | 5.0 | EUL/3 |

Base Case Material Cost ($/unit)

The base case material cost for a central air conditioner (AC) and heat pump (HP) was estimated using source data from EIA 2018.[[9]](#footnote-9) This regulatory study provides cost data for year 2017 and projections for year 2020, for a handful of SEER levels from 14 to 19. From this source, the cost data for central air conditioners represents coil-only units (presumably compressor/condenser units) without fan units, and the data for heat pumps represents split systems.

Considering the scope of equipment per the measure in this workpaper, a split system is a closer match than a coil-only unit, so this workpaper adopts the heat pump cost data for all equipment types. The costs were normalized per unit ton cooling capacity, then interpolated for SEER values between 14 and 19 and were extrapolated to SEER values above 19. See the cost calculation workbook for details.[[10]](#footnote-10) To summarize, the costs are tabulated below.

Central Air and Heat Pump prices by efficiency

|  |  |  |
| --- | --- | --- |
| **SEER rating** | **Materials cost (per ton cooling)** | **Labor cost (per ton cooling)** |
| 14 | $1,116.67 | $500.00 |
| 15 | $1,166.67 | $483.33 |
| 16 | $1,259.91 | $503.15 |
| 17 | $1,345.50 | $507.66 |
| 18 | $1,431.08 | $512.16 |
| 19 | $1,516.67 | $516.67 |
| 20 | $1,602.25 | $521.17 |
| 21 | $1,687.84 | $525.68 |

Measure Case Material Cost ($/unit)

The same sources used for the base case material cost were used to define measure case material cost.

Base Case Labor Cost ($/unit)

The same sources used for the base case material cost were used to define base case labor cost.

Measure Case Labor Cost ($/unit)

The same sources used for the base case material cost were used to define measure case labor cost.

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 NTG value for upstream and downstream delivery varies and are based on CPUC, 2018. Resolution E-4952

Net-to-Gross Ratios

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| NTG - residential, upstream delivery | 0.65 | Adopted by: CPUC, 2018. *Resolution E-4952: DEER2020 and Revised DEER2019*. Page A-36, Table 7.  Based on: Impact Evaluation of 2015 Upstream HVAC Programs (HVAC1), prepared for California Public Utilities Comission by DNVGL, CALMAC ID CPU0116.03, April 4, 2017. |
| NTG - residential, downstream delivery | 0.60 | Adopted by: CPUC, 2018. *Resolution E-4952: DEER2020 and Revised DEER2019*. Page A-50, attachment "SupportTable-NTG2020.xlsx.". |

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

DEER Differences Analysis

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

DEER Difference Summary

| **DEER Item** | **Comment / Used for Workpaper** |
| --- | --- |
| Modified DEER methodology | Yes |
| Scaled DEER measure | No |
| DEER Base Case | Yes |
| DEER Measure Case | Yes |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | Yes |
| DEER Version | 2020 |
| Reason for Deviation from DEER | No deviation from DEER for energy impacts. |
| DEER Measure IDs Used | No. Statewide measure ID were used |
| NTG | Source: DEER2020. The NTG of 0.65 is associated with NTG ID: *Res-sAll-mHVAC-DX-up*. The NTG of 0.60 is associated with NTG ID: *Res-sAll-mHVAC-Pkg-dn*. |
| GSIA | Source: DEER2011. The GSIA of 1.0 is associated with GSIA ID: *Def-GSIA* |
| EUL/RUL | Source: DEER2014. The value of 15 years is associated with *EUL\_ID: HV-ResHP* and *HV-ResAC* |

Revision History

Measure Characterization Revision History

| **Revision Number** | **Revision Complete Date** | **Primary Author, Title, Organization** | **Revision Summary and Rationale for Revision**  **Effective Date and Approved By** |
| --- | --- | --- | --- |
| 01 | 2020-04-06 | Nicholas Fette / Akhilesh Reddy Endurthy Solaris-Technical, LLC. | New Workpaper with DEER2020 impacts |
| 01 | 2020-05-06 | Andres Fergadiotti / SCE | Removed gas baseline language for new construction  Revised EAD Table – Sector field |

1. California Energy Commission (CEC). 2019. California Code of Regulations Title 20 Public Utilities and Energy. CEC-140-2019-002. January. [↑](#footnote-ref-1)
2. California Energy Commission (CEC). 2019. California Code of Regulations Title 20 Public Utilities and Energy. CEC-140-2019-002. January. Table C-3 [↑](#footnote-ref-2)
3. 10 C.F.R. section 430.32(c) [↑](#footnote-ref-3)
4. California Energy Commission (CEC). 2010. 2010 Appliance Efficiency Regulations. CEC-400-2010-012.  [↑](#footnote-ref-4)
5. SWHC049-01 SEER AC & HP, Residential - POE Survey.docx [↑](#footnote-ref-5)
6. “Any” PA savings were not able for a few measures for CZs 14,15, and 16 in READI v2.5.1. Savings for “SCE” PA were typically used since SCE is the primary IOU in these CZs. [↑](#footnote-ref-6)
7. California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 32. [↑](#footnote-ref-7)
8. KEMA, Inc. 2008. "Summary of EUL-RUL Analysis for the April 2008 Update to DEER." Memorandum submitted to Itron, Inc. [↑](#footnote-ref-8)
9. U.S. Energy Information Administration, 2018. *Updated Buildings Sector Appliance and Equipment Costs and Efficiencies: Appendix A.* <https://www.eia.gov/analysis/studies/buildings/equipcosts/> [↑](#footnote-ref-9)
10. "SWHC049-01 Cost analysis.xlsx." Southern California Edison, 2020. [↑](#footnote-ref-10)