

**HV A C**

H EA T P U M P H V A C , R ES I D EN T I A L , F U EL SU B STI TU TI O N

S WH C0 4 5 - 01

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# MEASURE NAME

Heat Pump HVAC, Residential, Fuel Substitution

# STATEWIDE MEASURE ID

SWHC045-01

# TECHNOLOGY SUMMARY

A central high efficiency air-source heat pump provides cooling and heating using electric energy. A heat pump provides cooling using direct expansion vapor compression and expansion. During the heating mode, the heat pump reverses the refrigeration cycle and moves heat rather than generates heat from sources such as gas furnaces and radiant heating. When installed properly, an air-source heat pump delivers 1.5 to 3 times more heat than the electricity consumed (energy.gov)[1](#_bookmark0). At a site for which a heat pump cannot serve all the heating loads, supplemental heating is provided through an electric resistance heating coil. This technology will use only electricity and no other fuel for heating and cooling requirements.

A central heat pump distributes cooled and heated air throughout the house through ductwork. Typically, a residential central heat pump is served by a single-phase circuit. 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.

This measure recommends replacing the existing central air conditioner used for cooling and the existing gas furnace used for heating with central heat pump. This fuel substitution measure meets the eligibility requirements Decision 19-08-009.[2](#_bookmark1) Further, since natural gas is being substituted with electricity this is an electrification measure.

# MEASURE CASE DESCRIPTION

The measure case is defined as an all-electric residential central air-source heat pump using electric resistance heating if supplemental heating is required. The measure case exceeds the code requirements and is defined by the efficiency tiers specified below. The central heat pump should meet or exceed both the SEER and HSPF rating listed below.

Measure Offering IDs

|  |  |  |
| --- | --- | --- |
| Statewide Offering ID | Measure Case Description | Base Case Description |
| SWHC045A | Residential Central Heat Pump SEER>=15 and HSPF>=8.7 |  |

1 <https://www.energy.gov/energysaver/heat-pump-systems/air-source-heat-pumps>

2 California Public Utilities Commission (CPUC). 2019. *Decision 19-08-009 in the Order Instituting Rulemaking Concerning Energy Efficiency Rolling Portfolios, Policies, Programs, Evaluation, and Related Issues (R.13-11-005).* Issued August 5.

|  |  |  |
| --- | --- | --- |
| Statewide Offering ID | Measure Case Description | Base Case Description |
| SWHC045B | Residential Central Heat Pump SEER>=16 and HSPF>=9 | Residential split air-conditioner with SEER=14 & gas furnace with Thermal Efficiency 80% |
| SWHC045C | Residential Central Heat Pump SEER>=17  and HSPF>=9.4 |
| SWHC045D | Residential Central Heat Pump SEER>=18 and HSPF>=9.7 |
| SWHC045E | Residential Central Heat Pump SEER>=15  and HSPF>=8.7 | Residential split air-conditioner with SEER=13 & gas furnace with Thermal Efficiency 80% |
| SWHC045F | Residential Central Heat Pump SEER>=16 and HSPF>=9 |
| SWHC045G | Residential Central Heat Pump SEER>=17 and HSPF>=9.4 |
| SWHC045H | Residential Central Heat Pump SEER>=18  and HSPF>=9.7 |

# BASE CASE DESCRIPTION

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

The base case for the existing condition is a residential central air conditioning unit for cooling and gas furnace for space heating meeting that meets the California Appliance Efficiency Regulations (Title 20) code requirements prevailing in 2010 (see Code Requirements).

Base, Standard, and Measure Cases

|  |  |
| --- | --- |
| Case | Description of Typical Scenario |
| Measure | Residential split heat pump with SEER>=15 and HSPF >=8.7 |
| Existing Condition | Residential split air-conditioner with SEER=13 & gas furnace with Thermal Efficiency 80% |
| Code/Standard | Residential split air-conditioner with SEER=14 & gas furnace with Thermal Efficiency 80% |

# CODE REQUIREMENTS

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 Appliance Efficiency Regulations – Title 20 | Section 1605.1(c)(1) Table C-2 and Section 1605.1 (e)(1) Table E-4 | January 23, 2006 |
| CA Building Energy Efficiency Standards – Title 24 (2019) | N/A | N/A |
| Federal Standards (Title 10) | N/A | N/A |

California Appliance Efficiency Regulations (Title 20)[3](#_bookmark2) 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. Section 1605.1 (e) (1) Table E-8 and Table E-9 (also replicated below) provide the standards for central gas furnaces < 225,000 Btu and duct furnaces.

3 California Energy Commission (CEC). 2019. *California Code of Regulations Title 20 Public Utilities and Energy.* CEC-140-2019-

002. January.

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[4](#_bookmark3)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *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 |

Table E-6: Standards for Central Furnaces[5](#_bookmark4)

|  |  |  |
| --- | --- | --- |
| *Appliance* | *Application* | *Minimum Efficiency %* |
| Central furnaces with 3-phase electrical supply < 225,000 Btu/hour | Mobile Home | 75 AFUE |
| All others | 78 AFUE or 80 Thermal Efficiency (at  manufacturer’s option) |

Table E-7: Standards for Duct Furnaces [6](#_bookmark5)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Appliance* | *Fuel* | *Standards* | | |
| *Minimum Thermal Efficiency%* | | *Maximum Energy Consumption during standby (watts)* |
| *At maximum rated capacity* | *At minimum rated capacity* |
| Duct Furnace | Natural gas | 80 | 75 | 10 |
| Duct Furnace | LPG | 80 | 75 | 147 |

Title 10 of the Code for Federal Regulations, section 430.32(c)[7](#_bookmark6) has less stringent standards for split system air conditioners and heat pumps. Hence, Title 20 was adopted for this measure.

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

4 California Energy Commission (CEC). 2019. *California Code of Regulations Title 20 Public Utilities and Energy.* CEC-140-2019-

002. January. Table C-3

5 California Energy Commission (CEC). 2019. *California Code of Regulations Title 20 Public Utilities and Energy.* CEC-140-2019-

002. January. Table E-6.

6 California Energy Commission (CEC). 2019. *California Code of Regulations Title 20 Public Utilities and Energy.* CEC-140-2019-

002. January. Table E-7.

7 10 C.F.R. section 430.32(c)

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.[8](#_bookmark7) 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

*Fuel Substitution Test*

Per CPUC Decision 19-08-009 Rulemaking 13-11-005, *Decision Modifying the Energy Efficiency Three- Prong Test Related to Fuel Substitution*,[9](#_bookmark8) all fuel substitution measures must “not increase total source energy consumption when compared with the baseline comparison measure available utilizing the original fuel.” Also, the measure “must not adversely impact the environment compared to the baseline measure utilizing the original fuel.” Fuel substitution calculations were conducted using the CPUC “Fuel Substitution Calculator” to confirm all measure offerings pass Parts One and Two of the Fuel Substitution Test.[10](#_bookmark9)

*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 |
| Normal replacement | DnDeemDI | Res |
| Normal replacement | DnDeemed | Res |
| Normal replacement | UpDeemed | Res |

8 California Energy Commission (CEC). 2010. *2010 Appliance Efficiency Regulations.* CEC-400-2010-012.

9 California Public Utilities Commission (CPUC). 2019. *Decision 19-08-009 in the Order Instituting Rulemaking Concerning Energy Efficiency Rolling Portfolios, Policies, Programs, Evaluation, and Related Issues (R.13-11-005).* Issued August 5. OP 1.

10 Southern California Edison (SCE). 2019. “SWHC045-01 Fuel Sub Calculator.xlsx.”

|  |  |  |
| --- | --- | --- |
| Accelerated replacement | DnDeemDI | Res |
| Accelerated replacement | DnDeemed | Res |

For upstream/mid-stream delivery method, the participant baselines are unknown, and the spillover effects are unknown. The manufacturer or distributor doesn’t know whether the purchased measure is replacing a gas or an electric baseline appliance. Claimed savings for these delivery types will be adjusted using the ratio of baseline gas appliance to total baseline appliances. These ratios will be determined from (Residential Appliance Saturation Survey (RASS)[11](#_bookmark10). The implementer shall survey 10% of the mid-stream and upstream installations, to determine actual gas/electric baseline proportions, and the program administrator shall adjust claimed savings based upon these survey results.”

In addition, for upstream/mid-stream delivery method, the implementer should provide the retailer or distribution location where the product was sold, rated capacity, proposed building type where the product will be installed (single family, multi-family or mobile homes), and cooling and heating efficiency.

*Eligible Products*

This measure involves fuel substitution and the implementer must replace an existing central air conditioner and a natural gas furnace. Care must be taken that the existing gas lines are capped off meeting the local code requirements.

The residential central heat pump must meet the SEER and HSPF requirements in the Measure Case Description are eligible.

*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.

*Incentive Amounts*

Fuel substitution measures face market barriers, including consumer market failures and supplier market failures.[12](#_bookmark11) Deployment of the program may require rebates or financial incentives to participants that exceed the measure cost.

11 California Energy Commission. 2010. “2009 California Residential Appliance Saturation Study”.

12 Energy+Environmental Economics. April 2019. “Residential Building Electrification in California <https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf> Consumer economics, greenhouse gases and grid impacts”.

# PROGRAM EXCLUSIONS

This measure is not eligible if there is no natural gas to electricity fuel substitution for space heating. This measure is not applicable for new construction installations. However new services, as defined in

*Fuel Substitution Technical Guidance for Energy Efficiency*, are eligible. [13](#_bookmark12) New service measures are only

eligible for Downstream application, when:

* measures are installed in new areas of an existing building,
* measures are installed in a major renovation of an existing building, or
* measures are installed in capacity expansions of existing systems to serve existing and/or new load retrofits that require a new energy service.

New service measures will follow the same baseline technology requirements as a Normal Replacement measure application type.

# DATA COLLECTION REQUIREMENTS

Per CPUC Decision 19-08-009[14](#_bookmark13), building infrastructure costs which include panel upgrades or gas line installations/upgrades required to facilitate these fuel substitution measures shall be collected for all downstream and direct install measures.

# USE CATEGORY

HVAC

# ELECTRIC SAVINGS (KWH)

The unit energy savings (UES) of this measure were derived as the difference of baseline and measure case unit energy consumption (UEC); the UEC were derived from simulations with DOE-2.3/ eQUEST 3.65 energy modeling software. Prototypes from the Database for Energy Efficient Resources (DEER) 2020 were used for the simulations. MASControl3, an updated version of the measure analysis software for DEER2020, was used to generate the energy savings values for all measure offerings. The following Tech IDs from MASControl3 were used to determine the existing, baseline, and measure energy consumption.

|  |  |  |  |
| --- | --- | --- | --- |
| Statewide Measure Offering ID | Existing  Baseline Description and DEER Tech ID | Code/ Standard Baseline Description | Measure Description and DEER Tech ID |

13 California Public Utilities Commission (CPUC), Energy Division. 2019. *Fuel Substitution Technical Guidance, Version 1.1*. October

31. Page 3.

14 California Public Utilities Commission (CPUC). 2019. “Decision 19-08-009 Rulemaking 13-11-005 Decision Modifying the Energy Efficiency Three-Prong Test Related to Fuel Substitution”. August 1

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | and DEER Tech ID |  |
| SWHC045A/ SWHC045E | 13 SEER Res AC and 80% Thermal Efficiency Gas Furnace (SplitAC1Sp-S13) | 14 SEER Res AC  and  80% Thermal Efficiency Gas Furnace (SplitAC1Sp- lt45-S14) | 15 SEER and 8.7 HSPF Central Heat pump (SplitHP1SpRes-S15-H8.7) |
| SWHC045B/  SWHC045F | 16 SEER and 9.0 HSPF Central Heat pump  (SplitHP2SpRes-S16-H9) |
| SWHC045C/ SWHC045G | 17 SEER and 9.4 HSPF Central Heat pump (SplitHP2SpRes-S17-H9.4) |
| SWHC045D/  SWHC045H | 18 SEER and 9.7 HSPF Central Heat pump  (SplitHP2SpRes-S18-H9.7) |

The energy use simulations for the selected DEER measures were run for all residential building types, for all California climate zones, all residential DEER thermostat settings, and for the median vintage 2007.

Using the vintage 2007 is a simplification approach and suggested in Resolution E-4952[15](#_bookmark14) when age is not known.

MAScontrol3 generated the annual energy usage (electric and gas) and hourly energy usage (electric) for each of the Tech IDs.[16](#_bookmark15) The energy consumption values were available for five thermostat schedules defined in DEER2020. Using the residential thermostat weights post processing file within MASControl3, the weighted average energy consumption values were calculated.[17](#_bookmark16) The normalized UEC values were calculated by dividing the energy consumption by the normalizing unit (cap-tons), which vary by climate zone, for each building type.

The UES was calculated as the difference between the baseline and measure case UEC. For normal replacement (NR) measures, the baseline is defined as the code/ standard baseline described in the table above. For accelerated replacement (AR) measures, the first baseline is the existing baseline and the second baseline is the code/standard baseline described in the table above. Because of the added electric load for heating in the measure case, there could be increase in electric energy consumption (indicating a kWh penalty).

# PEAK ELECTRIC DEMAND REDUCTION (KW)

In accordance with the requirements of the CPUC Fuel Substitution Technical Guidance, for Energy Efficiency, October 31, 2019, there will not be any peak demand reduction or penalty towards peak demand goal achievement from fuel substitution measures.

# GAS SAVINGS (THERMS)

The gas unit energy savings (UES) were determined using methodology described in the Electric Savings section. There will always be therms savings as a result of this measure because the natural gas heating in the base case will be substituted with all electric heating in the measure case.

15 California Public Utilities Commission (CPUC). 2018. *Resolution E-4952.* October 11. Page A-21.

16 Southern California Edison (SCE). 2019. “SWHC045-01 MASControl3 Files.zip”

17 Southern California Edison (SCE). 2019. “SWHC045-01 Heat Pump HVAC, Residential, Fuel Sub-Calculations.xlsx.”

# 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.”[18](#_bookmark17) This approach provides an RUL estimate without the requiring any a priori knowledge about the age of the equipment being replaced.[19](#_bookmark18)

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.* | 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.* | 5.0 | EUL/3 |

18 California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 32.

19 KEMA, Inc. 2008. "Summary of EUL-RUL Analysis for the April 2008 Update to DEER." Memorandum submitted to Itron, Inc.

# BASE CASE MATERIAL COST ($/UNIT)

The base case material cost for a central air conditioner (AC) was obtained in 2019 from an online consumer information website (https:[//www.](http://www.centralairconditionerprice.com/))ce[ntralairconditionerprice.com/)](http://www.centralairconditionerprice.com/)) that gathers central air conditioner information from homeowners throughout the U.S. This source also organizes the data based on SEER rating tiers normalized to a 2.5-ton unit.

The base case material cost for a central gas furnace was obtained from the 2019 Third Quarter release of RSMeans Online.[20](#_bookmark19) The material cost was normalized per ton (12,000 Btu). The cost of central AC and gas furnace were summed to calculate the total base case material cost of this measure.[21](#_bookmark20)

# MEASURE CASE MATERIAL COST ($/UNIT)

The measure case material costs for central heat pumps were obtained in 2019 from an online consumer information website (<https://www.heatpumppriceguides.com/>) that gathers information from homeowners across projects throughout the nation. This source also organizes the data based on SEER rating tiers normalized to a 3-ton unit.

# BASE CASE LABOR COST ($/UNIT)

The base case labor cost installing a central air conditioner (AC) and a gas furnace were obtained from the 2019 Third Quarter release of RSMeans Online.[22](#_bookmark21) The labor costs were normalized per ton (12,000 Btu).

The cost of central AC and gas furnace were summed to calculate the total base case labor cost of this measure.[23](#_bookmark22)

# MEASURE CASE LABOR COST ($/UNIT)

The measure case labor costs include the cost of

* installing the heat pump system
* capping the existing gas line
* demolition of existing AC and gas furnace

The labor cost for installing the heat pump was obtained from RSMeans Online.[24](#_bookmark23) The labor cost for capping off the gas line when the all-electric central heat pump is installed was obtained from an online source (https://[www.homeadvisor.com/cost/plumbing/install-or-repair-gas-pipes/).](http://www.homeadvisor.com/cost/plumbing/install-or-repair-gas-pipes/)) Because this source provided a labor cost range, the cost per ton of capping the gas line was calculated as the average of the

20 Gordian Group, Inc. (n.d.) "RSMeans Data Online." Residential Costs 2019.

21 Southern California Edison (SCE). 2019. “SWHC045-01 Heat Pump HVAC, Residential, Fuel Sub-Calculations.” See Cost Analysis tab.

22 Gordian Group, Inc. (n.d.) "RSMeans Data Online." Residential Costs 2019.

23 Southern California Edison (SCE). 2019. “SWHC045-01 Heat Pump HVAC, Residential, Fuel Sub-Calculations.” See Cost Analysis tab.

24 Gordian Group, Inc. (n.d.) "RSMeans Data Online." Residential Costs 2019.

range and assumed that an average size of central heat pump of 3-tons.[25](#_bookmark24) The demolition costs for AC and gas furnace were also obtained from RSMeans Online.[26](#_bookmark25)

# 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 for fuel substitution measures was stipulated in Decision 19-08-009, *Decision Modifying the Energy Efficiency Three-Prong Test Related to Fuel Substitution,* issued by the California Public Utilities Commission (CPUC).[27](#_bookmark26) “When a fuel substitution measure passes the Fuel Substitution Test, it shall be included in the cost-effectiveness analysis of the portfolio with a net-to-gross (NTG) ratio assumption of 1.0, until such time as evaluated NTG information is available, when the assumption shall be updated on a prospective basis.” (OP 1)

Net-to-Gross Ratios

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Source |
| FuelSubst-Default | 1.0 | California Public Utilities Commission (CPUC). 2019. *Decision 19-08-009 in the Order Instituting Rulemaking Concerning Energy Efficiency Rolling Portfolios, Policies, Programs, Evaluation, and Related Issues (R.13-11-005).*  Issued August 5. OP 1. |

# 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. |

# NON-ENERGY IMPACTS

The measures in this workpaper having passed the fuel substitution test reduce the environmental impact by decreasing CO2 emissions. These measure help align with the state’s decarbonizing goals.

25 Southern California Edison (SCE). 2019. “SWHC045-01 Heat Pump HVAC, Residential -Calculations.xlsx.” See Cost Analysis tab.

26 Gordian Group, Inc. (n.d.) "RSMeans Data Online." Residential Costs 2019.

27 California Public Utilities Commission (CPUC). 2019. *Decision 19-08-009 in the Order Instituting Rulemaking Concerning Energy Efficiency Rolling Portfolios, Policies, Programs, Evaluation, and Related Issues (R.13-11-005).* Issued August 5. OP 1.

# 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 | No |
| Scaled DEER measure | No |
| DEER Base Case | Yes (DEER2020 prototypes) |
| DEER Measure Case | Yes (DEER2020 prototypes) |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | Yes |
| DEER Version | 2020 |
| Reason for Deviation from DEER | Measure does not exist in DEER |
| DEER Measure IDs Used | N/A |
| NTG | Source: DEER2020. The NTG of 01.0 is associated with NTG ID: *FuelSubst- Default* |
| 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.* |

# 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 | 12/02/2019 | Akhilesh Reddy Endurthy/ Solaris- Technical, LLC. | New Workpaper |
| 05/05/2020 | Jesse Manao  SCE | Added PG&E & SDGE Implementation IDs in Implementation tab with additional changes to the EAD Table:   * Fixed ScaleBasis to None * Fixed IETableName to None * Fixed misspelling on DnDeemDI * Fixed error on Version and LastMod date |
|  | 11/30/2021 | Akhilesh Reddy Endurthy/ Solaris- Technical, LLC. | Addendum to report refrigerant avoided cost calculations in compliance with Resolution E-5152. |