**Work Paper PGECOHVC166**

**Upstream Residential HVAC**

**Revision # 2**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**Upstream Residential HVAC**

**Measure Codes: S8803, S8804, S8805, S8806, S8807, S8808, S8809, S8810, S8811, S8812, S8813**

# At-a-Glance Summary At-a-Glance Summary

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Applicable Measure Codes:** | **S8803** | **S8804** | **S8805** | **S8806** | **S8807** | **S8808** | **S8809** | **S8810** | **S8811** | **S8812** | **S8813** |
| **Measure Description:** | 15 SEER Package H/P | 16 SEER  Package H/P | 17 SEER  Split System H/P | 18 SEER  Split System H/P | 15 SEER  Packaged AC | 16 SEER  Packaged AC | 17 SEER  Split System AC | 14.5 EER,  Evaporatively Cooled A/C Condenser | 18 SEER  Split System A/C | 96 AFUE  Furnace | 97 AFUE  Furnace |
| **Energy Impact Common Units:** | Savings/Ton of cooling for Air Conditioners and Heat Pumps  Savings/Household for Furnaces | | | | | | | | | | |
| **Base Case Description:** | Source: DEER2015 READi (Version 2.1.0)  Heating and Cooling equipment meeting Title 20, Title 24, and Federal Efficiency Standards. | | | | | | | | | | |
| **Base Case Energy Consumption:** | Source: DEER2015 READi (Version 2.1.0) | | | | | | | | | | |
| **Measure Energy Consumption** | Source: DEER2015 READi (Version 2.1.0) | | | | | | | | | | |
| **Energy Savings**  **(Base Case – Measure)** | Source: DEER2015 READi (Version 2.1.0)  Varies by climate zone | | | | | | | | | | |
| **Costs Common Units:** | $/ton of Cooling for Air Conditioners and Heat Pumps, $/household for Furnaces | | | | | | | | | | |
| **Base Case Equipment Cost ($/unit):** | Source: DEER2016  Varies by Equipment Type and Size | | | | | | | | | | |
| **Measure Equipment Cost ($/unit):** | Source: DEER2016  Varies by climate zone | | | | | | | | | | |
| **Gross Measure Cost ($/unit)** | Source: DEER2016  Varies by climate zone | | | | | | | | | | |
| **Measure Incremental Cost ($/unit):** | Source: DEER2016  Varies by climate zone | | | | | | | | | | |
| **Effective Useful Life (years):** | Source: DEER2014  15 years for Air Conditioners/Heat Pumps, 20 years for furnaces | | | | | | | | | | |
| **Measure Application Type:** | Replace on Burnout (ROB) | | | | | | | | | | |
| **Net-to-Gross Ratios:** | Source: DEER2016  0.75, NonRes-sAll-mHVAC-DX-up (All package and split system AC & HP replacements) | | | | | | | | | | |

# Work Paper Approvals

The following Manager(s) approved this workpaper through the PG&E Electronic Data Routing System under Routing Requisition # \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |
| --- |
|  |
| **Grant Brohard**  Manager, Engineering Services  (Technical Product Support) |
| **Carolyn Weiner**  Manager, Core Products |

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision #** | **Revision Date** | **Section-by-Section Description of Revisions** | **Author (Company)** |
| Revision 0 | 3/03/2014 | Upstream Residential HVAC | Chris Li (PG&E) |
| Revision 1 | 12/17/2014 | 1. Update impact savings, kW, kWh, and therm, for single phase air conditioners and heat pumps to reflect new federal code coming into effect January 01, 2015. | Chris Li (PG&E) |
| Revision 2 | 12/11/2015 | Update NTG and costs for DEER 2016. | Jia Huang (PG&E) |

# Section 1. General Measure & Baseline Data

## Product Measure Description & Background

Table 1 Base and Measure Cases

|  |  |
| --- | --- |
| **Typical Base Case Description** | * Residential SEER-rated split Air Conditioners, Size Range: 18 - 45 kBTU/h, SEER = 14 (EER = 12.2), EIR = 0.239, Fan W/CFM = 0.29, one-speed fan * Residential SEER-rated split Heat Pumps, SEER = 14 (EER = 11.9), HSPF = 8.2 (COP = 3.48), EIR = 0.245, Fan W/CFM = 0.29, one-speed fan * Furnace AFUE 80 |
| **Typical Measure Description** | * Residential SEER-rated split Air Conditioners, Size Range: 18 - 65 kBTU/h, SEER = 15 (EER = 12.8), EIR = 0.232, Fan W/CFM = 0.25, one-speed fan * Residential SEER-rated split Air Conditioners, Size Range: 18 - 65 kBTU/h, SEER = 16 (EER = 12.5), EIR = 0.238, Fan W/CFM = 0.27, two-speed fan * Residential SEER-rated split Air Conditioners, Size Range: 18 - 65 kBTU/h, SEER = 17 (EER = 13.3), EIR = 0.223, Fan W/CFM = 0.27, two-speed fan * Residential SEER-rated split Air Conditioners, Size Range: 18 - 65 kBTU/h, SEER = 18 (EER = 14), EIR = 0.209, Fan W/CFM = 0.27, two-speed fan * Residential SEER-rated split Air Conditioners, Size Range: 18 - 45 kBTU/h, SEER = 17.4, one-speed fan, evaporative cooled condenser * Residential SEER-rated split Heat Pumps, SEER = 15 (EER = 12.8), HSPF = 8.7 (COP = 3.68), EIR = 0.232, Fan W/CFM = 0.25, one-speed fan * Residential SEER-rated split Heat Pumps, SEER = 16 (EER = 12.5), HSPF = 9 (COP = 3.57), EIR = 0.238, Fan W/CFM = 0.27, two-speed fan * Residential SEER-rated split Heat Pumps, SEER = 17 (EER = 13.3), HSPF = 9.4 (COP = 3.74), EIR = 0.223, Fan W/CFM = 0.27, two-speed fan * Residential SEER-rated split Heat Pumps, SEER = 18 (EER = 14), HSPF = 9.7 (COP = 3.86), EIR = 0.209, Fan W/CFM = 0.27, two-speed fan * Efficient Residential Gas Furnace - AFUE 96 * Efficient Residential Gas Furnace - AFUE 97 |

The following air conditioners, heat pumps, and furnaces are eligible under the Upstream HVAC program for residential customers:

Table 2: Measure Names

|  |  |  |  |
| --- | --- | --- | --- |
| PG&E Measure Codes | SCG / SDG&E Codes | SCE Solution Code | Measure name |
| S8807 |  |  | 15 SEER (12.8 EER) Split-System Air Conditioner |
| S8808 |  |  | 16 SEER (12.5 EER) Split-System Air Conditioner |
| S8809 |  |  | 17 SEER (13.3 EER) Split-System Air Conditioner |
| S8811 |  |  | 18 SEER (14.0 EER) Split-System Air Conditioner |
| S8810 |  |  | 17.4 SEER (15.1 EER) Evap-Cooled Split-System Air Conditioner |
| S8803 |  |  | 15 SEER Heat Pump (EER = 12.8) (HSPF = 8.7) |
| S8804 |  |  | 16 SEER Heat Pump (EER = 12.5)(HSPF = 9.0) |
| S8805 |  |  | 17 SEER Heat Pump (EER = 13.3)(HSPF = 9.4) |
| S8806 |  |  | 18 SEER Heat Pump (EER = 14.0)(HSPF = 9.7) |
| S8813 |  |  | Efficient Residential Gas Furnace - AFUE 97 |
| S8812 |  |  | Efficient Residential Gas Furnace - AFUE 96 |

***Catalog Description –***

The measures presented on this workpaper are not on the rebate catalog, it’s promoted under our upstream residential HVAC program.

***Program Restrictions and Guidelines***

The rebate is upstream provided to the distributor at the time of sale upon receipt of sales data. This is not a direct install program.

***Terms and Conditions:***

Only those Air Conditioning and Heat Pump systems covered by AHRI 210/240 2008 are included. 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.

Natural Gas furnaces shall be those tested using the DOE procedures Code of Federal Regulations, 10 CFF Part 430, Subpart B, Appendix N (Standard) which incorporates ANSI/ASHRAE Standard 103. The efficiency is verified by the AHRI certification number. Propane and oil fired furnaces are not eligible.

Installed address must be located in PG&E’s service territory.

***Eligibility Requirements:***

The purpose of the Upstream Program is to encourage HVAC Distributors to stock premium efficiency equipment. This premium efficient equipment is significantly more efficient than the standard efficient equipment, which is mandated by California Title 20 appliance standards and California Title 24 standards. Table C-3 the incentives are paid to the Distributor who may do what they deem best with the incentive. The program does not control or restrict the distributor’s use of the funding.

***Implementation Requirements:***

The region will be defined by postal zip codes and incentives will only be paid on systems:

1. That are being installed in those zip codes
2. For which the applicant has documented the purchase as a replacement on burnout.
3. That meets the WHPA working group’s efficiency tiers.

Table 3: WHPA efficiency tiers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tier 2** | | | | | |
|  | **Air Conditioners** | | **Heat Pumps** | | **Gas Furnaces** |
|  | **Split System** | **Packaged** | **Split Air Source** | **Packaged** | **AFUE** |
| **Efficiency** | 17 SEER, 13 EER | 15 SEER, 12 EER | 17 SEER, 13 EER, 9 HSPF | 15 SEER, 12 EER, 8 HSPF | 96% AFUE gas and propane furnaces, gas and propane boilers, oil furnaces and hot water boilers |
|  | | | | | |
| **Tier 3** | | | | | |
|  | **Air Conditioners** | | **Heat Pumps** | | **Gas Furnaces** |
|  | **Split System** | **Packaged** | **Split Air Source** | **Packaged** | **AFUE** |
| **Efficiency** | 18 SEER, 13 EER | 16 SEER, 12 EER | 18 SEER, 13 EER, 9 HSPF | 16 SEER, 12 EER, 9 HSPF | 97% AFUE gas and propane furnaces, gas and propane boilers, oil furnaces and hot water boilers |

Note: The tiers and equipment are based on WHPA tiers which represent what is produced and sold in the market which can be different than DEER or Consortium for Energy Efficiency (CEE) values.

## 1.2 Product Technical Description

Packaged HVAC

A single-package Air Conditioner or Heat Pump 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 coil. The two system components are connected by a pair of refrigerant lines. A forced air furnace is usually installed with the indoor evaporator coil to permit deliver of either heating or cooling. In the case of a heat pump, the air handler is used with the indoor coil 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.

The evaporatively cooled condenser is a split system AC that is covered by AHRI 210/240 but does not receive an SEER rating. Its EER rating is used for the program and is verified using the AHRI certification number.

Central Natural Gas Furnaces

Natural gas burning, forced-air furnaces provide heat to the conditioned space by passing indoor air through a heat exchanger. A blower fan pulls cool air from inside the dwelling through the return air ducts and forces it through the furnace heat exchanger heating it by up to 50 degrees Fahrenheit. The combustion gases from the furnace are vented outside through flue connected to the combustion unit near the heat exchanger. The AFUE 90 and higher furnaces use two heat exchangers which lower the temperature of the combustion gases to where the moisture condenses and drained in a code approved manner. These condensing furnaces use plastic flue piping making them easy to identify.

## 1.3 Measure Application Type

The Delivery Mechanism of these measures is Upstream Programs – Upstream incentive. The incentives are provided to the HVAC equipment distributor, who provides the site installation information for each unit.

The Program Type/Application Type of these measures are Replace on Burnout (ROB). ROB use he effective useful life (EUL) for the measure life basis.

Table 4: Measure Application Type

|  |  |  |
| --- | --- | --- |
| **Code** | **Description** | **Comment** |
| ROB | Replace on Burnout | measure applied when existing equipment fails or maintenance requires replacement |

Note: See Appendix A for a comparison of the application types used by and incorporated into SCE systems versus the application types available in the newest revision of DEER 2015. Appendix A will serve as a translation between the outputs of this workpaper and application types used by READi.

## 1.4 Product Base Case and Measure Case Cost Effectiveness Data

## 1.4.1 DEER Base Case and Measure Case Information

## The DEER2016 data cited in this work paper include: peak demand reduction, electric savings, interactive gas savings, equipment unit costs, equipment incremental costs, equipment useful life, Net to Gross and measure load shapes.

Table 5: DEER Difference Summary

|  |  |
| --- | --- |
| DEER Difference Summary Table | |
| Modified DEER Methodology | No |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | Yes |
| Deviation from DEER | None |
| DEER Version | DEER2016 READi v.2.3.0 |
| DEER Run ID and Measure Name (Sample) | RE-HV-ResAC-lt45kBtuh-15S, RE-HV-ResAC-lt45kBtuh-16S, RE-HV-ResAC-lt45kBtuh-17S, RE-HV-ResAC-lt45kBtuh-18S, RE-HV-ResEvapAC-lt45kBtuh-17p4S, RE-HV-ResHP-15p0S-8p7H, RE-HV-ResHP-16p0S-9p0H, RE-HV-ResHP-17p0S-9p4H, RE-HV-ResHP-18p0S-9p7H, Res-GasFurnace-AFUE96, Res-GasFurnace-AFUE97 |

**Net to Gross**

Table 6 below summarizes all applicable DEER based Net-to-Gross ratios for programs that may be used by this measure.

See Section 1.1 Terms and Conditions and Market Applicability to reference the type of program delivery mechanism and customer status used to determine this entry.

Table 6: Net-to-Gross Ratio

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NTGR\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID\* | NTG\* |
| NonRes-sAll-mHVAC-DX-up | All package and split system AC & HP replacements | Res | Any | PreRebUp | 0.75 |

\*Denotes that the column is taken from the DEER NTG Table.

**Installation Rate (GSIA)**

The installation rate (IR) is identified in the calculation attachment. This value is obtained from the support table available in READi. Currently there is no versioning on the installation rate table. To address appropriate selection of the installation rate the date of the workpaper will serve as the last date checked for updated IR values. The installation rate varies by end use, sector, technology, application, and delivery method. The relevant IR values for this measure are shown in Table 7 below.

Table 7: Installation Rate

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| GSIA\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID\* | GSIAValue\* |
| Def-GSIA | Default GSIA values | Any | Any | Any | 1 |

\*Denotes that the column is taken from the DEER GSIA Table.

**Spillage Rate**

Spillage rate will also be applied to measures however the values will not be tracked in the workpapers. The spillage rate will be tracked in an external table to be supplied to the Energy Division.

**READi Technology Fields**

To support the development of the ED ex ante tables, select fields from the ex ante database will be identified in the workpaper. For a full set of values associated with the measures in the workpaper refer the Excel calculation template. (In the event that the READi IDs do not support the technology in this workpaper simply indicate “Non-DEER”.)

Table 8: READi Tech IDs

|  |  |  |  |
| --- | --- | --- | --- |
| READi Field Name | Air Conditioner | Heat Pump | Furnace |
| Measure Case UseCategory | HVAC | HVAC | HVAC |
| Measure Case UseSubCats | HVAC-SpCl | HVAC-HtCl | HVAC-SpHt |
| Measure Case TechGroups | dxAC\_equip | dxHP\_equip | SpaceHtg\_eq |
| Measure Case TechTypes | SpltSEER | SpltSEER | Gas Furnace |
| Base Case TechGroups | dxAC\_equip | dxHP\_equip | SpaceHtg\_eq |
| Base Case TechTypes | SpltSEER | SpltSEER | Gas Furnace |

**Effective Useful Life / Remaining Useful Life:**

DEER14 update documentation provides EUL and RUL information to be used for the 2015 program year on [www.deeresources.com](http://www.deeresources.com). The DEER documentation “DEER2014-EUL-table-update\_2014-02-05.xlsx” provides the RUL value as a flat 1/3 of the EUL value. The RUL value will only be applied to the first baseline period for retrofit measures that have applicable code that will affect the energy savings. In all other installation types and retrofit with no applicable code that affects the energy savings, the RUL is not applicable to either the first or second baseline period.

To obtain the EUL value the DEER14 update documentation, “DEER2014-EUL-table-update\_2014-02-05.xlsx” [436], was used. Table 9 below identifies the value/methodology used for the measures in this work paper.

Table 9: EUL/RUL Value/Methodology

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **READi EUL ID** | **Description** | **Sector** | **Enduse** | **EUL (Years)** | **RUL (Years)** |
| HV-ResHP | High Efficiency Heat Pump | RES | HVAC | 15 | 5 |
| HV-ResAC | High Efficiency Air Conditioner | RES | HVAC | 15 | 5 |
| HV-ResEvapAC | Evap Cooled Split Systems Air Conditioner | RES | HVAC | 15 | 5 |
| HV-EffFurn | High Efficiency Gas Furnace | RES | HVAC | 20 | 6.7 |
| HV-ResHP | High Efficiency Heat Pump | RES | HVAC | 15 | 5 |

**1.4.2 Codes & Standards Requirements Base Case and Measure Information**

Table 10: Code Summary

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Dates |
| Title 24 (2013) | Title 24, 2013 (Residential Compliance Manual-Building HVAC Requirements) Tables 4-1 and 4-6 | January 1, 2015 |
| Title 20 (2014) | Title 20, 2014 Appliance Efficiency Regulations. Tables C-2, C-4, and E-6 | January 1, 2015 for AC and HP  May 1, 2013 for Gas furnaces |
| Federal Codes (DOE / EPA) | Federal DOE Energy Regulations, CRF part 430 | January 1, 2015 for AC and HP  May 1, 2013 for Gas furnaces |

**Title 20[[1]](#endnote-2):**

These measures fall under Title 20 of the California Energy Regulations. The efficiency requirements in Title 20 apply for units less than 5.4 tons (65,000 Btu/hr). Under the 2010 Title 20 regulation, the following is required by Section 1605.1(c) (1), “State Standards for Federally-Regulated Appliances. The EER, SEER, COP, and HSPF, as applicable, of all central air conditioners and heat pumps shall be not less than the applicable values shown in Table C-2.”

Under section 1605.1 c)(1), the minimum SEER requirement for the ‘single phase air-cooled air conditioners’ with cooling capacity of less than 65,000 Btu/h is 14.0 SEER and 12.2 EER. Effective January 01, 2015, for single phase air-cooled heat pumps with cooling capacity of less than 65,000 Btu/h the SEER and HSPF requirements is 14.0 SEER, and 8.2 HSPF. The minimum standards for evaporatively-cooled air conditioners, under Table C-4 of the 2013 Title 20 manual, is 12.1 EER for units with cooling capacity of less than 65,000 Btu/h.

For furnaces, under section 1605.1(B) on Table E-6, the minimum standard for gas furnaces with less than 225,000 Btu/h is 80% AFUE.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Title 20 Std. Description** | **Base or Measure Case** | **Value** | **Units** | **Code Source or Reference** |
| Single package air-cooled air conditioners (<65,000 Btuh) | Base | 14.0 | SEER | Table C-2, Title 20, 2014 |
| Single package air-cooled heat pumps (<65,000 Btuh) | Base | 14.0 | SEER | Table C-2, Title 20, 2014 |
| Evaporatively-cooled air conditioners (<65,000 Btuh) | Base | 12.1 | EER | Table C-4, Title 20, 2014 |
| Natural Gas Furnaces | Base | 80% | AFUE | Table E-6, Title 20, 2014 |

**Title 24[[2]](#endnote-3):**

These measures do fall under Title 24 2013 of the California Energy Regulations. Under the 2013 Title 24 for Central Air Conditioners and Air Source Heat Pumps with cooling capacity greater than 45,000 Btu/h and less than 45,000 Btu/h with single-phase power must have a minimum seasonal energy efficiency ratio (SEER) of 14.0 (Effective: 1/1/2015)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Title 24 Std. Description** | **Base or Measure Case** | **Value** | **Units** | **Code Source or Reference** |
| Central Air Conditioners | Base | 14.0 | SEER | Table 4-6, Title 24, 2013 (Residential Compliance Manual-Building HVAC Requirements) |
| Central Air Source Heat Pumps | Base | 14.0 | SEER | Table 4-6, Title 24, 2013 (Residential Compliance Manual-Building HVAC Requirements) |
| Central Furnaces | Base | 80% | AFUE | Table 4-1, Title 24, 2013 (Residential Compliance Manual-Building HVAC Requirements) |

***Federal Standards:***

These measures do fall under Federal DOE Energy Regulations. Title 20 adopts the Federal Standard but did not adopt the newer regional standards. Starting January 1, 2015, new Federal Regional Standards are scheduled to go into effect for central split system air conditioners smaller than 45,000 Btu/h will require a SEER 14 and EER 12.2 and for larger systems, the requirements is SEER 14 and EER 11.7.

Federal Regional Standards for furnaces, are incorporated into Federal DOE (10 CFR Part 430)[[3]](#endnote-4) Energy Regulations. Under this regulation, regional standards are scheduled for to change the AFUE for non-weatherized furnaces on May 1, 2013 and on January 1, 2015 for weatherized furnaces and central air conditioners and heat pumps. Most residential type furnaces are installed inside the house and are classified as non-weatherized for which the minimum AFUE is 80% for units less than 225,000 Btu/h in input capacity sold in the warm regions of the country.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Federal Std. Description** | **Base or Measure Case** | **Value** | **Units** | **Code Source or Reference** |
| Central Air Conditioners | Base | 14.0 SEER, 12.2 or 11.7 EER | Per System | CFR Part 430 |
| Central furnaces | Base | 80% AFUE | Per System | CFR Part 430 |

## 1.4.3 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information

## There were no M&V or other studies which were referenced for these measures.

## 1.4.4 Assumptions and Calculations from other sources—Base and Measure Cases

There are no further data or calculations provided for the support of the measures in this work paper. The savings were downloaded from DEER2015 directly.

**Section 2. Calculation Methods**

Table 11 contains the data files for measures that are taken directly from the DEER 2015 READi Tool. These results for the air conditioners and heat pumps measures have not been modified, only the furnaces were modified to reflect the units of “per household”.

Table 11 READi Tool Outputs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PG&E Measure Code** | **SCG and SDG&E Solution Code** | **SCE Solution Code** | **Measure Name** | **READi Results** |
| S8807 |  |  | 15 SEER (12.72 EER) Split-System Air Conditioner | accompanying calculation spreadsheet |
| S8808 |  |  | 16 SEER (11.61 EER) Split-System Air Conditioner | accompanying calculation spreadsheet |
| S8809 |  |  | 17 SEER (12.28 EER) Split-System Air Conditioner | accompanying calculation spreadsheet |
| S8811 |  |  | 18 SEER (13.37 EER) Split-System Air Conditioner | accompanying calculation spreadsheet |
| S8810 |  |  | 17.4 SEER (15.1 EER) Evap-Cooled Split-System Air Conditioner | accompanying calculation spreadsheet |
| S8803 |  |  | 15 SEER Heat Pump (HSPF = 8.8) | accompanying calculation spreadsheet |
| S8804 |  |  | 16 SEER Heat Pump (HSPF = 8.4) | accompanying calculation spreadsheet |
| S8805 |  |  | 17 SEER Heat Pump (HSPF = 8.6) | accompanying calculation spreadsheet |
| S8806 |  |  | 18 SEER Heat Pump (HSPF = 9.2) | accompanying calculation spreadsheet |
| S8813 |  |  | Efficient Residential Gas Furnace - AFUE 97 | accompanying calculation spreadsheet |
| S8812 |  |  | Efficient Residential Gas Furnace - AFUE 96 | accompanying calculation spreadsheet |

|  |  |  |  |
| --- | --- | --- | --- |
| **Install/Program Type** | **Measure Life Basis** | **First Baseline Period Gross Measure Cost (RUL)** | **Second Baseline Period Gross Measure Cost (EUL – RUL)** |
| ***ROB*** | EUL | Calculated as Incremental Measure Cost | N/A |

Note: For ROB measure, First Baseline is the baseline for the full EUL. There is no second baseline.

## 2.1 Electric Energy Savings Estimation Methodologies

Energy savings for these measures were downloaded from the DEER2015[[4]](#endnote-5) READI tool (v2.1.0) directly.

Energy savings values vary by building types, building vintages, and climate zones. For this work paper, a weighted DEER building type of residential (RES) was chosen, along with using “existing” (weighted DEER vintages) building vintage and all California CEC climate zones.

|  |  |  |  |
| --- | --- | --- | --- |
| **Impact ID** | **Measure Description** | **Measure Code** | **DEER Version** |
| RE-HV-ResAC-15S | 15 SEER,12.72 EER Split-System Air Conditioner | S8807 | DEER2015 |
| RE-HV-ResAC-16S | 16 SEER, 11.61 EER Split-System Air Conditioner | S8808 | DEER2015 |
| RE-HV-ResAC-17S | 17 SEER, 12.28 EER Split-System Air Conditioner | S8809 | DEER2015 |
| RE-HV-ResAC-18S | 18 SEER, 13.37 EER Split-System Air Conditioner | S8811 | DEER2015 |
| RE-HV-ResEvapAC-17p4S | 17 SEER, 15.1 EER Evap-cooled Split-System Air Conditioner | S8810 | DEER2015 |
| RE-HV-ResHP-15p0S-8p8H | 15 SEER Heat Pump (HSPF = 8.8) | S8803 | DEER2015 |
| RE-HV-ResHP-16p0S-8p4H | 16 SEER Heat Pump (HSPF = 8.4) | S8804 | DEER2015 |
| RE-HV-ResHP-17p0S-9p4H | 17 SEER Heat Pump (HSPF = 8.6) | S8805 | DEER2015 |
| RE-HV-ResHP-18p0S-9p7H | 18 SEER Heat Pump (HSPF = 9.2) | S8806 | DEER2015 |

See accompanying calculation spreadsheet for complete list of measure case savings

## 2.2. Demand Reduction Estimation Methodologies

Energy savings for these measures were downloaded from the DEER2015 READI tool (v2.1.0) directly.

Energy savings values vary by building types, building vintages, and climate zones. For this work paper, a weighted DEER building type of residential (RES) was chosen, along with using “existing” (weighted DEER vintages) building vintage and all California CEC climate zones.

|  |  |  |  |
| --- | --- | --- | --- |
| **Impact ID** | **Measure Description** | **Measure Code** | **DEER Version** |
| RE-HV-ResAC-15S | 15 SEER (12.72 EER Split-System Air Conditioner | S8807 | DEER2015 |
| RE-HV-ResAC-16S | 16 SEER (11.61 EER Split-System Air Conditioner | S8808 | DEER2015 |
| RE-HV-ResAC-17S | 17 SEER (12.28 EER Split-System Air Conditioner | S8809 | DEER2015 |
| RE-HV-ResAC-18S | 18 SEER (13.37 EER Split-System Air Conditioner | S8811 | DEER2015 |
| RE-HV-ResEvapAC-17p4S | 17 SEER (15.1 EER Evap-cooled Split-System Air Conditioner | S8810 | DEER2015 |
| RE-HV-ResHP-15p0S-8p8H | 15 SEER Heat Pump (HSPF = 8.8) | S8803 | DEER2015 |
| RE-HV-ResHP-16p0S-8p4H | 16 SEER Heat Pump (HSPF = 8.4) | S8804 | DEER2015 |
| RE-HV-ResHP-17p0S-9p4H | 17 SEER Heat Pump (HSPF = 8.6) | S8805 | DEER2015 |
| RE-HV-ResHP-18p0S-9p7H | 18 SEER Heat Pump (HSPF = 9.2) | S8806 | DEER2015 |

See accompanying calculation spreadsheet for complete list of measure case savings.

## 2.3. Gas Energy Savings Estimation Methodologies

Gas savings for these measures were downloaded from the DEER2015 READI tool (v2.1.0) directly. These measures include HVAC interactive effects savings.

|  |  |  |  |
| --- | --- | --- | --- |
| **Impact ID** | **Measure Description** | **Measure Code** | **DEER Version** |
| Res-GasFurnace-AFUE97 | Efficient Residential Gas Furnace - AFUE 97 | S8813 | DEER2014 |
| Res-GasFurnace-AFUE96 | Efficient Residential Gas Furnace - AFUE 96 | S8812 | DEER2014 |

Energy savings values vary by building types, building vintages, and climate zones. For this work paper, a weighted DEER building type of residential (RES) was chosen, along with using “existing” (weighted DEER vintages) building vintage and all California CEC climate zones.

DEER measure savings impacts for gas furnaces are reported per kBTUh. DEER impacts are multiplied by the Res-weighted per unit kBTUh capacity to arrive at therms per household.

See accompanying calculation spreadsheet for complete list of measure case savings.

# *Section 3. Load Shapes*

## 3.1 Base Case Load Shapes

The closest load shape chosen for this measure is the DEER:HVAC\_Split-Package\_AC load shape. See Table 12 for a list of all Building Types and Load Shapes. See the KEMA report[[5]](#endnote-6) for a more thorough discussion regarding the load shapes for this measure.

Table 12: Base Case Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Residential | Res | DEER:HVAC\_Split-Package\_AC |

## 3.2 Measure Load Shapes

The closest load shape chosen for this measure is the DEER:HVAC\_Split-Package\_ACload shape. See Table 13 for a list of all Building Types and Load Shapes. See the KEMA report for a more thorough discussion regarding the load shapes for this measure.

Table 13: Measure Case Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Residential | Res | DEER:HVAC\_Split-Package\_AC |

# Section 4. Base Case & Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Measure Life Basis** | **First Baseline Period Full Measure Cost (RUL)** | **Second Baseline Period Full Measure Cost (EUL – RUL)** |
| **ROB(replace on burnout)** | EUL | Calculated as Incremental Measure Cost | N/A |

Cost data for split system air conditioners and heat pumps are obtained directly from DEER 2016. Costs for residential gas furnaces are taken from Work Order 17: 2010-12 Ex-Ante Measure Cost Study.

A Department of Energy report titled *Measure Guideline: Evaporative Condensers[[6]](#endnote-7)*

Includes estimates for the incremental cost of a residential evaporative condenser.

*Assuming volume production similar to that of air-cooled condensers, manufacturers predict a 30% system price increase over a high efficiency (SEER 15) air-cooled unit, or roughly $350. Estimated mature market incremental cost over a SEER 13 unit is $750. Currently, costs are significantly higher with incremental equipment costs to the homeowner over a SEER 15 condensing unit between $1,000 and $1,350.*

Since the report was released in 2012, it’s reasonable to assume the lower bound of $1,000 per unit. Assuming a 3-ton unit, the incremental cost of an evaporative cooled condenser over a SEER 15 condensing unit is $333 per ton. Therefore, the incremental cost of an evaporative condenser over a baseline SEER 14 split air conditioner is $333+$92.12 = $425.12 per ton.

## 4.1 Base Case(s) Costs

The following Measure Application Type is appropriate to these measures. The Base Case Costs are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Measure Application Type** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Base Case Cost** |
| S8807 | ROB | Code | $514.98 | N/A | N/A | $514.98 |
| S8808 | ROB | Code | $514.98 | N/A | N/A | $514.98 |
| S8809 | ROB | Code | $514.98 | N/A | N/A | $514.98 |
| S8811 | ROB | Code | $514.98 | N/A | N/A | $514.98 |
| S8810 | ROB | Code | $514.98 | N/A | N/A | $514.98 |
| S8803 | ROB | Code | $777.64 | N/A | N/A | $777.64 |
| S8804 | ROB | Code | $777.64 | N/A | N/A | $777.64 |
| S8805 | ROB | Code | $777.64 | N/A | N/A | $777.64 |
| S8806 | ROB | Code | $777.64 | N/A | N/A | $777.64 |
| S8813 | ROB | Code | $640.51 | N/A | N/A | $640.51 |
| S8812 | ROB | Code | $640.51 | N/A | N/A | $640.51 |

*All costs are noted as $ per measure unit, for air conditioners/heat pumps this unit is per ton and for furnaces, the unit is per household*

## 4.2 Measure Case Costs

The following Measure Application Type is appropriate to these measures. The Measure Case Costs are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Measure Application Type** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Measure Case Cost** |
| S8807 | ROB | Code | $607.10 | N/A | N/A | $607.10 |
| S8808 | ROB | Code | $699.23 | N/A | N/A | $699.23 |
| S8809 | ROB | Code | $791.36 | N/A | N/A | $791.36 |
| S8811 | ROB | Code | $883.48 | N/A | N/A | $883.48 |
| S8810 | ROB | Code | $940.10 | N/A | N/A | $940.10 |
| S8803 | ROB | Code | $960.40 | N/A | N/A | $960.40 |
| S8804 | ROB | Code | $1,143.16 | N/A | N/A | $1,143.16 |
| S8805 | ROB | Code | $1,325.93 | N/A | N/A | $1,325.93 |
| S8806 | ROB | Code | $1,508.69 | N/A | N/A | $1,508.69 |
| S8813 | ROB | Code | $1,221.88 | N/A | N/A | $1,221.88 |
| S8812 | ROB | Code | $1,074.75 | N/A | N/A | $1,074.75 |

*All costs are noted as $ per measure unit, for air conditioners/heat pumps this unit is per ton and for furnaces, the unit is per household*

## 4.3 Incremental & Full Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Full Measure Cost**  **(RUL Period/First Baseline)** | **Full Measure Cost**  **(EUL-RUL Period/ Second Baseline)** | **Incremental Measure Cost** |
| ROB | Measure Equipment Cost  – Base Case Equipment Cost | N/A | Measure Equipment Cost  – Base Case Equipment Cost |

# *4.3.1 Full Measure Cost*

Full Measure Cost is the cost to install an energy efficient measure per the CPUC calculators. This definition implies a different meaning depending on the Measure Application type.

This Measure Application Type is: **ROB**, so the Full Measure Cost (FMC) is represented by the equation below (choose):

FMC = Measure Equipment Cost – Base Case Equipment *Cost*

\*Note: Various complicated price fluctuations are not addressed in these equations, such as future costs due to inflation in labor, future costs due to deflation in material cost, and other variables that cannot be accurately described at this time.

# *4.3.2 Incremental Measure Costs*

Incremental Measure Cost is the premium cost to install an energy efficient measure over a standard efficiency measure or code baseline measure. While IMC has a straightforward definition depending on the Measure Application type, the equation does vary.

This Measure Application Types is: **ROB** so the Gross Measure Cost (GMC) is represented by the appropriate equation below:

IMC = Measure Equipment Cost – Base Case Equipment Cost

Table 14: Summary Table for Section 4

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Measure ID** | **Impact IDs** | **Measure Application Types** | **Base Case Total Cost** | **Measure Case Total Cost** | **Full Measure Case Cost** | **Incremental Measure Cost** |
| S8807 | RE-HV-ResAC-15S | ROB | $514.98 | $607.10 | N/A | $92.12 |
| S8808 | RE-HV-ResAC-16S | ROB | $514.98 | $699.23 | N/A | $184.25 |
| S8809 | RE-HV-ResAC-17S | ROB | $514.98 | $791.36 | N/A | $276.38 |
| S8811 | RE-HV-ResAC-18S | ROB | $514.98 | $883.48 | N/A | $368.50 |
| S8810 | RE-HV-ResEvapAC-17p4S | ROB | $514.98 | $940.10 | N/A | $425.12 |
| S8803 | RE-HV-ResHP-15p0S-8p8H | ROB | $777.64 | $960.40 | N/A | $182.76 |
| S8804 | RE-HV-ResHP-16p0S-8p4H | ROB | $777.64 | $1,143.16 | N/A | $365.52 |
| S8805 | RE-HV-ResHP-17p0S-9p4H | ROB | $777.64 | $1,325.93 | N/A | $548.29 |
| S8806 | RE-HV-ResHP-18p0S-9p7H | ROB | $777.64 | $1,508.69 | N/A | $731.05 |
| S8813 | Res-GasFurnace-AFUE97 | ROB | $640.51 | $1,221.88 | N/A | $581.37 |
| S8812 | Res-GasFurnace-AFUE96 | ROB | $640.51 | $1,074.75 | N/A | $434.24 |

# *All costs are noted as $ per measure unit, for air conditioners/heat pumps this unit is per ton and for furnaces, the unit is per household*

# 

References

1. California Energy Commission (CEC). “California Code of Regulations – Title 20 Public Utilities and Energy”. CEC-140-2013-002, August 2013

   <http://www.energy.ca.gov/2013publications/CEC-140-2013-002/CEC-140-2013-002.pdf> [↑](#endnote-ref-2)
2. California Energy Commission (CEC). “2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings”. CEC-400-2012-004-CMF, May 2012

   <http://www.energy.ca.gov/2012publications/CEC-400-2012-004/CEC-400-2012-004-CMF.pdf> [↑](#endnote-ref-3)
3. Department of Energy, “Energy Conservation Program: Energy Conservation Standards for Residential Furnaces and Residential Central Air Conditioners and Heat Pumps”, 10 CFR Part 430, Docket Number EERE-2011-BT-STD-0011, June 27, 2011. <http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/cacfurn_dfr.pdf> [↑](#endnote-ref-4)
4. Itron, Inc. “2014 Database for Energy Efficiency Resources”, Version 1.0.3, November 2013.

   <http://www.deeresources.com/> [↑](#endnote-ref-5)
5. KEMA Inc., JJ Hirsch and Assoc., Itron Inc, Final Report - Load Shape Update Initiative, Prepared for the California Public Utility Commission Under contract to Pacific Gas and Electric Company, revised 11/17/2006 [↑](#endnote-ref-6)
6. A. German, B. Daikin, and M. Hoeschele. (March 2012). Measure Guidelines: Evaporative Condensers. Prepared for U.S. Department of Energy. Retrieved from <http://www.davisenergy.com/wp-content/uploads/2012/06/BA_measure_guide_evap_condensers_PUBLISHED.pdf>. [↑](#endnote-ref-7)