

APPLIANCE & PLUG LOADs

ROOM AIR CONDITIONER, Residential

SWAP007-01

C O N T E N T S

[Measure Name 2](#_TOC_250023)

[Statewide Measure ID 2](#_TOC_250022)

[Technology Summary 2](#_TOC_250021)

[Measure Case Description 2](#_TOC_250020)

[Base Case Description 3](#_TOC_250019)

[Code Requirements 3](#_TOC_250018)

[Normalizing Unit 4](#_TOC_250017)

[Program Requirements 4](#_TOC_250016)

[Program Exclusions 5](#_TOC_250015)

[Data Collection Requirements 5](#_TOC_250014)

[Use Category 5](#_TOC_250013)

[Electric Savings (kWh) 6](#_TOC_250012)

[Peak Electric Demand Reduction (kW) 7](#_TOC_250011)

[Gas Savings (Therms) 8](#_TOC_250010)

[Life Cycle 8](#_TOC_250009)

[Base Case Material Cost ($/unit) 9](#_TOC_250008)

[Measure Case Material Cost ($/unit) 9](#_TOC_250007)

[Base Case Labor Cost ($/unit) 10](#_TOC_250006)

[Measure Case Labor Cost ($/unit) 10](#_TOC_250005)

[Net-to-Gross (NTG) 10](#_TOC_250004)

[Gross Savings Installation Adjustment (GSIA) 10](#_TOC_250003)

[Non-Energy Impacts 11](#_TOC_250002)

[DEER Differences Analysis 11](#_TOC_250001)

[Revision History 11](#_TOC_250000)

# MEASURE NAME

Room Air Conditioner, Residential

# STATEWIDE MEASURE ID

SWAP007-01

# TECHNOLOGY SUMMARY

A room air conditioner (AC) is a factory-encased air conditioner that is designed as a unit for mounting in a window, through a wall, or as a console; and for delivery of conditioned air to an enclosed space without ducts. Room AC units include a prime source of refrigeration and may include a means for ventilating and heating.1

The energy efficiency is represented by the combined energy efficiency ratio (CEER). The CEER is the ratio of measured cooling output (Btu/hr) to the sum of the measured average annual electrical energy input (watts) and measured annual standby/off-mode power consumption (watts). CEER is expressed in Btu/W- hr.

# MEASURE CASE DESCRIPTION

The measure case specification is defined by three efficiency tiers based upon the ENERGY STAR® Program Requirements Product Specification for Room Air Conditioners, Version 4.0.2

1. *ENERGY STAR Basic tier:* The unit efficiency meets the ENERGY STAR Version 4.0 eligibility criteria,
2. *ENERGY STAR Connected Tier:* The connected model offers advanced controls and increased functionality, such as the ability to turn off the unit remotely when the user is not at home and provides feedback on the energy use of the product.
3. *ENERGY STAR Advanced tier*: The unit efficiency exceeds the ENERGEY STAR 4.0 requirements by 10%.

As shown below, the specific efficiency threshold requirements depend upon the size (capacity) and configuration (louvered sides, casement type) of the unit.

1 ENERGY STAR. 2015. "ENERGY STAR® Program Requirements Product Specification for Room Air Conditioners - Eligibility Criteria Version 4.0." Effective October 26, 2015.

2 ENERGY STAR. 2015. "ENERGY STAR® Program Requirements Product Specification for Room Air Conditioners - Eligibility Criteria Version 4.0." Effective October 26, 2015.

Measure Case Specification

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Product Class | Louvered Sides? | Cooling Capacity (Btu/h) | Min. CEER for Basic Tier (ENERGY STAR) | Min. CEER for Advanced Tier (ENERGY STAR +10%) |
| Room AC | Yes | < 6,000 | 12.1 | 13.3 |
| 6,000 – 7,999 | 12.1 | 13.3 |
| 8,000 – 13,999 | 12.0 | 13.2 |
| 14,000 – 19,999 | 11.8 | 13.0 |
| 20,000 – 27,999 | 10.3 | 11.3 |
| ≥ 28,000 | 9.9 | 10.9 |
| No | <6,000 | 11.0 | 12.1 |
| 6,000 – 7,999 | 11.0 | 12.1 |
| 8,000 – 10,999 | 10.6 | 11.7 |
| 11,000 – 13,999 | 10.5 | 11.6 |
| 14,000 – 19,999 | 10.2 | 11.2 |
| ≥ 20,000 | 10.3 | 11.3 |
| Room AC Heat Pump | Yes | < 20,000 | 10.8 | 11.9 |
| ≥ 20,000 | 10.2 | 11.2 |
| No | < 14,000 | 10.2 | 11.2 |
| ≥ 14,000 | 9.6 | 10.6 |
| Casement-Only Room AC | Either | Any | 10.5 | 11.6 |
| Casement-Slider Room AC | Either | Any | 11.4 | 12.5 |

# BASE CASE DESCRIPTION

The base case room air conditioner is defined as a unit that complies with the minimum specification of the California Appliance Efficiency Regulations (Title 20)3 (see Code Requirements section), and that does not meet the ENERGY STAR Version 4.0 efficiency criteria.

# CODE REQUIREMENTS

As shown below, room air conditioners are governed by California 2016 Appliance Efficiency Regulations (Title 20)4 which mirror current federal efficiency standards. The combined EER or room air conditioners manufactured on or after June 1, 2014 shall not be less than the applicable values shown in the following tables. (Note that room air conditioning heat pumps are also frequently referred to as reverse cycle room air conditioners.)

3 California Energy Commission (CEC). 2017. *2016 Appliance Efficiency Regulations*. CEC-400-2017-002.

4 California Energy Commission (CEC). 2017. *2016 Appliance Efficiency Regulations*. CEC-400-2017-002.

Applicable State and Federal Codes and Standards

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Date |
| CA Appliance Efficiency Regulations – Title 20 (2016) | Section 1605.1 (b) | June 1, 2014 |
| CA Building Energy Efficiency Standards – Title 24 | None. | n/a |
| Federal Standards | Section 430.32 (b) | June 1, 2014 |

California Title 20 Requirements for Room Air Conditioners

|  |  |  |  |
| --- | --- | --- | --- |
| Product Class | Louvered Sides? | Cooling Capacity (Btu/h) | Minimum Combined EER |
| Room Air Conditioner | Yes | < 6,000 | 11.0 |
| 6,000 – 7,999 | 11.0 |
| 8,000 – 13,999 | 10.9 |
| 14,000 – 19,999 | 10.7 |
| 20,000 – 27,999 | 9.4 |
| ≥ 28,000 | 9.0 |
| No | <6,000 | 10.0 |
| 6,000 – 7,999 | 10.0 |
| 8,000 – 10,999 | 9.6 |
| 11,000 – 13,999 | 9.5 |
| 14,000 – 19,999 | 9.3 |
| ≥ 20,000 | 9.4 |
| Room Air Conditioning Heat Pump | Yes | < 20,000 | 9.8 |
| ≥ 20,000 | 9.3 |
| No | < 14,000 | 9.3 |
| ≥ 14,000 | 8.7 |
| Casement-Only Room Air Conditioner | Either | Any | 9.5 |
| Casement-Slider Room Air Conditioner | Either | Any | 10.4 |

# NORMALIZING UNIT

Each.

# 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 |
| Normal replacement | UpDeemed | Res |
| Normal replacement | DnDeemed | Res |
| Normal replacement | DnDeemDI | Res |
| New construction | UpDeemed | Res |
| New construction | DnDeemed | Res |
| New construction | DnDeemDI | Res |

*Eligible Products*

The room air conditioner must meet or exceed the current ENERGY STAR efficiency levels and carry the ENERGY STAR qualification, as per specification in the Measure Case Description.

*Eligible Building Types*

Eligible building types include all single-family, multifamily, and mobile homes residential buildings of any vintage.

*Eligible Climate Zones*

The measure is applicable in all California climate zones.

# PROGRAM EXCLUSIONS

The following products are not eligible: packaged terminal air conditioners (PTACs), portable air conditioners, room air conditioner models with electric resistance heat as the primary heat source, and dehumidifiers.

# DATA COLLECTION REQUIREMENTS

Data collection requirements are to be determined.

# USE CATEGORY

Appliance and plug loads (AppPlug)

# ELECTRIC SAVINGS (kWh)

ENERGY STAR Basic Tier Unit Energy Savings

Unit energy savings (UES) for a basic tier room air conditioner (AC) unit was based on the Residential Retrofit High Impact Measure Evaluation Report published by The Cadmus Group in 2010.5 The analysis provides room AC modeled annual energy savings (in climate zones 6, 8, 9 and 10) based on the California Appliance Efficiency Regulations (Title 20) code effective October 1, 2000. The results of the study were subsequently updated to reflect the new federal code (effective June 1, 2014) and the ENERGY STAR Version 4.0 eligibility criteria.

The estimated annual UES for the remaining climate zones were extrapolated by using the California Statewide Residential Appliance Saturation Study (RASS)6 unit energy consumption (UEC) values for room AC by climate zone. The RASS UECs were used to determine a scaling factor calculated as Residential HIM Savings/RASS UEC.7 Based on climatic parallels, energy savings for Climate Zones 11, 13, 14, 15 were derived from the Climate Zone 10 Residential HIM/RASS UEC scaling factor. Similarly, estimated energy savings for Climate Zones 12 and 16 are determined via the Climate Zone 8 scaling factor. Remaining Climate Zones 1, 2, 3, 4 and 5 were calculated in a similar manner using Climate Zone 6.

UES values were also developed for each investor-owned utility (IOU) as the weighted average UES across all climate zones in each IOU service area.

ENERGY STAR Connected Tier Unit Energy Savings

The UES of an ENERGY STAR Connected room air conditioner model is identical to the UES of the ENERGY STAR Basic Tier UES.

ENERGY STAR Advanced Tier Unit Energy Savings

The UES of an advanced tier room AC unit was scaled from the Basic Tier UES value, as shown in the following calculation.

*UESES+10% = Unit energy savings of an advanced tier room AC unit (kWh) UESES = Unit energy savings of a basic tier room AC unit (kWh) CEERBase= Efficiency of a base case room AC unit (CEER)*

*CEERES+10%= Efficiency of an advanced tier room AC unit (CEER)*

5 The Cadmus Group, Inc. 2010. *Residential Retrofit High Impact Measure Evaluation Report.* Prepared for the California Public Utilities Commission.

6 KEMA, Inc. 2010. *2009 California Residential Appliance Saturation Study. Volume 2: Results*. Prepared for the California Energy Commission. CEC-200-2010-004.

7 Southern California Edison (SCE). 2016. “SCE Energy Star Room Air Conditioners\_Final.xlsx.”

*CEERES = Efficiency of a basic tier room AC unit (CEER)*

# PEAK ELECTRIC DEMAND REDUCTION (KW)

It is assumed that this measure operates within the Database of Energy Efficient Resources (DEER) peak period of 4 p.m. to 9 p.m. on weekdays.8 The derivation of peak demand reduction for each efficiency tier is explained below.

ENERGY STAR Basic Tier Unit Demand Reduction

The peak demand reduction a basic tier room air conditioner (AC) was based on the Residential Retrofit High Impact Measure Evaluation Report published by The Cadmus Group in 2010.9 The analysis provides room AC modeled demand reduction (in climate zones 6, 8, 9 and 10) based on the Title 20 code effective as of October 1, 2000. The results of the study were subsequently updated to reflect the new federal code (effective June 1, 2014) and the ENERGY STAR Version 4.0 eligibility criteria.

The estimated demand reduction for the remaining climate zones were extrapolated by using the California Statewide Residential Appliance Saturation Study (RASS)10 UEC values for room AC by climate zone. The RASS unit energy consumption (UEC) values were used to develop a scaling factor calculated as *[Residential HIM Savings/RASS UEC]*.11 Based on climatic parallels, the demand reduction values for climate zones 11, 13, 14, 15 were derived from the climate zone 10 Residential HIM/RASS UEC scaling factor. Similarly, estimated demand reduction for climate zones 12 and 16 are determined via the climate zone 8 scaling factor. Remaining climate zones 1, 2, 3, 4 and 5 were calculated in a similar manner using climate zone 6.

At the time when the Cadmus High Impact Measure Evaluation was conducted, the DEER peak demand period was 2:00 p.m. to 5:00 p.m. An additional step was necessary to map the peak demand savings from the period of 2:00 p.m. to 5:00 p.m. to the current DEER peak demand period of 4:00 p.m. to 9:00

p.m. The Cadmus evaluation study presented hourly mean energy usage during the peak demand period for climate zones 6 to 10 (see Table 152). The mean hourly percent of each peak day energy usage was calculated for the period of 2:00 p.m. to 5:00 p.m. and for 4:00 p.m. to 9:00 p.m.; the ratio of these percentages was then applied to the peak demand savings for each climate zone to scale the peak demand of the previous peak period to derive the peak demand of the new peak period. Since the peak demand period studied corresponded to days when the highest temperatures occurred in the hours of 2:00 p.m. to 5:00 p.m. rather than the hours of 4:00 p.m. to 9:00 p.m., this analysis may understate the peak demand reduction.

8 California Public Utilities Commission (CPUC). 2018. *Resolution E-4952.* October 11. Op 1.

9 The Cadmus Group, Inc. 2010. *Residential Retrofit High Impact Measure Evaluation Report*. Prepared for the California Public Utilities Commission.

10 KEMA, Inc. 2010. *2009 California Residential Appliance Saturation Study. Volume 2: Results*. Prepared for the California Energy Commission. CEC-200-2010-004.

11 Southern California Edison (SCE). 2016. “SCE Energy Star Room Air Conditioners\_Final.xlsx.”

Peak demand reduction values were also developed for each investor-owned utility (IOU) as the weighted average UES across all climate zones in each IOU service area.

ENERGY STAR Connected Tier Unit Demand Reduction

The peak demand reduction of an ENERGY STAR Connected room air conditioner model is equal to the peak demand reduction of the ENERGY STAR Basic Tier.

ENERGY STAR Advanced Tier Unit Demand Reduction

Peak demand reduction estimates for an advanced tier room AC were derived by applying a scaling factor to the Basic Tier unit demand reduction values.

*UDRES+10% = Unit demand reduction of an advanced tier room AC unit (kW) UDRES = Unit demand reduction of a basic tier room AC unit (kW) CEERBase= Efficiency of base case room AC unit (CEER)*

*CEERES+10%= Efficiency of an advanced tier room AC unit (CEER) CEERES = Efficiency of a basic tier room AC unit (CEER)*

# GAS SAVINGS (THERMS)

Not applicable.

# 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. EUL is often, but not always, derived from measure persistence or retention studies. 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 a room air conditioner (AC) are specified below. Note that RUL is only applicable for add-on and accelerated replacement measures and not applicable for this measure.

Note that the original source for the estimated lifetime of a room AC unit was adopted in the Database for Energy Efficient Resources 2008 update, with the original source noted as “Appliance Magazine.” Documentation for this EUL has not been located or is no longer available.

Effective Useful Life and Remaining Useful Life

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Source |
| EUL (yrs) | 9.0 | Appliance Magazine 1998. “Portrait of the U.S. Appliance Industry.”  This reference has not been located or is no longer available. |
| RUL (yrs) | n/a | - |

# BASE CASE MATERIAL COST ($/UNIT)

The base case material cost for equipment *delivered via direct install* is equal to $0.

The estimation of the base case material cost for *all other delivery types* follows the approach to estimate measure case costs, as summarized in Measure Case Material Cost.

# MEASURE CASE MATERIAL COST ($/UNIT)

Measure case material costs for *all delivery types* were estimated from a hedonic price model that utilized web-scraped (“web harvested”) data from eight online retailers yielded 516 initial product models and approximately 110 initial attributes.12

Hedonic price models are often used to estimate the contribution of specific characteristics (including energy efficiency) to the product price. This is the method utilized in the 2010-2012 Ex Ante Measure Cost Study13 to identify key drivers of price and determine the fraction of price explained by specific variables (such as energy efficiency). As outlined in Young et al.,14 the key drivers of cost may be unrelated to energy efficiency. In this modeling approach, the incremental measure cost (IMC) is defined as the fraction of cost difference between the program-qualified (measure case) and base case model that can be attributed to energy efficiency. For example, if the measure is an ENERGY STAR product and the base case is a non-ENERGY STAR product, IMC is defined as the fraction of incremental cost that can be attributed to an ENERGY STAR product. The IMC may be different for various models, and therefore a weighted average is calculated across multiple model-specific IMC values to establish an overall IMC for the product category.

The results of the hedonic price model indicate that ENERGY STAR-qualified air conditioners are estimated to cost $22 more than non-qualified products. Because the coefficient of the ‘ENERGY STAR’ term in the model was highly statistically significant (p=0.008), the IMC model estimate is accepted (rather than the null hypothesis that the IMC is equal to $0.00).

12 This analysis is part of a broader effort to understand the dynamics between product attributes and price. A web harvesting approach was initially utilized by the Statewide IOU Codes and Standards team to identify key drivers of product costs for LED lamps from 2012-2014 and was presented at the ACEEE Summer Study Conference in 2014.

13 Itron, Inc. 2014. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report.* Prepared for the California Public Utilities Commission.

14 Young, D., M. McGaraghan, N. Dewart, D. Hopper, P. Borocz, F. Kaser, et al. (Energy Solutions). 2014. “Leveraging Big Data to Develop Next Generation Demand Side Management Programs and Energy Regulations.” Proceedings of the 2014 ACEEE Summer Study on Energy Efficiency in Buildings, 11-332. Washington, DC: American Council for an Energy Efficient Economy (ACEEE).

# BASE CASE LABOR COST ($/UNIT)

For *all delivery types*, a high efficiency model does not require additional installation labor compared to a base case model. Since this measure is applicable for normal replacement and new construction installations, the base case and measure case model installation costs are expected to be the same for the customer and thus not estimated for the incremental cost analysis.

# MEASURE CASE LABOR COST ($/UNIT)

For *all delivery types*, a high efficiency model does not require additional installation labor compared to a base case model. Since this measure is applicable for normal replacement and new construction installations, the base case and measure case model installation costs are expected to be the same for the customer and thus not estimated for the incremental cost analysis.

# 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. According to the disposition by the California Public Utilities Commission (CPUC) Energy Division issued on December 15, 2015, these NTG values were derived from a variety of analyses and are intended to represent short-term (one to two years) program outcomes.15

Net-to-Gross Ratios

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Source |
| NTG Ratio | 0.36 | California Public Utilities Commission (CPUC), Energy Division. 2015. "Workpaper  Disposition for PGECOAPP128 Revision 0 Retail Products Platform." December 15. Page 8. |

# 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. This rate is logical, as consumers do not typically stockpile home appliances or consumer electronics products.

Gross Savings Installation Adjustment

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

15 California Public Utilities Commission (CPUC), Energy Division. 2015. “Workpaper Disposition for PGECOAPP128 Revision 0 Retail Products Platform.” December 15. Page 7.

# NON-ENERGY IMPACTS

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

# DEER DIFFERENCES ANALYSIS

This section provides a summary of DEER-based inputs and methods, and the rationale for inputs and methods that are not DEER-based. This measure is not included in the Database for Energy Efficient Resources (DEER), thus the only parameters drawn from DEER are noted below.

DEER Difference Summary

|  |  |
| --- | --- |
| DEER Item | Comment |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | No |
| DEER Measure Case | No |
| DEER Building Types | No |
| DEER Operating Hours | No |
| DEER Version | n/a |
| Reason for Deviation from DEER | There are no measure savings for room air conditioners in DEER |
| DEER Measure IDs Used | n/a |
| NTG | Source: The value of 0.36 is associated with NTG-ID: *Res-sAll-mHVAC-RmAC-dn* |
| GSIA | The value of 1.0 is associated with GSIA ID: *Def-GSIA* |
| EUL/RUL | Source: DEER. The EUL of 9 years is associated with EUL ID: *HV-RAC-ES.* |

# 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 | 12/31/2017 | Jennifer Holmes  Cal TF Staff | Draft of consolidated text for this statewide measure is based upon: |
|  |  |  | PGECOAPP128, Revision 6 (January 30, 2018) |
|  |  |  | PGECOAPP128, Revision 3 (March 29, 2017) |
|  |  |  | SCE17HC001, Revision 0 (November 18, 2016) |
|  |  |  | Consensus reached among Cal TF members. |
|  | 12/21/2018 | Jennifer Holmes  Cal TF Staff | Revisions for submission of version 01 |
|  |  |  |  |
|  | 02/11/2021 | Soe K Hla  PG&E | Adopted measures for DnDeemed and DnDeemDI |
|  |  |  |  |