Work Paper SCE17HC017

**Revision 1**

**Southern California Edison**

**Direct-Indirect Evaporative Coolers**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | AC-50888 Two-stage (Indirect-Direct) Evap Cooler replacing standard compressor-based DX space cooling  H172 - Direct-indirect or two-stage evaporative coolers in residential buildings |
| **Measure Description** | Direct-indirect or two-stage evaporative coolers (measure) in residential buildings |
| **Base Case Description** | Standard compressor based direct-expansion (DX) split type air conditioning units. |
| **Units** | SCE: Per 1,000 sq ft  PG&E: Per Household |
| **Energy Savings** | Refer to Excel Calculation Attachment 1 |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment 3 |
| **Incremental Measure Cost ($/unit)** | Refer to Excel Calculation Attachment 3 |
| **Effective Useful Life** | 15 years (HV-Evap) |
| **Measure Installation Type** | SCE: Replace-On-Burnout (ROB)  PG&E: Replace-On-Burnout (ROB) |
| **Net-to-Gross Ratio** | 0.55 (Res-Default>2) |
| **Important Comments** | This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| 0 | 12/02/2016 | Arvind Subramanya/TRC | - This work paper is an update of SCE13HC017.2  - WP effective from 1/1/2017 through 12/31/2017  - New calculation template for 2017 program year.  - Base system cost updated based on the 2016 Mechanical RSMeans and Measure cost updated based on manufacturer quote. - All (16) climate zones were added to the calculation template. |
| 1 | 06/18/2018 | Joseph Ling/AESC | - Code references updated  - Cost references updated |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
|  |  |  |  |  |  |

Cal TF website: <http://www.caltf.org/>

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

This work paper outlines energy savings due to replacing standard compressor based direct-expansion (DX) split type air conditioning units (baseline) with direct-indirect or two-stage evaporative coolers (measure) in residential buildings. The saving values are based on Database for Energy Efficient Resources (DEER) READI tool, v.2.4.7; however, DEER did not have updated measure savings developed since DEER2005.

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | Two-stage (Indirect-Direct) Evap Cooler |
| Existing Condition | N/A |
| Code/Standard | N/A |
| Industry Standard Practice | Standard compressor-based DX space cooling |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
| N/A | N/A | AC-50888 | - | Two-stage (Indirect-Direct) Evap Cooler replacing standard compressor-based DX space cooling |

Please see below for utility specific requirements.

**Southern California Edison (SCE)**

**Home Energy Efficiency Rebate Program Requirements**

This rebate is part of the Home Energy Efficiency Rebate Program. To Qualify, Your New Evaporative Cooling System Must:

1. Be permanently installed.
2. Have UL recognized electrical components.
3. Come with a water quality management system that provides positive removal of sump water on a regular interval (a bleed system is not allowed).
4. Have a single duct or multi ducted distribution system.
5. Have either:

* A multi-function manual control switch which offers high and low fan speed, pump on or off and the unit control of on or off. When a multifunction manual control switch is used, pressure relief dampers are not required.
* A thermostat specifically designed for evaporative coolers which automatically controls the unit operation based on the indoor temperature, fan speed, and pump operation. The automatic thermostat must be mounted remotely from the cooler. If new pressure relief dampers are installed, they must be indicated on your proof of purchase.

**Pacific Gas and Electric (PG&E)**

To be eligible for these measures, customers must be a PG&E electric customer, live in a multifamily dwelling and live in Climate Zones 11, 12 or 13. **PG&E currently does not offer a rebate for customers living a single family home.**

An Advanced Evaporative Cooler Level 2 (AEC-2) must have an indirect evaporative stage, rigid media direct stage, manufactured evaporative media with a rated saturation effectiveness of 0.95 or better (a natural fiber pad is not allowed – the rigid media is generally 8” or 12” thick), a two speed fan, a multi-position control switch that allows two fan speed operation and fan only operation and be equipped with water quality management system that provides positive removal of sump water on a regular interval (a bleed system is not allowed).

## 1.2 Technical Description

The operation of direct-indirect evaporative coolers consists of two stages, direct and indirect stage. These units provide necessary cooling capacity and comfort with a fraction of the energy required for traditional DX cooling. The indirect evaporative cooling is accomplished through a heat exchanger, either plate and frame or tube type. In this stage, cooling is accomplished by reducing the outdoor air temperature without adding moisture. Direct cooling in second stage is achieved by passing the air from indirect stage over the cooling media that is saturated with water. The result of two stage evaporative cooling process is cooler and drier supply air than that compared to a single-stage evaporative cooler [434].

According to the Public Interest Energy Research (PIER) program’s White Paper on “Advanced Evaporative Cooling,” the projected annual cooling savings average 93% over the 8 climate zones, and demand savings average 84%[434]*.*

## 1.3 Installation Types and Delivery Mechanisms

The delivery mechanism used for the measures within this work paper is Financial Support – Downstream Incentives – Deemed. The install type for the measure within this work paper is Replace-on-Burnout (ROB) for both SCE and PG&E.

**Installation Type Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Replace on Burnout (ROB) | Above Code or Standard | N/A | EUL | N/A |

A delivery mechanism is a delivery method paired with an incentive method. Delivery mechanisms are used by programs to obtain program participation and energy savings.

**Delivery Method Descriptions**

|  |  |
| --- | --- |
| **Delivery Method** | **Description** |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |

**Incentive Method Descriptions**

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Down-Stream Incentive | The customer installs qualifying energy efficient equipment and submits an incentive application to the utility program. Upon application approval, the utility program pays an incentive to the customer. Such an incentive may be deemed or customized. |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

This specific measure is included in the DEER READi tool, v.2.4.7. Therefore, DEER data was used as a basis for establishing electrical energy savings and demand reductions, as well as natural gas energy savings. DEER 2018 data was also used to obtain the effective useful life (EUL) and cost for this measure. Specifically, DEER measure ID D03-407 was used.

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | Yes (PGE); No (SCE) |
| Scaled DEER measure | No |
| DEER Base Case | Yes |
| DEER Measure Case | No |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | Yes |
| DEER Version | DEER 2005, READI D05 v2.01 |
| Reason for Deviation from DEER | Weighting of Savings using DEER normalizing units to get per Home values for PG&E. |
| DEER Measure IDs Used | D03-407 ; Direct-Indirect Evaporative Cooler |

**Net-to-Gross Ratio**

The NTG values were obtained using the DEER READI tool. The relevant NTG values for the measures in this work paper are in the table below.

**Net-to-Gross Ratio**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| Res-Default>2 | All other EEM with no evaluated NTGR; existing EEM with same delivery mechanism for more than 2 years | Res | Any | Any | 0.55 |

**Spillage Rate**

Spillage rates are not tracked in work papers; they are tracked in an external document which will be supplied to the Commission Staff.

**Installation Rate**

The IR values were obtained using the DEER READI tool. The relevant IR values for the measures in this work paper are in the table below.

**Gross Savings and Installation Adjustment**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Res-AC-SCE | Res AC Replacement; Annual Installation Rate | Res | Any | NonUpStrm | 1 |

**Effective and Remaining Useful Life**

The EUL and RUL values were obtained using the DEER READI tool. DEER defines the RUL as 1/3 of the EUL value which is in accordance with Draft Resolution E-4807 [510]. The RUL value is only applicable to the first baseline period for an RET measure with an applicable code baseline. The relevant EUL and RUL values for the measures in this work paper are in the table below.

**Effective Useful Life**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| HV-Evap | Evaporative Cooler | Res | HVAC | 15 | 5 |

### 1.4.2 Codes and Standards Analysis

There are no energy efficiency standards or energy design standards for this measure. The Title 24 2016 Residential/Non-Residential Compliance Manual [496] provides indirect and indirect-direct evaporative coolers with compliance credits, but does not allow compliance credit for direct evaporative coolers.

As the measure involves replacing of existing Direct Expansion (DX) split system, minimum efficiency to be considered to calculate program eligible savings is presented in 2016 Title-24 Standards [496] Table 110.2-A - ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS –

MINIMUM EFFICIENCY REQUIREMENTS. Title-24 does not mandate code baseline to be a specific system type, therefore, code baseline efficiency for the existing system type based on the size can be considered.

2018 Title 20 [508] does not cover evaporative coolers, and gives the following language, “There are no energy efficiency standards or energy design standards for spot air conditioners, evaporative coolers, whole house fans, or residential exhaust fans.”

According to 2018 Title-20 code Section 1605.1, systems installed after January 1, 2015 must have a minimum SEER of 14.0. Federal and State Standards for Federally-Regulated Appliances Table C-3. 2018 Title-20 code is mentioned as a reference only. Savings impacts are not updated as a result of this baseline change. Below is the minimum efficiency table from Title-20 code.



Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 24 (2016) | Table 110.2-A - ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS –  MINIMUM EFFICIENCY REQUIREMENTS | January 1, 2017 |
| Title 20 (2018) | Table C-3  Standards for Air-Cooled Air Conditioners and Air-Source Heat Pumps Subject to EPAct  (Standards Effective January 1, 2018 Do Not Apply To Single Package Vertical Air Conditioners) | January 1, 2018 |

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

### Program & Technology Review of Two Residential Product Programs: Home Energy Efficiency Rebate (HEER) / Business & Consumer Electronics (BCE), dated August 30, 2012, was reviewed. Recommendations and Conclusions of that report did not affect the content of this workpaper.

**1.6 Data Quality and Future Data Needs**

N/A

# Section 2. Calculation Methodology

The energy savings for the measure contained within this work paper were taken directly from the 2018 DEER READi tool, v.2.4.7, however, DEER did not update measure savings developed under DEER2005. SCE offers the measure on a per 1,000 sq ft basis, so the energy savings are taken directly from DEER. PG&E, however, offers the measure on a per home basis, which requires the application of building weights to convert the units. These weights are found in the same DEER READi export under column “K” titled “NumUnit.” Please see below for a sample calculation.

Note that for PGE, measure impacts are limited to the Multi-Family building type and Climate Zones 11, 12, and 13. All building types and related Climate Zones are applicable for SCE.

**(PGE) Multi Family Home in Climate Zone 11:**

2014 DEER Database kWh (AStdWBkWh): 525 kWh/1,000 sq ft

DEER weighted building type’s household area (MeasArea): 998 sq ft/home

The same calculations are done for both kW and therm savings.

Table below contains the data files for measures that are taken directly from the DEER READi Tool v2.4.7 or were created using the READi Tool. These results have not been modified and are only being included in the workpaper for reference. READI data was not updated based on the most recent version of the tool available.

The following table indicates which measures are taken directly from or created with the DEER READI tool.

READI Data Used

|  |  |  |
| --- | --- | --- |
| **Measure Code** | **Measure Name** | **READI Data** |
| AC-50888 | Two-stage (Indirect-Direct) Evap Cooler replacing standard compressor-based DX space cooling |  |

# Section 3. Load Shapes

The ideal load shape for net benefits estimates would represent the difference between the base case and measure case. The closest load shapes that are applicable to the measures in this work paper are listed in the table below.

Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| Residential – Single Family | DEER: HVAC\_Eff\_AC | RES |
| Residential – Multi-Family | DEER: HVAC\_Eff\_AC | RES |
| Residential – Double-wide Mobile Home | DEER: HVAC\_Eff\_AC | RES |

# Section 4. Costs

## 4.1 Base Case Cost

The base case cost for the measures contained within this work paper was originally taken from DEER 2005 Update Report. The base cost has been updated in this revision based on 2018 RSMeans. Base cost for a split system unit per ton is $1,730.00 from 2018 Mechanical RSMeans. For a 1000 Sq.ft. area, total base cost is calculated as $4,325.00 assuming an average capacity requirement of 1 ton of cooling for 400 sqft. Material Cost: $3,062.50 and Labor Cost: $1,262.50.

## 4.2 Measure Case Cost

The measure case cost for the measures contained within this work paper was originally taken from DEER 2005 study report. The measure cost was revised in this version of the work paper based on a quote from a manufacturer for material cost based on Aztec indirect/direct evaporative product line. Based on the quote, an indirect-direct evaporative cooler costs around $11.00 per CFM based on a 3,000 cfm system. Assuming 1,000 CFM for a 1000 sqft space or 1 CFM/sqft flow rate, the material cost will be in the order of $11,000.00. Assuming the labor cost to be the same as for the base system cost of $1,262.50, total measure cost is calculated as $12,262.50.

The water cost from direct-indirect system operation and/or water piping additions and/or alterations work was reviewed but not considered in this workpaper revision. For this measure, the measure case cost is driven by the equipment cost, which is much more than the cost of the water usage based on CEC’s requirements of 0.15 gallons per minute per ton (gpm/ton), hence, not included.

## 4.3 Full and Incremental Measure Cost

For this measure category, the incremental measure cost is used strictly for providing insight to program managers to assist in determining rebates for deemed measures.

**Full and Incremental Measure Cost Equations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ROB | (MEC + MLC) – (BEC + BLC) | (MEC + MLC) – (BEC + BLC) | N/A |
| NEW/NC |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

BEC = Base Case Equipment Cost; BLC = Base Case Labor Cost

**Full and Incremental Costs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| AC-50888 | ROB | $7,937.50 | $7,937.50 | N/A |

Please refer to Attachment #2 for cost calculation and sources.

# Attachments

1. SCE17HC017.1 A1 - Dir-Indir Evap Coolers Calculation Template.xlsm
2. SCE17HC017.1 A2 - Direct-Indirect Evaporative Coolers Cost Calculations.xlsx

# References



[434]

[493]

[496]