Work Paper SCE13HC017

**Revision 2**

**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* |
| **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 |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Incremental Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **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 | 5/23/2012 | Rafik Sarhadian/SCE | - This is the original work paper for the 2013-2014 cycle and is based off of WPSCREHC0017.0. 9 climate zones covering PG&E territory have been added. |
| 1 | 6/2/2014 | Alfredo Gutierrez/SCE | -Work paper updated for the reporting period, effective 7/1/14 – 12/31/14.  -Changed installation type from RET to ROB. |
| 2 | 1/27/2016 | Andres Fergadiotti/SCE | -New template update for 2016 program year  -WP effective from 1/1/2016 thru 12/31/2016  -Removed SCE building types  -No modifications to measure impacts |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
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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) 2014 READI tool, v.2.0.1.

**Base, Standard, and Measure Cases**

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

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 |

The measures contained within this work paper are applicable only for the building types listed further in the report (all residential) and for all Southern California Edison and Pacific Gas & Electric climate zones. 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 2014 READi tool, v.2.0.1. Therefore, DEER data was used as a basis for establishing electrical energy savings and demand reductions, as well as natural gas energy savings. DEER 2014 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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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. 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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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 2013 Residential Compliance Manual [355] provides indirect and indirect-direct evaporative coolers with compliance credits, but does not allow compliance credit for direct evaporative coolers.

The 2014 Title 20 [422] Appliance Efficiency Standards 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.” Please note that Title 20 also specifies that air cooled air conditioners must be 13.0 SEER effective June 15, 2008. This requirement impacts the energy savings as the baseline used for the measures is a SEER 13 air conditioner.

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 24 (2013) | N/A | N/A |
| Title 20 (2014) | Table C-3  Standards for Air-Cooled Air Conditioners and Air-Source Heat Pumps Subject to EPAct  (Standards Effective January 1, 2010 Do Not Apply To Single Package Vertical Air Conditioners) | June 15, 2008 |

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

### 1.5.1 Study Title #1

N/A

## 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 2014 DEER READi tool, v.2.0.1. 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.

**Single Family Home in Climate Zone 4:**

2014 DEER Database kWh: 206 kWh/1,000 sq ft

NumUnit: 1,710 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 2011 READi Tool or were created using the READi Tool. These results have not been modified and are only being included in the workpaper for reference.

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 taken from DEER for D03-407. Although the measure is included within the 2014 DEER READi Tool, the additional cost documentation “Revised DEER Measure Cost Summary (05\_30\_2008) Revised (06\_02\_2008).xls” only gives the material cost as $0.27 and does not clarify on the normalizing unit, therefore it is not clear what the cost of the equipment actually is. As such, DEER 2005 was consulted to obtain a cost of $839.17 per 1,000 sq ft which is used directly for SCE’s climate zones. As PG&E uses units of per home, the value is converted in a similar manner as the energy savings.

## 4.2 Measure Case Cost

The measure case cost for the measures contained within this work paper was taken from DEER. Similar to the base case cost, the measure case cost was found from DEER 2005 to be $1,553.00 per 1,000 sq ft for SCE and converted to a per home basis for PG&E.

## 4.3 Full and Incremental Measure Cost

The measure case cost for the measures contained within this work paper was taken from DEER. Similar to the base case cost, the measure case cost was found from DEER 2005 to be $1,553.00 per 1,000 sq ft for SCE and converted to a per home basis for PG&E.

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 | $713.83 | $713.83 | N/A |

# Attachments

1. 

2.

# References



[351]

[355]

[422]

[434]