Work Paper SCE17HC013

**Revision 0**

**Southern California Edison**

**Direct Evaporative Coolers**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | AC-17382 (Res) With Damper Direct Evap Cooler  AC-78424 (Res) Direct Evap Cooler |
| **Measure Description** | The installation of direct evaporative coolers displaces compressor based space cooling in residential buildings. |
| **Base Case Description** | SCE residential: existing customer equipment.  PG&E residential code/standard vapor compression air conditioning system. |
| **Units** | SCE residential: per 1,000 sq. ft.  PG&E residential: per household. |
| **Energy Savings** | Refer to Excel Calculation Attachment 1 |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment 1 and 4 |
| **Incremental Measure Cost ($/unit)** | Refer to Excel Calculation Attachment 1 and 4 |
| **Effective Useful Life** | NEW/ROB: 15 Years (EUL ID: HV-Evap)  REA: 5 Years (EUL ID: HV-Evap) |
| **Measure Installation Type** | SCE residential: retrofit add-on (REA).  PG&E residential: replace on burnout (ROB)/ New Construction (NEW). |
| **Net-to-Gross Ratio** | Residential (NTGR\_ID=Res-Default>2) 0.55. |
| **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 | 02/07/2017 | Arvind Subramanya/TRC | - This work paper is an update of SCE13HC013.2  - New calculation template update for 2017 program year  - Work paper is updated with 2016 Title-20 code language only. Savings impacts are not updated.  - Baseline and Measure cost has been updated.  - New Program type has been added.  - Non-Residential measure has been removed. |

# 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 details the installation of direct evaporative coolers to displace compressor based space cooling in both residential and non-residential buildings. The operation of direct evaporative coolers provides necessary cooling capacity and comfort with a fraction of the energy required for traditional DX cooling. Direct evaporative cooling is achieved by passing outdoor air over a cooling media that is saturated with water and distributing it into the indoor space.

For the residential sector in Southern California Edison (SCE), this measure assumes that direct evaporative coolers are added equipment to the home, i.e., they are not replacing any existing central air conditioning equipment. The evaporative coolers are used to displace the use of an existing central air conditioning system when cooling is required and the ambient dew point is less than 55 F. The residential measures in this work paper are applicable to all Southern California Edison climate zones and the associated building types shown later in the report.

For Pacific Gas & Electric (PG&E), this measure assumes that direct evaporative coolers are replacing an existing, whole house vapor-compression air conditioning system. The residential measures are applicable only for multifamily dwellings in climate zones 11, 12 and 13.

Energy savings is reported for both cases i.e. with and without pressure relief dampers. The use of pressure relief dampers negates the need to open windows and discharges air into the attic, keeping the attic cool and reduces heat gain in the house.

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | Direct Evap Cooler |
| Existing Condition | DxAC equipment / DxHP equipment |
| Code/Standard | Title-20 code language has been updated. No changes in impact values. |
| Industry Standard Practice | N/A |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
|  |  | AC-17382 |  | (Res) With Damper Direct Evap Cooler |
|  |  | AC-78424 |  | (Res) Direct Evap Cooler |

**Southern California Edison**

**Home Energy Efficiency Rebate Program Requirements (Residential)**

This rebate is part of the Home Energy Efficiency Rebate Program. To qualify, your new evaporative cooling system must:

1. Appear on the list of qualifying products that can be found at [www.sce.com/rebates](http://www.sce.com/rebates)
2. Be installed by December 31, 2017
3. Be permanently installed.
4. Have UL recognized electrical components.
5. Come with a water quality management system that provides positive removal of sump water on a regular interval (a bleed system is not allowed).
6. Have a single duct or multi ducted distribution system.
7. Note: Evaporative coolers mounted through a window do not qualify for this rebate.

**Pacific Gas and Electric (Residential)**

An Advanced Evaporative Cooler Level 1 (AEC-1) must have a rigid media direct stage, manufactured evaporative media with a rated saturation effectiveness of 0.85 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 a water quality management system that provides positive removal of sump water on a regular interval (a bleed system is not allowed).

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 or mobile homes.

## 1.2 Technical Description

Direct evaporative cooling is achieved by passing outdoor air through a wetted media and distributing it into the indoor space. Evaporating water from this media removes sensible heat from the airstream, lowering its dry bulb temperature. At the same time, moisture is added to the airstream, raising its relative humidity, which can sometimes reach uncomfortable levels. However, for most conditions throughout a typical cooling season, direct evaporative cooling can adequately meet cooling loads and maintain reasonable humidity levels.

## 1.3 Installation Types and Delivery Mechanisms

The delivery method is Financial Support – Down-Stream – Deemed and Financial.

The program type/application type for these measures varies by IOU and building sector as shown in the table below.

Program Type by Utility and Sector

|  |  |  |
| --- | --- | --- |
| **IOU** | **Building Sector** | **Program Type/Application Type** |
| Southern California Edison | Residential | Retrofit Add-On (REA) |
| Pacific Gas and Electric | Residential | Replace on Burn-out (ROB) |
| Pacific Gas and Electric | Residential | New Construction (NEW) |

**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 |
| Retrofit Add-on (REA) | Above Customer Existing | N/A | EUL | N/A |
| New Construction (NEW) | 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 measure is included in the 2017 DEER READI tool, version 2.4.7. DEER measure ID D03-405 was used for estimating the savings. DEER Run IDs can be found in the embedded Excel workbook in the Attachment section. Because DEER assumes HVAC unit replacement, and the SCE program measures are designed to supplement the HVAC unit operation, the DEER values for the SCE measure are adjusted as indicated in Section 2 below. Because DEER presents savings on 1,000 sqft basis and PG&E savings are reported on a per household basis, the DEER values for the PG&E measures are adjusted as indicated in Section 2 below.

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | Yes |
| Scaled DEER measure | Yes |
| DEER Base Case | Yes |
| DEER Measure Case | Yes |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | Yes |
| DEER Version | DEER 2017 |
| Reason for Deviation from DEER | SCE: Energy and demand adjustment factors applied as the DEER savings values assume replacement whereas the program assumes an add on.  PG&E: DEER savings values converted to a per household basis. |
| DEER Measure IDs Used | N/A |

**Net-to-Gross Ratio**

The NTG values were obtained using the DEER READI tool v.2.4.7. 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 | All | 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** |
| Def-GSIA | Default GSIA values | Any | Any | Any | 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 (REA) | Evaporative Cooler | Res | HVAC | 5 | NA |
| HV-Evap (ROB) | Evaporative Cooler | Res | HVAC | 15 | 5 |
| HV-Evap (NEW) | 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 and 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.

The measure involves only residential retrofit, therefore, 2016 Title-24 code for non-residential efficiency requirements do not apply to this work paper.

2016 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 2016 Title-20 code, systems installed after January 1, 2015 must have a minimum SEER of 14.0 according to Section 1605.1. Federal and State Standards for Federally-Regulated Appliances Table C-3. 2016 Title-20 code is mentioned as a reference only. Savings impacts are not updated. Below is the minimum efficiency table from Title-20 code.



Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 20 (2016) | Section 1605.1. Federal and State Standards for Federally-Regulated Appliances Table C-3  Standards for Air-Cooled Air Conditioners and Air-Source Heat Pumps Subject to EPAct | January 1, 2017 |
| DOE | N/A | N/A |

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

### 1.5.1 Non-DEER Study Review

No other studies were used or reviewed in preparation for this workpaper.

## 1.6 Data Quality and Future Data Needs

N/A

# Section 2. Calculation Methodology

The savings methodology varies by IOU and sector. Since energy impacts varies per IOU and sector, three calculation templates are developed specific to each IOU and the corresponding sector. Please see Attachment #1 SCE Calculation Template for details. The calculation methodology is described below for each sector.

**Residential Sector**

**Southern California Edison**

The residential SCE savings values are represented by the equations below:

*Annual energy savings = DEER kWh Savings \* ESAF \* HEAF*

*Demand reduction = DEER kW reduction \* PDAF \* HEAF*

where: DEER savings are from the READi tool v.2.4.7, measure D03-405

ESAF is the Energy Savings Adjustment Factor

PDAF is the Peak Demand Adjustment Factor

HEAF is the Human Error Adjustment Factor

The annual energy and demand savings for the residential sector are based on the full DEER measure savings from D03-405, taken directly from the DEER 2017 READi Tool,multiplied by the appropriate adjustment factor to account for the air conditioning system runtime during the year (see Attachment #2 Residential Savings Calculations). Where dampers are installed, 38 kWh per home is added (see Attachment #1 SCE Calculation Template, “Impact” tab, column AE). This value was derived from the 2004-2005 incentive program direct evaporative cooler savings values, as given in workpaper SCE13HC013.0.

There are three adjustment factors: The energy savings adjustment factor (ESAF) which is multiplied by the annual energy savings (DEER field: ACustWBkWh), the peak demand adjustment factor (PDAF) which is multiplied by the demand reduction (DEER field: ACustWBkW) and the human error adjustment factor (HEAF) which is multiplied by both the annual energy savings and the demand reduction.

**Human Error Adjustment Factor (HEAF)**

This measure requires that only one mechanical system at a time can operate, and this will be made clear to the customer. However, the customer may forget to do so and end up operating both DX and evaporative systems simultaneously. Therefore, a human error adjustment factor is required to de-rate savings. As there have been no studies performed to measure this particular factor, the HEAF will be arbitrarily set at 75% until a study yields a more conclusive value. This implies that up to 25% of the savings will be lost due to non-ideal operation of the evaporative cooler and DX system.

**Energy Savings and Peak Demand Adjustment Factors (ESAF & PDAF)**

The ESAF and PDAF varies by climate zone and was estimated using hourly dry bulb, wet bulb, humidity ratio, and atmospheric pressure from the DEER2014 supporting Excel workbook CompareWeatherData-v4.xls. Attachment #3 Weather Data – ESAF and PDAF contains the estimation of these values and is attached. Two data filters were used to determine when the direct evaporative cooler would be effective.

* Filter #1 (Column G, worksheet ‘Summary Table’): The total number of hours that the dry bulb temperature is greater than or equal to 80°F was determined by filtering Ambient Dry-Bulb Temp (Column N, worksheet ‘hourly weather data’) and then counting the number of hours that met this condition. This gives the total number of hours that cooling is needed (tcool).
* Filter #2 (Column H, worksheet ‘Summary table’): This filter determines the number of cooling hours that can be satisfied by the direct evaporative cooler (tdir evap). It repeats Filter #1 (T>=80°F), air delivered temperature (ADT) less than or equal to 75°F, and dew point temperatures below 55°F. The next two bullets further describe the calculation methodology and reasoning behind these additional filters.
* ADT: This value represents the estimated potential cooler delivered air temperatures from the corresponding hourly temperatures using the above equation.

Column AD of worksheet ‘hourly weather data’ calculates the wet bulb depression (WBD):

Column AE calculates the achievable air delivery temperature (ADT):

The chart in Figure 1 is a summary tabulation of air temperatures that a direct evaporative cooler can deliver, derived from the psychometric chart using an 85% approach to the wet bulb depression [B]. As indicated in the highlighted boxes, 75°F is estimated to be the highest deliverable temperature in the optimum conditions range.



Figure 1 Direct Evaporative Cooler Operating Range

* Dew point temperature: This criterion originates from the fact that direct evaporative coolers are most effective at relatively dry outdoor conditions. If the outside dew point is >55°F, a direct evaporative cooler will likely not be able to adequately cool the space, and the indoor humidity level may rise to an unacceptable level. This filter gives the number of cooling hours that can be satisfied by the direct evaporative cooler (tdir evap).

The humidity ratio (w) in units of lb water per lb dry air, and the total atmospheric pressure (p) in units of inches Hg is used to calculate the vapor pressure. The vapor pressure (pv) in units of hPa is calculated from these two values based on this humidity ratio formula [C]:

The same equation written to solve for the vapor pressure of water (pv) and converting to hPa as required for the dew point temperature calculation (column AG, worksheet ‘hourly weather data’):

Next the dew point temperature (°C) is calculated in column AH, of worksheet ‘hourly weather data’ [A]:

Where m, A, and Tn are constants.

This is converted to Fahrenheit (T, °F) in column AI, worksheet ‘hourly weather data’:

* The energy savings adjustment factor (ESAF) is calculated as the ratio of the total cooling hours that may be satisfied by a direct evaporative cooler to the total number of hours in the year that may require cooling:

The calculated ESAF for SCE climate zones is shown in column E of worksheet ‘Summary Table’ and in table below.

* Finally, the peak demand adjustment factor (PDAF) was determined by applying these same filters but only for the three-day peak heat wave as given by DEER for each climate zone. For example, climate zone 6 would require that the filters are applied only between the hours of 2:00 p.m. and 5:00 p.m from September 1st – 3rd. The PDAF was calculated by the ratio of the total cooling hours that may be satisfied by a direct evaporative cooler during the peak demand hours to the total number of peak demand hours (9).
* The calculated PDAF for SCE and PGE climate zones is shown in column D of tab ‘ESAF\_&\_PDAF\_Summary’ in Attachment #2 and in table below.

ESAF and PDAF Summary Table

|  |  |  |  |
| --- | --- | --- | --- |
| **IOU** | **CZ** | **ESAF** | **PDAF** |
| PG&E | 1 | 100% | 100% |
| PG&E | 2 | 100% | 100% |
| PG&E | 3 | 100% | 100% |
| PG&E | 4 | 100% | 100% |
| PG&E | 5 | 100% | 100% |
| SCE | 6 | 56% | 33% |
| SCE | 8 | 33% | 33% |
| SCE | 9 | 26% | 0% |
| SCE | 10 | 48% | 0% |
| PG&E | 11 | 100% | 100% |
| PG&E | 12 | 100% | 100% |
| Both | 13 | 65% | 0% |
| SCE | 14 | 88% | 100% |
| SCE | 15 | 57% | 11% |
| Both | 16 | 95% | 89% |

**Pacific Gas and Electric**

PG&E only offers this measure for multifamily dwellings in climate zones 11, 12, 13. Therefore, the savings are only calculated for instances meeting these criteria (column AR, worksheet ‘EnergyImpacts\_RES\_EvapCool’). However, all the climate zones are added in the impacts tab of Attachment #1 Calculation Template. The calculation of the energy savings and demand savings follows the methodology described above for Southern California Edison, except for the following differences:

1. PG&E savings values are based on the above code savings (DEER field: AStdWBkWh and AStdWBkW) for DEER measure D03-405. The above code savings are used as PG&E offers this measure as a complete retrofit (as ROB) and not a retrofit add-on as SCE does. Also for this reason no adjustment factors are applied.
2. The savings are presented on a per household basis. Since PG&E uses household as the unit measure, DEER savings were converted to per household unit instead of the DEER common unit of per 1,000 sqft by multiplying the savings values by the number of common units.

All residential calculations are shown in Attachment #2 Residential Savings Calculations.

# 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 Mobile Home - Double-Wide | DEER:HVAC\_Eff\_AC | RES |
| Residential Multi-family | DEER:HVAC\_Eff\_AC | RES |

# Section 4. Costs

## 4.1 Base Case Cost

**Residential Sector**

**Southern California Edison (REA)**

The base cost has been updated in this revision to $0.00 as this is a REA program type measure.

**Pacific Gas and Electric (ROB)**

The base case cost for this measure category was originally taken from DEER 2005 Update Report. The base cost has been updated in this revision based on 2010-12 Work Order 017 Study Report. Please refer to the cost calculation methodology below.

**Baseline System Cost Calculation Methodology**

1. Baseline system material, labor, and total costs per ton were calculated based on the costs from 2010-2012 Work Order 017 Study report for a 3-ton residential split system 14 SEER (Appendix F.1 Hedonic Model Estimates).
2. System size was calculated based on industry standard of 1-ton per 400 Sq.ft. For a 1000 sq.ft. space it would require 2.5 Tons.
3. Cost per 1000 Sq.ft. was calculated by multiplying system size from Step 2 with Average Costs per ton from Step 1.
4. Refrigerant piping cost was calculated assuming a 20ft. run and was added to costs in Step 3 to calculate total measure costs.
5. In order to calculate costs per household, material and labor costs for thebaseline system calculated from the above step were multiplied by the number of units per household from DEER (column L) in Attachment #2 Residential Savings Calculations, “EnergyImpacts\_RES\_EvapCool” tab in column AW. The Average of all the values in column AW (including all 3 building types) for PGE was calculated to get the baseline cost per household.

Please refer to Attachment #4 Cost Calculation for detailed costing and Attachment #2 for the conversion to per household costs.

## 4.2 Measure Case Cost

The measure case costs are as described in the following section.

**Measure System Cost Calculation Methodology**

1. Measure system material, labor, and total costs per ton were calculated based on the costs from 2010-2012 Work Order 017 Study report for a 3-ton Evaporative Cooler system (Appendix F.1 Hedonic Model Estimates).
2. System size was calculated based on the industry standard of 1-ton per 400 Sq.ft. For a 1000 sq.ft. space, it would require 2.5 Tons.
3. Cost per 1000 Sq.ft. was calculated by multiplying system size from Step 2 with Average Costs per ton from Step 1.
4. In order to calculate costs per household for **PGE only**, material and labor costs for the baseline system calculated from the above step were multiplied by the number of units per household (column L) from DEER in Attachment #2 Residential Savings Calculations, “EnergyImpacts\_RES\_EvapCool” tab in column AY. The Average of all the values in column AY (including all 3 building types) for PGE was calculated to get the measure cost per household.
5. Water piping cost was calculated assuming a 20ft. run and was added to costs in Step 3 to calculate total measure costs.
6. For **Southern California Edison (REA),** cost of $175.12 per 1,000 sq. ft was added to the measure case cost calculated from the above calculation methodology to account for additional water usage typically associated with evaporative cooling measures. The water costs represent an average over the life of the measure, including inflation, from a sampling of water rate sheets from climate zones 6, 9 and 15. The details of this calculation can be found in Attachment 2, tab ‘Water Costs’. Rate schedules are found in the attachments. Please refer to Attachment #4, “Cost Summary” tab for details. Water rates have been updated to reflect latest available data.
7. For **Pacific Gas and Electric (ROB),** cost of $64.70 per household was added to the measure case cost calculated from the above calculation methodology to account for additional water usage typically associated with evaporative cooling measures. The water costs represent the average usage over the life of the measure, including inflation, for climate zones 12 and 14. The details of this calculation can be found in Attachment 2, tab ‘Water Costs’. Rate schedules are found in the attachments. Please refer to Attachment #4, “Cost Summary” tab for details. Water rates have been updated to reflect latest available data.

Please refer to Attachment #4 Cost Calculation for detailed costing.

## 4.3 Full and Incremental Measure Cost

**Southern California Edison (REA)**

The measure costs in DEER are per the common unit of 1000 ft2. This was calculated according to the following equation with specific calculations available in the last version of this workpaper.

[Installed Cost (CZ,Vintage)] ÷ [Number of Common Units (CZ, Vintage)] = $/1000sqft

To obtain a per 1000 ft2 that is consistent across the residential building types, the measure case costs described above were averaged for the three building types. The result is an average $2,244.70/1000 sqft. Refer to Attachment #2 Residential Savings Calculations and Attachment #4 Cost Calculation “Cost Summary” tab for details.

For installations that include pressure relief dampers (Measure: AC-17382), an additional fixed cost of $200 per cooler was added. The company Climate Control Systems, ([www.updux.com](http://www.updux.com), CA Contractors Lic.# 782461) offers a package of six “Up-dux” pressure relief dampers for $284. Thus, installing three dampers per site would cost an additional $142 in materials and $58 for installation and labor. These costs are added to the DirectEvapCooler measure costs (AC-78424) in the Attachment #4 Cost Calculation “Cost Summary” tab.

**Pacific Gas and Electric (ROB)**

For measures specific to PG&E climate zones (ROB), the costs were calculated as described above except that the measure costs are converted to a per household basis.

This calculation can be found in Attachment #2 Residential Savings Calculations columns AW and AY.

Table below shows baseline and measure costs for both SCE and PGE under each solution code.



**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 |
| REA | MEC + MLC | MEC + MLC | N/A |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

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

**Full and Incremental Costs**

**Southern California Edison**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| (Res) With Damper Direct Evap Cooler | REA | $2,444.70 | $2,444.70 | N/A |
| (Res) Direct Evap Cooler | REA | $2,244.70 | $2,244.70 | N/A |

**Pacific Gas and Electric**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| (Res) With Damper Direct Evap Cooler | ROB | $320.46 | $320.46 | N/A |
| (Res) With Damper Direct Evap Cooler | NEW | $320.46 | $320.46 | N/A |
| (Res) Direct Evap Cooler | ROB | $120.46 | $120.46 | N/A |
| (Res) Direct Evap Cooler | NEW | $120.46 | $120.46 | N/A |

Please refer to Attachment #1 Calculation Template and Attachment #4 Cost Calculation for complete details.

# Attachments

1. SCE17HC013.0 A1 - Calculation Templates\_Final.zip
2. SCE17HC013.0 A2 - Residential Savings Calculations.xlsx
3. SCE17HC013.0 A3 - Weather Data - ESAF and PDAF - REV 3.xlsx
4. SCE17HC013.0 A4 - Cost Calculation.xlsx
5. SCE17HC013.0 A5 - CZ 9 Cooling Load.pdf
6. SCE17HC013.0 A6 - Alhambra Water Schedule (CZ09).pdf
7. SCE17HC013.0 A7 - Burbank Water Schedule (CZ09).pdf
8. SCE17HC013.0 A8 - Torrance Water Schedule (CZ06).pdf
9. SCE17HC013.0 A9 - Fresno Water Rates (CZ12).pdf
10. SCE17HC013.0 A10 - Barstow Rate Schedule (CZ14).pdf
11. SCE17HC013.0 A11 - Domestic Water Rates CZ15.pdf
12. SCE17HC013.0 A12 - Desert Water Agency (CZ15).pdf

# References

1. References\_12122016\_100741.xlsx

[496]

[508]

[A] Vaisala Oyj (2013). Humidity Conversion Formulas. [www.vaisala.com](http://www.vaisala.com)

[B] California Energy Commission, Consumer Energy Center. (2013, April 26). Evaporative cooling. Retrieved from <http://www.consumerenergycenter.org/home/heating_cooling/evaporative.html>

[C] 2013 Fundamentals. ASHRAE Handbook. I-P Edition.