Work Paper SCE17HC049

**Revision 0**

**Southern California Edison**

**Programmable Thermostat - Nonres**

**For Work Paper Reviewer Use Only**

**List all major comments that occurred during the review. This table may only be removed during management review.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Major Comment** | **Reviewer Name** | **Date** | **Outcome/Resolution** |
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# At-a-Glance Summary

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| --- | --- |
| **Measure Codes** | AC – 19973  AC – 19974 |
| **Measure Description** | Programmable thermostat controlling unitary HVAC equipment (split and packaged electric cooling and gas heating – **DXGF** and electric cooling and heating heat pump **PKHP**) with and without economizer and set supply fan to AUTO during unoccupied periods |
| **Base Case Description** | Existing non-programmable thermostat controlling unitary (split and packaged electric cooling and gas heating – **DXGF** and electric cooling and heating heat pump **PKHP**) systems with and without an economizer. |
| **Units** | Per Unit |
| **Energy Savings** | Refer to Excel Calculation Attachment 1 |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment 1 |
| **Incremental Measure Cost ($/unit)** | Refer to Excel Calculation Attachment 1 |
| **Effective Useful Life** | HVAC-ProgTStats (EUL 11 / RUL 3.7 years) |
| **Measure Installation Type** | REA – Retrofit-add-on |
| **Net-to-Gross Ratio** | DEER NTGR ID: NonRes-sAll-mHVAC-RCA (0.73) |
| **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 | 10/24/2017 | Arvind Subramanya/TRC | - This workpaper supports the Thermostat Replacement measure based on referenced Workpaper Disposition – Attachment 2.  - New calculation template update for 2017 program year.  - (2) New solution codes.  - Updated 2016 Title-24 code requirements.  - Measure cost has been updated with costs from 2016 RSMeans Mechanical Cost Data. |

# 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 measure is to replace an existing non-programmable thermostat which allows the supply fan to change from continuous operation during unoccupied periods to intermittent fan operation.

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | Install programmable thermostat and set supply fan to AUTO during unoccupied periods for split and packaged electric cooling and gas heating (DXGF) and Heat Pump (PKHP) units with and without economizers |
| Existing Condition | Existing non-programmable thermostat installed on split and packaged dx cooling systems with or without an economizer.  Per referenced Disposition [Attachment 2], the baseline should not assume that facilities with non-programmable thermostats operate connected HVAC systems continuously. Baseline should account for building owner intervention or possible building-wide time-clock control. The baseline model assumes that 30% of all sites using non-programmable thermostats exhibit either manual control or time-clock control of units. Replacement of the existing thermostat with a programmable thermostat for those sites will result in unit cycling at set-back/set-up temperature settings during unoccupied periods as opposed to a deactivated system. |
| Code/Standard | 2016 Title-24 - Section 120.2 - Thermostatic Controls |
| Industry Standard Practice | N/A |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
|  |  | AC – 19973  AC – 19974 |  | Non-Res Programmable Thermostat - DXGF  Non-Res Programmable Thermostat – PKHP |

* **Eligibility requirements**: Participants must ensure the facility is physically located within the Utility’s service territory. Participants must receive electricity services from corresponding Utility, via which the customer pays into the PPP surcharges. Additionally, this policy restricts Commercial Quality Maintenance (CQM) Program participation to only those customers that have not received incentives (not including tax credits available under the Energy Policy Act of 2005), for the same measures or services from another utility, state, or local program for 3 years prior to and following participation in the CQM Program. Participation is conditional upon agreement by the customer to comply with this prohibition.
* **Implementation requirements**: This measure is applicable to non-residential customers with unitary (DXGF and PKHP) systems with and without economizers. The measure is applicable in all climate zones and applicable commercial building.
* The intent of the energy efficiency measure is to set the supply fan control to operate in AUTO mode during unoccupied periods to reduce unnecessary equipment operation. Measure implemented to verified that intent of measure (with fan control to operate in AUTO) mode is fully met.

## 1.2 Technical Description

This measure replaces existing non-programmable thermostats on unitary split and packaged dx cooling systems with and without economizers. The programmable thermostat allows the supply fan to change from continuous operation during unoccupied periods to intermittent fan operation. Electric and gas savings are also achieved from reducing the amount of outside air brought into the conditioned space during unoccupied hours. The replacement thermostat must be set during unoccupied hours to call for heating at < 55 degrees Fahrenheit and call for cooling at > 85 degrees Fahrenheit. Occupied comfort settings must be in the range of 72 to 78 degrees Fahrenheit for cooling and 65 to 68 degrees Fahrenheit for heating.

## 1.3 Installation Types and Delivery Mechanisms

The installation type for this measure is Retrofit Add-On (REA) since the baseline is the existing unit.

The Delivery Mechanism of these measures is Financial Support or Midstream Programs. The Incentive Method of these measures isDirect Install, Down-Stream Incentive – Deemed, or Mid-Stream Incentive.

**Installation Type Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Retrofit Add-on (REA) | Above Customer Existing | 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. |
| Partnership | The program implements projects through a partnership between the utility and an institutional, government, or community-based organization. |
| Mid-Stream Programs | *See Mid-Stream Incentive in the Incentive Method Descriptions table.* |

**Incentive Method Descriptions**

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Direct Install | The program implements energy efficiency measures for qualifying customers, at no cost to the customer. |
| 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. |
| Mid-Stream Incentive | The program gives a financial incentive to a midstream market actor, such as a retailer or contractor, to encourage the promotion of efficient measures. The incentive may or may not be passed on to the end-use customer. |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

The Database for Energy Efficient Resources (DEER) does contain measure similar to supported measure. Measure impacts are adopted from referenced CPUC’s disposition suggesting that measure will enabled savings due to unit cycling at set-back/set-up temperature settings during unoccupied periods as opposed to a deactivated system. Refer to Attachment #3. DEER values are used for Net-to-Gross, EUL, and ISR.

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | No |
| DEER Measure Case | No |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | No |
| DEER Version | N/A |
| Reason for Deviation from DEER | N/A |
| DEER Measure IDs Used | N/A |

**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** |
| NonRes-sAll-mHVAC-RCA | HVAC Maintenance: Refrigerant Charge Adjustment (RCA); all delivery mechanisms except upstream | Non-Res | Any | NonUpStrm | 0.73 |

**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)** |
| HVAC-ProgTStats | Setback Programmable Thermostats | Com | HVAC | 11 | 3.7 |

### 1.4.2 Codes and Standards Analysis

Title 20: This measure does not fall under Title 20 of the California Energy Regulations

2016 Title 24 [496]: New thermostats must meet the below requirements:

Section 120.2(a) - Thermostatic Controls for Each Zone

The supply of heating and cooling energy to each space-conditioning zone or dwelling unit shall be controlled by an individual thermostatic control that responds to temperature within the zone and that meets the applicable requirements of Section 120.2(b). An Energy Management Control System (EMCS) may be installed to comply with the requirements of one or more thermostatic controls if it complies with all applicable requirements for each thermostatic control.

EXCEPTION to Section 120.2(a): An independent perimeter heating or cooling system may serve more than one zone without individual thermostatic controls if:

1. All zones are also served by an interior cooling system;
2. The perimeter system is designed solely to offset envelope heat losses or gains;
3. The perimeter system has at least one thermostatic control for each building orientation of 50 feet or more and
4. The perimeter system is controlled by at least one thermostat located in one of the zones served by the system.

Section 120.2(b) - Criteria for Zonal Thermostatic Controls:

The individual thermostatic controls required by Section 120.2(a) shall meet the following requirements as applicable:

1. Where used to control comfort heating, the thermostatic controls shall be capable of being set, locally or remotely, down to 55°F or lower.
2. Where used to control comfort cooling, the thermostatic controls shall be capable of being set, locally or remotely, up to 85°F or higher.
3. Where used to control both comfort heating and comfort cooling, the thermostatic controls shall meet Items 1 and 2 and shall be capable of providing a temperature range or dead band of at least 5°F within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

EXCEPTION to Section 120.2(b)3: Systems with thermostats that require manual changeover between heating and cooling modes.

1. Thermostatic controls for all single zone air conditioners and heat pumps, shall comply with the requirements of Section 110.2(c) and Reference Joint Appendix JA5 or, if equipped with DDC to the Zone level, with the Automatic Demand Shed Controls of Section 120.2(h).

EXCEPTION 1 to Section 120.2(b)4: Systems serving exempt process loads that must have constant temperatures to prevent degradation of materials, a process, plants or animals.

EXCEPTION 2 to Section 120.2(b)4:, Package terminal air conditioners, package terminal heat pumps, room air conditioners, and room air-conditioner heat pumps.

Section 120.2(e) - Shut-off and Reset Controls for Space-conditioning Systems.

Each space-conditioning system shall be installed with controls that comply with the following:

1. The control shall be capable of automatically shutting off the system during periods of nonuse and shall have:
2. An automatic time switch control device complying with Section 110.9, with an accessible manual override that allows operation of the system for up to 4 hours; or
3. An occupancy sensor; or
4. A 4-hour timer that can be manually operated.

EXCEPTION to Section 120.2(e)1: Mechanical systems serving retail stores and associated malls, restaurants, grocery stores, churches, and theaters equipped with 7-day programmable timers.

1. The control shall automatically restart and temporarily operate the system as required to maintain:
2. A setback heating thermostat setpoint if the system provides mechanical heating; and

EXCEPTION to Section 120.2(e)2A: Thermostat setback controls are not required in nonresidential buildings in areas where the Winter Median of Extremes outdoor air temperature determined in accordance with Section 140.4(b)4 is greater than 32°F.

1. A setup cooling thermostat setpoint if the system provides mechanical cooling.

EXCEPTION to Section 120.2(e)2B: Thermostat setup controls are not required in nonresidential buildings in areas where the Summer Design Dry Bulb 0.5 percent temperature determined in accordance with Section 140.4(b)4 is less than 100°F.

1. Multipurpose room less than 1000 square feet, classrooms greater than 750 square feetand conference, convention, auditorium and meeting center rooms greater than 750 square feet that do not have processes or operations that generate dusts, fumes, vapors or gasses shall be equipped with occupant sensor(s) to accomplish the following during unoccupied periods:
2. Automatically setup the operating cooling temperature set point by 2°F or more and setback the operating heating temperature set point by 2˚F or more; and
3. Automatically reset the minimum required ventilation rate with an occupant sensor ventilation control device according to Section 120.1(c)5.

EXCEPTION 1 to Sections 120.2(e)1, 2, and 3: Where it can be demonstrated to the satisfaction of the enforcing agency that the system serves an area that must operate continuously.

EXCEPTION 2 to Sections 120.2(e)1, 2, and 3: Where it can be demonstrated to the satisfaction of the enforcing agency that shutdown, setback, and setup will not result in a decrease in overall building source energy use.

EXCEPTION 3 to Sections 120.2(e)1, 2, and 3: Systems with full load demands of 2 kW or less, if they have a readily accessible manual shut-off switch.

EXCEPTION 4 to Sections 120.2(e)1 and 2: Systems serving hotel/motel guest rooms, if they have a readily accessible manual shut-off switch.

EXCEPTION 5 to Sections 120.2(e)3:. If Demand Control Ventilation is implemented as required by

Section 120.1(c)3 and 120.1(c)(4).

1. Hotel and motel guest rooms shall have captive card key controls, occupancy sensing controls, or automatic controls such that, no longer than 30 minutes after the guest room has been vacated, setpoints are setup at least +5°F (+3°C) in cooling mode and set-down at least -5°F (3°C) in heating mode.

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 24 (2016) | Section 120.2(a) - Thermostatic Controls for Each Zone  Section 120.2(b) - Criteria for Zonal Thermostatic Controls  Section 120.2(e) - Shut-off and Reset Controls for Space-conditioning Systems | January 1, 2017 |

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

**Impact Evaluation of 2015 Commercial Quality Maintenance Programs (HVAC3)**

This report presents DNV GL’s impact evaluation of heating, ventilation, and air conditioning (HVAC) quality maintenance (QM) measures and programs administered by the California investor-owned utilities in 2015. This work is a continuation of ongoing evaluation research on the California QM and related HVAC tune-up programs.

# Section 2. Calculation Methodology

Among various energy efficiency measures documented in the **Non-Residential HVAC Rooftop Quality Maintenance** disposition [Attachment 2], dated May 02, 2013, this workpaper only supports the “thermostat replacement” measure, which is intended to be supported under the CQM HVAC program.

The energy savings for this measure are adopted directly (and without deviations) from referenced disposition under the “**ED-Overall Tstat Savings**” tab [Attachment 2]. The energy savings for this measure are realized by allowing the supply fan to change from continuous operation during unoccupied periods to intermittent fan operation.

The measure savings are provided for systems with and without economizers and the measure impacts are the same under both conditions with variations based on system type (e.g., DXGF vs. PKHP). Hence, measure impacts for systems with economizers have been adopted for the measure.

Per disposition, the baseline accounts for building owner intervention or possible building-wide time-clock control. Until additional information is obtained that demonstrated otherwise, the baseline model assumes that 30% of all sites using non-programmable thermostats exhibit either manual control or time-clock control of units. Replacement of the existing thermostat with a programmable thermostat for those sites will result in unit cycling at set-back/set-up temperature settings during unoccupied periods as opposed to a deactivated system.

**Weather**

Weather files were updated from the CZ2 weather files based on TMY2 data to the CZ2010 weather files and other more recent data. The CZ2010 weather files were developed for the CPUC by Joe Huang of Whitebox Technologies.

Both the “demand reduction” and “gas energy” savings uses the same approach as the energy savings described above.

# 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. Please note that two different load shapes are used in this revision, one DXGF and the other for PKHP.

Building Types and Load Shapes

|  |  |  |  |
| --- | --- | --- | --- |
| **Building Type** | **Load Shape** | | **E3 Alternate Building Type** |
| Assembly | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Education - Community College | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Education - Primary School | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Education - Relocatable Classroom | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Education - Secondary School | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Education – University | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Grocery | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Health/Medical - Hospital | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Health/Medical - Nursing Home | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Office – Large | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Office – Small | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Restaurant - Fast-Food | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Restaurant - Sit-Down | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Retail - Multistory Large | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Retail - Single-Story Large | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Retail – Small | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Storage – Conditioned | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Storage – Unconditioned | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |
| Warehouse – Refrigerated | DEER:HVAC\_Split-Package\_AC | DEER:HVAC\_Split-Package\_HP | NON\_RES |

# Section 4. Costs

Costs in this work paper were adopted from 2017 RSMeans Mechanical Cost Data [504].

## 4.1 Base Case Cost

There is no base case cost since the base case is the customer’s existing equipment.

## 4.2 Measure Case Cost

Measure case cost is taken from 2017 RSMeans Mechanical Cost Data [504]. Cost considered is per thermostat (per unit) with material cost of $246.00 and labor cost of $44.00.

|  |  |  |  |
| --- | --- | --- | --- |
| **Cost Case Description** | **Source** | **Material Cost**  **(Per Unit)** | **Labor Cost**  **(Per Unit)** |
| Control component, thermostats, heating/cooling, low voltage, with clock | 2017 RS Means Mechanical Cost Data  Line Number: 230953105236 | $246 | $44 |

## 4.3 Full and Incremental Measure Cost

**Full and Incremental Measure Cost Equations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| REA | MEC + MLC | MEC + MLC | N/A |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

**Full and Incremental Costs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| AC-19973 | REA | $290 | $290 | N/A |
| AC-19974 | REA | $290 | $290 | N/A |

# Attachments

1. SCE17HC049.0 - Calculation Template (SCE)
2. SCE17HC049.0 – CPUC Disposition

# References

References in this version of the work paper is based on the references file “[References\_08212017\_083127]”.

[496]

[504]