

**H V A C**

C L A S S R O O M H V A C O C C U P A N C Y S E N S O R

SWHC012-01

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# MEASURE NAME

HVAC Occupancy Sensor for Classroom

# STATEWIDE MEASURE ID

SWHC012-01

# TECHNOLOGY SUMMARY

This measure pertains to a programmable thermostat with an occupancy sensor that controls a packaged HVAC unit that serves an education classroom. The thermostat has unoccupied setback temperature control for closed hours (evenings, weekends, furlough days and holidays). Importantly, the thermostat also reverts to unoccupied setback temperatures when there is no occupancy sensed for a predetermined duration.

The unit energy savings (UES) results from the reduced runtime of the HVAC system (fans, compressors, furnaces) due to the temperature setpoints setback to unoccupied mode when there is no occupancy during the school hours. The unoccupied mode temperature setpoints are 86 °F for cooling and 62 °F for heating. The HVAC unit will cycle on and off to meet the temperature setpoints.

# MEASURE CASE DESCRIPTION

The measure case is defined as a programmable thermostat with an occupancy sensor that controls a packaged HVAC unit that serves an education classroom. The thermostat has unoccupied setback temperature control during closed hours (evenings, weekends, furlough days and holidays). Importantly, the thermostat reverts to unoccupied setback temperatures when there is no occupancy sensed for a predetermined duration.

Measure offerings are specified for various education building types listed below and the corresponding default HVAC systems. DX furnace (electric cooling and natural gas heating for secondary and primary school and heat pump (electric cooling and heating) for relocatable classrooms. Energy savings and demand reduction were derived for the installation an occupancy sensor for each for each building type, corresponding HVAC system, and for each climate zone in California.

Measure Offerings

|  |  |  |
| --- | --- | --- |
| Statewide Measure Offering ID | Description | Building Type |
| SWHC012A | Classroom HVAC Occupancy Sensor, DX Furnace, Epr | Education - Primary School |
| SWHC012A | Classroom HVAC Occupancy Sensor, DX Furnace, ESe | Education - Secondary School |
| SWHC012B | Classroom HVAC Occupancy Sensor, Heat Pump, ERC | Education - Relocatable Classroom |

# BASE CASE DESCRIPTION

The base case is defined as a programmable thermostat without an occupancy sensor controlling packaged HVAC unit that serves classrooms. The base case thermostat has unoccupied setback temperature control during closed hours (evenings, weekends, furlough days and holidays).

# CODE REQUIREMENTS

This measure is governed by the 2019 California Building Energy Efficiency Standards (Title 24).1

Section 120.2 requires that zone thermostatic controls must be provided for each space-conditioning zone (of a nonresidential, hotel/motel, or high-rise residential building) to control the supply of heating and cooling energy within that zone. The setpoint may be adjustable either locally or remotely, by continuous adjustment or by selection of sensors.

Section 120.2 (e) 1. requires that each space-conditioning system must be provided with controls that can automatically turn the equipment OFF during unoccupied hours. The control device can be an automatic time switch, manual override abilities, an occupancy sensor, etc.

Section 120.2 (e) 2. requires that when shut down, the controls shall automatically restart the system to maintain:

1. A setback heating thermostat setpoint, if the system provides mechanical heating.

*Exception:* Thermostat setback controls are not required in nonresidential buildings in areas where the Winter Median of Extremes outdoor air temperature is greater than 32

°F.

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

*Exception:* Thermostat setup controls are not required in nonresidential buildings in areas where the Summer Design Dry Bulb 0.5 percent temperature is less than 100 °F.

ASHRAE Standard 90.1-20162 stipulates that the thermostat must be capable of temperature setback down to 55 °F and a temperature setup to 90 °F during unoccupied hours.

The 2015 ASHRAE Handbook for HVAC Applications3 states that science classrooms (or school laboratories) may require fume hoods with special exhaust systems. If there are no fume hoods, a room exhaust system is recommended for odor removal, depending on the type of experiments conducted in the room and whether animals are kept within the room. Any associated storage and preparation rooms are generally exhausted continuously to remove odors and vapors emanating from stored materials.

1 California Energy Commission (CEC). 2018. *2019 Building Energy Efficiency Standards for Residential and Nonresidential Buildings.* CEC-400-2018-020-CMF.

2 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE). 2016. *ASHRAE Standard 90.1*. Atlanta (GA): ASHRAE.

3 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE). 2015. *2015 ASHRAE Handbook – HVAC Applications.* Atlanta (GA): ASHRAE.

Applicable State and Federal Codes and Standards

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Date |
| CA Appliance Efficiency Regulations – Title 20 | None. | n/a |
| CA Building Energy Efficiency Standards – Title 24 (2019) | Sections 120.2 | January 1, 2020 |
| ASHRAE | Standard 90.1-2016 | 2016 |

# NORMALIZING UNIT

Per capacity ton.

# 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 (NR) | DnDeemDI | Com |
| Normal replacement (NR) | DnDeemed | Com |
| Normal replacement (NR) | UpDeemed | Com |

*Eligible Products*

The measure requires installation of an HVAC occupancy sensing thermostat in the classroom. This control equipment includes, but is not limited to:

* An occupancy sensing thermostat
* An occupancy sensor (wired or wireless)
* Wiring (if wired)
* Signal receiver and power pack (if wireless)

*Eligible Building Types and Vintages*

The measure is only applicable for classrooms in education primary schools (EPr), education secondary schools (ESe), and education re-locatable classrooms (ERC). This measure is not applicable for education community colleges, and education universities, unless these buildings have relocatable classrooms with packaged HVAC units. This measure is applicable to all vintages.

*Eligible Climate Zones*

This measure is applicable in any California climate zones.

# PROGRAM EXCLUSIONS

This measure is not applicable for education community colleges, and education universities, unless these buildings have relocatable classrooms with packaged HVAC units. Additionally, this measure is applicable only for the systems noted in the Base Case Description section.

# DATA COLLECTION REQUIREMENTS

Data collection requirements are to be determined.

# USE CATEGORY

HVAC

# ELECTRIC SAVINGS (kWh)

The electric unit energy savings (UES) of an occupancy sensor-controlled HVAC system for a classroom was derived from building energy use modeled in the eQuest 3.65 building energy simulation software.4

Prototypes from the Database for Energy Efficient Resources (DEER) 2020 were utilized for the building energy use simulations.

The DEER2020 base case prototypes specified below were used to develop the base and measure case energy use and demand estimates. The DEER prototypes were generated using MASControl3 software and all modeling used the CZ2010 weather files.

MASControl3, the measure analysis software for the 2020 version of DEER2020 was used to generate the prototypes for the Measure IDs specified below.

4 Southern California Edison (SCE). 2019. “SWHC012-01-BES Files.zip.”

Statewide Measure Offering IDs and DEER IDs

|  |  |  |  |
| --- | --- | --- | --- |
| Statewide Measure Offering ID | DEER Energy Impact ID | DEER Tech ID | Measure Offering Description |
| SWHC012A | NE-HVAC-airAC-Pkg-  lt55kBtuh-15p0seer | MsrNResPkgAC-lt55-S15 | Classroom HVAC Occupancy Sensor, DX Furnace, EPr |
| SWHC012A | NE-HVAC-airAC-Pkg-  lt55kBtuh-15p0seer | MsrNResPkgAC-lt55-S15 | Classroom HVAC Occupancy Sensor, DX Furnace, ESe |
| SWHC012B | NE-HVAC-airHP-Pkg-  lt55kBtuh-15p0seer-8p2hspf | MsrNResPkgHP-lt55-S15- H8.2 | Classroom HVAC Occupancy Sensor, Heat Pump, ERC |

Base Case and Measure Case Energy Use Simulations

Building Vintages. This measure is applicable to all the vintages. However, for the analysis the median vintage 2007 was considered.

Base Case. The base case building energy use was modeling for all Measure IDs with DEER default setpoints.

Measure Case. To model the measure case building energy use, the thermostat cooling and heating setpoints were setback to unoccupied mode, 86 oF for cooling and 62 oF for heating for the hours described below. When implemented, the setback will happen when there is no occupancy detected, such as the lighting turning OFF through lighting occupancy sensors. This could happen anytime during the classroom hours. However, in eQuest the minimum interval at which the thermostat settings can be changed is only hourly. Hence, it was assumed that (on average) the setbacks happen for two hours on weekdays and four hours on Saturday towards the closing hours of the classroom when the occupancy factor is less than or equal to 0.5. The table below summarizes the setback schedules.

Setback Schedules

|  |  |  |  |
| --- | --- | --- | --- |
| Building Type | Setback Hours | Occupancy Factor | Schedule name in DEER Prototype |
| ERC | Monday to Friday: 2PM to 4PM (close hour) | 0.5 | S1 Sys1 (PVVT) Cool S2 WD S1 Sys1 (PVVT) Heat S2 WD |
|  | Saturday: Noon to 3PM (close hour) | 0.3 | S1 Sys1 (PVVT) Cool S2 Sat S1 Sys1 (PVVT) Heat S2 Sat |
| Ese and EPr | Monday to Friday: 5PM to 7PM (close hour) | 0.5 | S1 Sys1 (PVVT) Cool S2 WD S1 Sys1 (PVVT) Heat S2 WD |
|  | Saturday: 1PM to 5PM (close hour) | 0.3 | S1 Sys1 (PVVT) Cool S2 Sat S1 Sys1 (PVVT) Heat S2 Sat |

Unit Energy Savings Calculation

The electric UES was calculated as the difference between the baseline and measure UEC.5 All savings values are normalized per rated capacity (tons) of HVAC systems.

# PEAK ELECTRIC DEMAND REDUCTION (kW)

The approach to derive the peak demand reduction for the peak period of 4:00 p.m. to 9:00 p.m. 6

followed the approach to estimate the electric unit energy savings. See Electric Savings.

# GAS SAVINGS (THERMS)

The approach to derive the gas unit energy savings followed the approach to estimate the electric unit energy savings. See Electric Savings.

# 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. 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 this measure are presented below. The EUL adopted for this measure is based upon a utility retention study and the *Energy Efficiency Policy Manual Version 2.0*. Note that RUL is only applicable for add-on equipment (AOE) and accelerated replacement (AR) measures thus is not applicable.

Effective Useful Life and Remaining Useful Life

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Source |
| EUL (yrs) | 11.0 | Mowris, R., E. Jones, and K. Carlson. 2004. *Evaluation Measurement and Verification Report for the Gas-Only Multifamily Efficiency Program #197-02.* Prepared for SESCO, Inc. April.    California Public Utilities Commission (CPUC), Energy Division. 2003.  *Energy Efficiency Policy Manual v 2.0.* Page 17. |
| RUL (yrs) | n/a |  |

5 Southern California Edison (SCE). 2019. “SWHC012-01-EnergyImpact Analysis.xlsx”

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

# BASE CASE MATERIAL COST ($/UNIT)

The base case material cost was derived as the average of cost estimates provided by a sample (three of seven that were contacted) of thermostat product manufacturers via phone/email in 2018.

The manufacturer cost data, provided as $/programmable thermostat, was converted to $/ton using the average rated capacity (tons) of HVAC units. The average rated capacity was calculated from the total capacity and total number of HVAC units generated using the Database for Energy Efficient Resources (DEER) MASControl3 batch processing in-built scripts.7

# MEASURE CASE MATERIAL COST ($/UNIT)

The measure case material cost was derived as the average of cost estimates provided by a sample (three of seven that were contacted) of thermostat product manufacturers via phone/email in 2018.

The measure case equipment cost includes $/unit of bare thermostat, $/unit for the occupancy sensor controls and fixed cost for wiring. As per the manufacturers, the programmable thermosets are pre- programmed to setback when there is no occupancy and the labor cost is same as installing a standard programmable thermostat.

The cost per ton is calculated as explained in the above section.

# BASE CASE LABOR COST ($/UNIT)

The base case labor installation was derived from the estimated labor hours to install and commission a programmable thermostat (without an occupancy sensor) provided by a sample (three of seven that were contacted) of thermostat product manufacturers via phone/email in 2018.

The installation cost assumes the average labor rate for low voltage controllers reported in 2018 RSMeans.8 The calculated installation cost was converted to $/ton as explained for the Base Case Material Cost.

Labor Cost Inputs

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Source |
| Labor Rate ($/hr) | $78.00 | RSMeans Engineering Department. 2018. *RSMeans Electrical Cost Data 2018*. |
| Labor Hours | 2.0 |  |

# MEASURE CASE LABOR COST ($/UNIT)

The measure case labor installation was derived from the estimated labor hours to install and commission a programmable thermostat (with an occupancy sensor) provided by a sample (three of seven that were contacted) of thermostat product manufacturers via phone/email in 2018.

7 Southern California Edison (SCE). 2019. “SWHC012-01-EnergyImpact Analysis.xlsx.” See “Cost Analysis” tab.

8 RSMeans Engineering Department. 2018. *RSMeans Electrical Cost Data 2018*.

The installation cost assumes the average labor rate for low voltage controllers reported in 2018 RSMeans.9 The calculated installation cost was converted to $/ton as explained for the Base Case Material Cost.

Labor Cost Inputs

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Source |
| Labor Rate ($/hr) | $78.00 | RSMeans Engineering Department. 2018. *RSMeans Electrical Cost Data 2018*. |
| Labor Hours | 2.0 |  |

# 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. The NTG value based upon the average of all NTG ratios for all evaluated 2006 – 2008 commercial and industrial programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. This sector average NTG (“default NTG”) is applicable to all energy efficiency measures that have been offered through commercial sector programs for more than two years and for which impact evaluation results are not available. If the measure complies with Decision 14-10-046, which specified a NTG ratio for all projects undertaken by all K-12 schools and community colleges using Proposition 39 funds, the project would be eligible to use a higher NTG of 0.85.

Net-to-Gross Ratios

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Source |
| NTG – Commercial | 0.60 | Itron, Inc. 2011. *DEER Database 2011 Update Documentation.* Prepared for the California Public Utilities Commission. Page 15-4 Table 15-3. |
| NTG - K-12School- ComCollege | 0.85 | California Public Utilities Commission (CPUC). 2014. *Decision 14-10-046. Decision Establishing Energy Efficiency Savings Goals and Approving 2015 Energy Efficiency Programs and Budgets.* Issued October 24. |

# 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.

Gross Savings Installation Adjustment Rates

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

9 RSMeans Engineering Department. 2018. *RSMeans Electrical Cost Data 2018*.

# NON-ENERGY IMPACTS

Non-energy benefits 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.

DEER Difference Summary

|  |  |
| --- | --- |
| DEER Item | Comment / 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 | Yes |
| DEER Version | N/A |
| Reason for Deviation from DEER | DEER does not contain this measure. |
| DEER Measure IDs Used | n/a |
| NTG | Source: DEER2019. The NTG of 0.60 is associated with NTG ID: *Com- Default>2yrs, K-12School-ComCollege* |
| GSIA | Source: DEER2011. The GSIA of 1.0 is associated with GSIA ID: *Def-GSIA* |
| EUL/RUL | Source: DEER2014. The value of 11 years is associated with EUL ID:  *HVAC-ProgTStats* |

# REVISION HISTORY

Measure Characterization Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision Number | Revision Complete Date | Primary Author, Title, Organization | Revision Summary and Rationale for Revision |
| 01 | 09/30/2018 | Jennifer Holmes Cal TF Staff | Draft of consolidated text for this statewide measure is based upon:  SCE17HC060, Revision 1 (August 16, 2018) Consensus reached among Cal TF members. |
|  | 06/12/2019 | Akhilesh Endurthy Solaris-Technical | DEER2020/ E-4952 updates  Updated calculations using DEER2020 prototypes |
|  | 06/27/2019 | Jennifer Holmes Cal TF Staff | Revisions for submittal of version 01. |
| 01 | 08/09/2021 | Ajay Wadhera, SCE | Changed E3MeaElecEndUseShape from “DEER:HVAC\_Eff\_AC” to “DEER:HVAC\_Split-Package\_AC” and “DEER:HVAC\_Eff\_HP “ to “DEER:HVAC\_Split-Package\_HP “in EAD table. |