|  |
| --- |
| Appliance & Plug loads  Vending and Beverage Merchandise Controller  SWAP011-02 |

CONTENTS

Measure Name 2

Statewide Measure ID 2

Technology Summary 2

Measure Case Description 2

Base Case Description 2

Code Requirements 3

Normalizing Unit 3

Program Requirements 3

Program Exclusions 5

Data Collection Requirements 5

Use Category 5

Electric Savings (kWh) 5

Peak Electric Demand Reduction (kW) 8

Gas Savings (Therms) 8

Life Cycle 8

Base Case Material Cost ($/unit) 9

Measure Case Material Cost ($/unit) 9

Base Case Labor Cost ($/unit) 9

Measure Case Labor Cost ($/unit) 9

Net-to-Gross (NTG) 10

Gross Savings Installation Adjustment (GSIA) 10

Non-Energy Impacts 10

DEER Differences Analysis 10

Revision History 11

Measure Name

Vending and Beverage Merchandise Controller

Statewide Measure ID

SWAP011-02

Technology Summary

A beverage merchandise cooler is a commercial reach-in refrigerator with transparent doors and a self-contained condensing unit. The beverage merchandise cooler maintains product temperatures for non-perishable goods. It typically has lighting to illuminate the product.

A beverage merchandise controller (BMC) is a device with a passive infrared occupancy sensor, a duplex receptacle, and a power cord for connecting the device to 120-volt power. The energy savings are achieved by shutdown of the cooler when there are no occupants present. During the unoccupied periods, the controller measures ambient air temperature outside of the case and periodically turns on the cooler to maintain preset product temperatures. The controller does not interrupt cooling cycles when shutting down the cooler.

A vending machine is similar to a beverage merchandise cooler but dispenses product through a coin or bill-operated interface. Snack vending machines are typically not refrigerated. Vending machine controllers (VMC) shut down compressors and/or lighting during periods of non-use.

Measure Case Description

This measure is defined as an occupancy sensor-based control that is installed on existing vending machine or beverage merchandise cooler. This sensor and control reduces the lighting and refrigeration and therefore the energy use of the host equipment. The measure offerings (and therefore savings) vary by the configuration of the existing host vending or beverage machine.

Vending and Beverage Merchandise Controller Measure Offerings

|  |  |
| --- | --- |
| **Type** | **Configuration** |
| Beverage Merchandise Coolers | Double-door beverage merchandise cooler |
| One-door beverage merchandise cooler |
| One-door under-counter beverage merchandise cooler |
| Triple-Door beverage merchandise cooler |
| Vending Machines | Cold vending machine control |
| Snack vending machine control |

Base Case Description

The base case for this measure is defines as an existing vending machine or beverage merchandise cooler with no control.

Code Requirements

The addition of controls on vending machines and beverage merchandise coolers is not regulated under 2019 California Appliance Efficiency Regulations (Title 20)[[1]](#footnote-2) or the Code of Federal Regulations Title 10.[[2]](#footnote-3) Both Title 20 and CFR Title 10 contain standards for daily energy use of both beverage and vending machines; Title 20 also includes a requirement for vending machines to have manufacturer-equipped hardware/software capable of automated low-power mode operation. However, these state and federal requirements do not apply to the beverage coolers included as measure offerings.

The maximum daily energy consumption of a beverage merchandise cooler is established by the federal requirements in CFR Title 10 Part 431 Subpart C §431.66 (b) are identical to the requirements set forth by Title 20 Table A-4.

The maximum daily energy consumption of a canned vending machine is established by the federal requirements in CFR Title 10 Part 431 Subpart Q §431.296 (b) are identical to Title 20 Table A-8.

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 | None | n/a |
| Federal Standards | CFR Title 10 Part 431 Subpart C §431.66 (b)  CFR Title 10 Part 431 Subpart Q §431.296 (a)  CFR Title 10 Part 431 Subpart Q §431.296 (b) | January 1, 2010  August 31, 2012  January 8, 2019 |

Normalizing Unit

Each (per sensor).

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** |
| Add-on equipment | DirInstall | Com |
| Add-on equipment | DirInstall | Res |
| Add-on equipment | PreRebDown | Ag |
| Add-on equipment | PreRebDown | Com |
| Add-on equipment | PreRebDown | Ind |
| Add-on equipment | PreRebDown | Res |

Eligible Products

Existing beverage merchandise coolers must:

* Have either glass sliding doors or glass pull-open doors.
* Have a self-contained condensing unit.
* Be used to maintain temperatures for non-perishable products.

The beverage merchandise controller (BMC) must:

* The controller must turn off the lights and the compressor when the surrounding area is unoccupied for 15 minutes to one hour, or if there is no sales traffic for a given period of time.
* Periodically power the cooler back on at a maximum increment of every four hours to reasonably maintain product temperatures.
* Be rated for 120 VAC applications.

Existing cold vending machines have the following requirements:

* The refrigerated vending machines must contain only non-perishable bottled and canned beverages.

ENERGY STAR qualified machines are not eligible as ENERGY STAR qualified machines already include a low power mode that is covered by this measure.

Eligible Building Types and Vintages

All measures offerings are eligible in all existing nonresidential building types, as well as for residential multifamily, and residential mobile-home and double-wide building types.

Eligible Climate Zones

This measure is applicable in any California climate zone.

Program Exclusions

None.

Data Collection Requirements

Data collection requirements are to be determined.

Use Category

Appliance and plug loads (AppPlug)

Electric Savings (kWh)

The electric unit energy savings (UES) from the installation of vending machine controller (VMC) or a beverage merchandise controller (BMC) is equal to the sum of the reduced energy use as a result of 1) reduced lighting use from turning off interior and backlit display lights, reduced refrigeration time for refrigerated beverage vending machines, and 3) reduced refrigeration time for commercial refrigerators, commercial refrigerator-freezers, and commercial freezers. *Note that any one particular controller may not exhibit all of these characteristics.*

Reduction of Lighting Use by Turning Off Interior and Backlit Display Lights

In an uncooled snack vending machines, a display light typically illuminates the products inside the vending machine. The savings for occupancy-based vending machine controller will occur in a load profile complimentary to an 8760 load shape, as represented by the following calculation. The savings are a function of the hours that the controller turns off the equipment and the wattage of the controlled light fixtures.

*UESltg = Annual energy savings due to reduction of interior and backlit display lighting hours (kWh)*

*EFLH = Effective full load hours (hours)*

*W = Controlled fixture wattage (W)*

The hours that the controller turns off the equipment is represented by the effective full load operating hours[[3]](#footnote-4) (EFLHs), or the hours when the building is occupied. For example, in a small office the EFLH is 1,760 hours; therefore, the time the VMC would turn the interior and backlit display lights off would be 8,760 hours minus 1,760 hours, resulting in 7,000 hours of off time.

A total of 17 beverage machine manufacturers and distributors were contacted, but we didn't receive a good response. To confirm that LED is the baseline lighting technology for these Merchandising Systems, the Automated Merchandising Systems Inc of Kearneysville, WV was contacted, and it was confirmed that LED is standard across their entire product line and has been for years. Additionally, a web scraping was conducted on major online retailers and all the automatic beverage merchandisers were found to be equipped with LED lighting. [[4]](#footnote-5) Also, according to the Federal Register, Volume 81, No. 5, the DOE notes that a comment from Royal Vendors, a global vending machine manufacturer and supplier, states that LED lighting is used to meet the current Federal standards. [[5]](#footnote-6) The inputs and assumptions for the calculation of energy savings calculations are specified below.

Energy Savings Input Parameters for Reduced Interior and Backlit Display Lighting Usage

| **Parameter** | **Value** | **Source** |
| --- | --- | --- |
| Effective full load operating hours (EFLH) | Varies by building type | California Public Utilities Commission (CPUC). 2020.  DEER2020 Commercial Indoor lighting HVAC Interactive Effects Factors including Hours-of-Use and Coincident Demand Factor |
| Interior display fixture wattage (W) | 44 | Lamp specification for (2) 5-foot, Type B, LED Tubes. 22 Watts each. |
| Backlit display fixture wattage (W) | 9 | Lamp specification for (1) 2-foot, Type B, LED Tubes. 9 Watts each. |

Equivalent Full Load Hours for Building Types Used

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Building Type** | **EFLH** | **Building Type** | **EFLH** | **Building Type** | **EFLH** |
| Asm | 1100 | Htl | 1270 | RSD | 3210 |
| Com | 2450 | MBT | 2360 | Rt3 | 5180 |
| DMo | 541 | MFm | 541 | RtL | 3000 |
| ECC | 2360 | MLI | 2370 | RtS | 2860 |
| EPr | 1300 | Mtl | 990 | SCn | 2030 |
| ERC | 1090 | Nrs | 3460 | SFm | 541 |
| ESe | 1780 | OfL | 2070 | SUn | 1880 |
| EUn | 2190 | OfS | 1760 | WRf | 4660 |
| Gro | 4780 | Res | 541 |  |  |
| Hsp | 5090 | RFF | 3910 |  |  |

Reduction of Refrigeration Time for Refrigerated Beverage Vending Machines

The reduction of refrigeration time as a result of a beverage vending machine controller (BMC) is a function of the daily energy consumption of the vending machine,[[6]](#footnote-7) the rated capacity of the appliance, and the maximum hours of “sleep mode” per day as a result of the BMC. The base case unit energy consumption (UEC) is based upon the California Appliance Efficiency Regulations (Title 20) for refrigerated canned and bottled beverage vending machines Part 431, Subpart Q §431.296 (b). A usage reduction rate, or the percentage of hours per day in sleep mode induced by the BMC, is calculated the ratio of the maximum sleep mode hours induced by the BMC divided by number of hours per day of refrigeration time prior to installation of the BMC. This analysis assumes without the BMC, the refrigeration was operating full-time, 24 hours. Further, for a conservative analysis is calculated for a Class B type Beverage Vending Machine, which assumes less than 25% of surface area of the front side of the machine is transparent. Class A type Beverage Vending Machines have higher energy usage allowances due to fenestration heat loss.

UESref = Annual unit energy savings due to reduced refrigeration time (kWh)

MDEC = Maximum daily energy consumption (kWh)

V = Refrigerator/freezer volume (ft3)

Days = Days of operation per year

SleepHours = Maximum hours of sleep mode per day

Energy Savings Input Parameters for Reduced Refrigeration of Beverage Vending Machines

| **Parameter** | **Value** | **Source** |
| --- | --- | --- |
| Operating Days Per Year | 365 | Typical assumption. |
| Capacity (12-ounce cans) | 450 | Houghton, David PE. 1996. “Refrigerated Vending Machines - Overlooked Devices Hold Opportunities for Efficiency, New Services.” E Source Tech Update, TU-96-7. |
| Sleep mode hours (hours/day) | 4 | Itron, Inc. 2005. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study - Final Report.* Prepared for the California Public Utilities Commission. |

Reduction of Refrigeration Time of Commercial Refrigerators, Refrigerator-freezers, and Freezers

The reduction of refrigeration time as a result of a beverage vending machine controller (BMC) is a function of the daily energy consumption of the appliance, the rated volume of the appliance, and the maximum hours of “sleep mode” per day as a result of the controller. The base case energy usage is based upon the California Appliance Efficiency Regulations (Title 20) for glass door reach-in refrigerators.[[7]](#footnote-8) A usage reduction rate, or the percentage of hours per day in sleep mode induced by the BMC, is calculated the ratio of the maximum sleep mode hours induced by the BMC divided by number of hours per day of refrigeration time prior to installation of the BMC. This analysis assumes without the BMC, the refrigeration was operating full-time, 24 hours.

UESref = Annual unit energy savings due to reduced refrigeration time (kWh)

MDEC = Maximum daily energy consumption (kWh)

V = Refrigerator/freezer volume (ft3)

Days = Days of operation per year

SleepHours = Maximum hours of sleep mode per day

It is worth noting that, for beverage coolers with volumes greater than 49 ft3, the power source for the built-in compressor can be a 208/240VAC single phase circuit. The BMC described in this workpaper, which is rated for 120 VAC applications, may not be used for this application. For energy savings claims for such coolers, a BMC specification needs to be submitted for validation purposes.

Refrigerated Volume[[8]](#footnote-9)

| **Measure Name** | **One Door Under Counter Beverage Merchandise Cooler Control** | **One Door Beverage Merchandise Cooler Control** | **Double Door Beverage Merchandise Cooler Control** | **Triple Door Beverage Merchandise Cooler Control** |
| --- | --- | --- | --- | --- |
| Nominal Volume Range (ft3) | < 15 | 15 - 29 | 29 - 49 | > 49 |
| Typical Volume (ft3) | 10 | 24 | 44 | 72 |

Interactive Effects

Interactive effects are not applicable for this measure. The function of an occupancy-based control of vending machines and beverage cabinets is to turn the equipment off when the building is not occupied. The applicability of interactive effects savings would imply that the HVAC equipment is operating the same when facility is closed as it is when it is open.

Peak Electric Demand Reduction (kW)

As presented in the Itron 2004-2005 DEER Update Study Final Report,[[9]](#footnote-10) the vending machine controller (VMC) is expected to operate primarily during off-peak hours; therefore, no demand reduction will occur during the peak period. This assumption is also applied to the beverage machine controller (BMC) due to its similar operation and application. While there will be some demand reduction due to occupancy during the defined peak hours, there is no substantial evidence available to apply a lighting coincident demand factor to vending and beverage cabinet control. As such, the demand reduction by the vending and beverage machine control measure is assumed to be zero.

Gas Savings (Therms)

Not applicable.

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 RUL is only applicable to the first baseline period for a retrofit or early retirement measure. The methodology to calculate the RUL conforms with Version 5 of the Energy Efficiency Policy Manual, which recommends “one-third of the effective useful life in DEER as the remaining useful life until further study results are available to establish more accurate values.”[[10]](#footnote-11) This approach provides a reasonable RUL estimate without requiring any a priori knowledge about the age of the equipment being replaced.[[11]](#footnote-12) The EUL for the REA measure cannot exceed the RUL of the pre-existing (“host”) equipment.

The EUL and RUL established for a beverage merchandise controller (BMC) and vending machine controllers (VMC) are specified below. Additional studies that examined the EUL of vending machines and occupancy controllers are Foster-Miller, Inc. (2000) [[12]](#footnote-13) which estimated a lifetime of 13 years, and Robert Mowris & Associates (2007) estimated a lifetime of three years. [[13]](#footnote-14)

Effective Useful Life and Remaining Useful Life

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| EUL (yrs) – host vending machine | 20.00 | Not available. Based upon professional judgement, host equipment has an extended life that would exceed the max value. Set equal to max value. |
| RUL (yrs) – host vending machine | 6.67 | California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 32. |
| EUL (yrs) – measure BMC/VMC | 5.00 | California Public Utilities Commission (CPUC). 2008. “EUL\_Summary\_10-1-08.xls.”  Energy & Resource Solutions (ERS). 2005. *Measure Life Study*. Prepared for the Massachusetts Joint Utilities. |

Base Case Material Cost ($/unit)

Insofar as this measure is add-on equipment, the base case material cost is equal to $0.

Measure Case Material Cost ($/unit)

The measure case equipment costs are the retail costs of control units (controller, occupancy sensor, and mounting equipment), were obtained from a major manufacturer and are updated as of 2020. The market for this type of device has been previously identified to be narrow, with one major manufacturer, and no market changes were noted based on additional research.

Base Case Labor Cost ($/unit)

Insofar as this measure is add-on equipment, the base case labor cost is equal to $0.

Measure Case Labor Cost ($/unit)

Labor cost assumptions reflect the miscellaneous labor rate in RS Means 2020 data.

Labor Cost Assumptions

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| Labor Rate ($/unit) | $91.32 | *2020 Mechanical Cost with RS means data* |
| Labor Hours | 1.0 | Professional Judgement. |

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 commercial and residential NTG value is based upon the average of all NTG ratios for all evaluated 2006 – 2008 residential, commercial, industrial, and agriculture programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. These sector average NTGs (“default NTGs”) are applicable to all energy efficiency measures that have been offered through residential, commercial, industrial, and agriculture sector programs for more than two years and for which impact evaluation results are not available.

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 – industrial |
| NTG – agriculture |
| NTG – residential | 0.55 |

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

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

Non-Energy Impacts

Non-energy impacts 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** |
| 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 | DEER 2016, READI v2.3.0 |
| Reason for Deviation from DEER | DEER does not contain these measures. |
| DEER Measure IDs Used | N/A |
| NTG | Source: DEER. The NTG of 0.60 is associated with NTG ID: *Com-Default>2yrs, Ind-Default>2yrs, Ag-Default>2yrs* and 0.55 with *Res-Default>2* |
| GSIA | Source: DEER. GSIA of 1.0 is associated with GSIA ID: D*ef-GSIA* |
| EUL/RUL | Source: DEER2014. The value of 5 years is associated with EUL ID: *Plug-VendCtrler*. |

Revision History

Measure Characterization Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision Number** | **Date** | **Primary Author, Title, Organization** | **Revision Summary and Rationale for Revision**  **Effective Date and Approved By** |
| 01 | 10/31/2017 | Jennifer Holmes  Cal TF Staff | Draft of consolidated text for this statewide measure is based upon:  SCE17CS005, Revision 0 (October 21, 2016)  PGECOREF111, Revision 5 (November 10, 2015)  WPSDGENRCS0001, Revision 0.1 (June 27, 2014)  PGE3PLTG168, Revision 1 (June 11, 2014)  Consensus reached among Cal TF members. |
| 01 | 11/7/2018 | Jennifer Holmes  Cal TF Staff | Revisions for submission of Version 01 |
| 02 | 10/29/2020 | Joseph Ling  AESC | Revisions to the following:   * Labor and material costs to most up-to-date amounts * Revised DEER EFLH used in calculations from 2016 to 2020   Revised ISP for lighting technology in calculations from linear fluorescent to LED per research and vendor outreach. |
| 02 | 3/26/2021 | Ajay Wadhera/SCE | Revised Program Eligibility requirement to cover Energy Star criteria of Low Power Mode. |
| 02 | 11/15/2021 | Ajay Wadhera/SCE | Corrected EAD CostExAnte Table with correct cost information. |
| 02 | 12/22/2021 | Lake Casco  TRC | Corrected EAD CostExAnte Table based on CPUC comments for labor cost. |

1. California Energy Commission (CEC). 2019. *2019 Appliance Efficiency Regulations.* CEC 400-2019-021. [↑](#footnote-ref-2)
2. Code of Federal Regulations at 10 CFR 431. Subpart Q §431.296. [↑](#footnote-ref-3)
3. California Public Utilities Commission (CPUC). 2013. “DEER2014 - Codes and Standards Update for the 2013-14 Cycle.” [↑](#footnote-ref-4)
4. Webscarping Analysis.xlsx [↑](#footnote-ref-5)
5. Department of Energy. (2016). Federal Register/ Vol. 81, No. 5, 10 CFR Parts 429 and 431. Docket Number EERE-2013-BT-STD-0022. Page 1057, Section f. Lighting and Lighting Low Power Modes [↑](#footnote-ref-6)
6. California Energy Commission. (2010). *2010 Appliance Efficiency Regulations.* Section 1605.3 Table A-10. [↑](#footnote-ref-7)
7. California Energy Commission (CEC). 2010. *2010 Appliance Efficiency Regulations.* CEC-400-2010-0012. Section 1605.1 Table A-4. [↑](#footnote-ref-8)
8. The source for this data/information is unknown. However, the categorization of beverage vending machines is consistent with the commercial refrigeration distribution industry. [↑](#footnote-ref-9)
9. Itron, Inc. 2005. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study - Final Report*. Prepared for the California Public Utilities Commission. [↑](#footnote-ref-10)
10. California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 32. [↑](#footnote-ref-11)
11. KEMA, Inc. 2008. "Summary of EUL-RUL Analysis for the April 2008 Update to DEER." Memorandum submitted to Itron, Inc. [↑](#footnote-ref-12)
12. Foster-Miller, Inc. 2000. Vending Machine Engineering Evaluation and Test Report. Prepared for the Bayview Technology Group. BAY-00159 (Rev. 1). [↑](#footnote-ref-13)
13. Robert Mowris & Associates. 2007. EM&V Report for the Small Nonresidential Energy Fitness Program #1409-04. Prepared for the California Public Utilities Commission. Study ID: RHA0002.01. [↑](#footnote-ref-14)