

**C O MME R C I A L RE F RI G E RA T I O N**

M E D IU M - T E M PE R A T U R E C A S E DOOR S

SWCR015-01

C O N T E N T S

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# MEASURE NAME

Medium-temperature Display Case Doors

# STATEWIDE MEASURE ID

SWCR015-01

# TECHNOLOGY SUMMARY

This measure pertains to the addition of glass doors on an existing medium–temperature, open-vertical, refrigerated display case (also known as an open multi-deck case). Such display cases are heavily represented in a typical supermarket and can also be found in a variety of other food retail settings, such as smaller grocery stores and some large convenience stores. They can be self-contained systems with a refrigeration compressor and condenser built into the case structure, but more commonly they are served by remote compressors and condensers. In supermarkets, the remote compressors are generally arranged into combined suction groups described as a multiplex system.

Several studies have shown that the infiltration, and thus the total refrigeration load, can be significantly reduced by adding glass doors to the existing open cases. One commonly cited lab-test study, conducted by the Southern California Edison Research and Thermal Test Center found that although air curtains help to reduce the infiltration of non-refrigerated air into the case, the infiltration of warm air and moisture is responsible for 70% to 80% of the refrigeration load on open-vertical refrigerated display case.[1](#_bookmark0)

Additionally, the cooling load attributable to infiltration was reduced by 68%after retrofitting doors on an open display case. This conclusion was based on lab testing conducted with static ambient temperature and humidity levels. The retrofit differed from the measure described in the paper because the added doors included anti-sweat heaters, which introduce an additional cooling load on the refrigeration system.

Another report, based on lab testing, concluded that the cooling load of open cases decreased 66% versus cases without doors or night covers and 53% when compared to an open case with night covers in place at night.[2](#_bookmark1)

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) sponsored a study to compare energy and sales results of open multi-deck compared to reach-in case for medium- temperature applications.[3](#_bookmark2) The display cases that were tested held alcoholic beverages and dairy products, and were located in two stores in Kansas. The report summary showed an 18% reduction in energy, using calculated compressor savings and measured refrigeration load. Even though this research

1 Faramarzi, R., B. Coburn, and R. Sarhadian. 2002. "Performance and Energy Impact of Installing Glass Doors on an Open Vertical Deli/Dairy Display Case." *ASHRAE Transactions: Symposia.* Page 673.

2 Lindberg, U., M. Axell, and P. Fahlen. 2010. "Vertical Display Case Cabinets without and with Doors - A Comparison of Measurements in a Laboratory and in a Supermarket." Proceedings of the 1st IIR International Conference on Sustainability and Cold Chain. Cambridge University. Page 5.

3 Fricke, B. and B. Becker. 2011. “Comparison of Vertical Display Cases: Energy and Productivity Impacts of Glass Doors Versus Open Vertical Display Cases.” *ASHRAE Transactions.*

compared a new open multi-deck case to a new reach-in case, not adding doors to an existing open multi- deck case, many of the measurements that were taken are valid for comparison to values used in this work paper including: 1) mean door open time for the reach-in case was 12 seconds, occurring six times per hour; 2) average lighting power = 2.0 W/sf in the open case; 3) average fan power = 0.010 kW/ft. in the open case; and 4) supply to return air delta temperature of 10 °F for the open case and 2 °F for the reach-in case.

The State of California Air Resources Board (CARB) estimated that adding doors to all viable open vertical refrigerated display cases in the state would reduce energy consumption by more than 1,000 GWH, or 5% of the total energy consumption attributed to the grocery sector.[4](#_bookmark3)

# MEASURE CASE DESCRIPTION

The measure case is defined as the retrofit of glass doors on a medium-temperature, open-vertical, refrigerated display case (also known as an open multi-deck case).

Measures Offerings

|  |  |
| --- | --- |
| Statewide Measure  Offering ID | Measure Offering Description |
| SWCR015A | Vertical Ref Case, Med. Temp: Open w/ Night Covers to Closed (Retrofit) |
| SWCR015B | Vertical Ref Case, Med. Temp w/Night Covers: Open to Closed with LED |

# BASE CASE DESCRIPTION

The base case is defined as a medium-temperature, open, vertical refrigerated display case. The base case scenario defined for the measure is as follows:

* Medium–temperature, open-vertical, refrigerated display case with night covers on for six hours per night

The following specifications apply to the base case for both measure offerings:

* The supply air temperature is 32 °F
* The coil capacity is 1,600 Btu/hr.-ft. of case.
* The case has two rows of T8 light fixtures in the canopy (16 W/ft. of case) and 10 W/ft. of evaporator coil fan electric use
* The case uses off-cycle defrost, with four defrost cycles per day

4 State of California Air Resources Board (CARB). 2009. *Inventory of Direct and Indirect GHG Emissions from Stationary Air Conditioning and Refrigeration Sources, with Special Emphasis on Retail Food Refrigeration and Unitary Air Conditioning, CARB Agreement No. 06-325.* Page 74.

# CODE REQUIREMENTS

This measure is not governed by either state or federal codes and standards. However, Federal standards exist for refrigerated cases produced on or after January 1, 2012.[5](#_bookmark4) These standards limit the total energy consumption of the units when tested under conditions outlined in ARI Standard 1200-2006. The federal standards pertain only to new equipment and do not pertain to this measure.

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 | None | n/a |

# NORMALIZING UNIT

Linear feet (Len-ft.)

# 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 | DnDeemed | Com |

*Eligible Products*

The retrofit of glass doors, or glass doors with LED lights, for a medium-temperature, open-vertical, refrigerated display case must be added to an existing open-vertical, medium temp display case.

5 Code of Federal Regulations at 10 CFR 431. Subpart C.

In addition to retrofitting the doors and door frames, the measure may require changes to the refrigeration system serving the affected display case(s). These changes *may* include but are not limited to: replacing the expansion valve and/or evaporator pressure regulating valve, adjusting the evaporator temperature/pressure set point, resizing refrigeration piping, replacing the flood back valve on the condenser, resizing the coil/piping on applicable heat reclaim systems, and replacing or removing compressors. These potential changes stem from the significant reduction in the overall refrigeration load. Due to the complexity in determining which system alterations will be required at a site to maintain optimum system performance, a refrigeration contractor with design experience should be consulted before proceeding with the retrofit.

*Eligible Building Types and Vintages*

This measure is applicable to existing commercial buildings of any vintage.

*Eligible Climate Zones*

This measure is applicable in all California climate zones.

# PROGRAM EXCLUSIONS

Exclusions relating to this measure include the following:

* The complete removal of the existing display case and replacing it with a new case with glass doors
* Total lighting power in the measure case may not exceed total lighting power in the base case[6](#_bookmark5)
* Anti-sweat heat (ASH) may not be present in the glass doors or door mounting.[7](#_bookmark6)

# DATA COLLECTION REQUIREMENTS

Data requirements are to be determined.

# USE CATEGORY

Commercial refrigeration (ComRefrig)

6 Several manufacturers interviewed stated that most retrofits include a switch to more efficient LED case lighting, but not an overall increase in lighting power density.

7 Two out of three manufacturers stated that their products did not contain ASH in the door or mullion. Thus, it was decided to specifically prohibit door and frame heat, as it does not appear necessary in medium-temperature applications.

# ELECTRIC SAVINGS (kWh)

The electric unit energy savings (UES) of this measure are based upon the reduction of infiltration, and thus the total refrigeration load by adding double-paned glass to an existing open medium-temperature display case. Energy consumption and therefore savings vary by climate zone and are applicable to all building vintages.

This measure is included in the Database for Energy Efficient Resources (DEER).[8](#_bookmark7) However, because of significant differences between the DEER measure and the measure defined herein, the UES for this measure were derived from detailed computer simulations based on the DOE-2.2R energy analysis program. DOE-2.2R calculates hour-by-hour building and refrigeration system energy consumption over an entire year (8760 hours) using the California Energy Commission (CEC) Title 24 weather data for a representative city in each of the 16 California climate zones. The models utilized test data from the Southern California Edison (SCE) Research and Thermal Test Center (RTTC) and an ASHRAE study to represent changes in display case infiltration, conduction, and refrigeration load for open cases versus cases with doors.

The following subsection describes the base and measure case DOE-2.2R model simulations.

Base and Measure Case Model Simulations

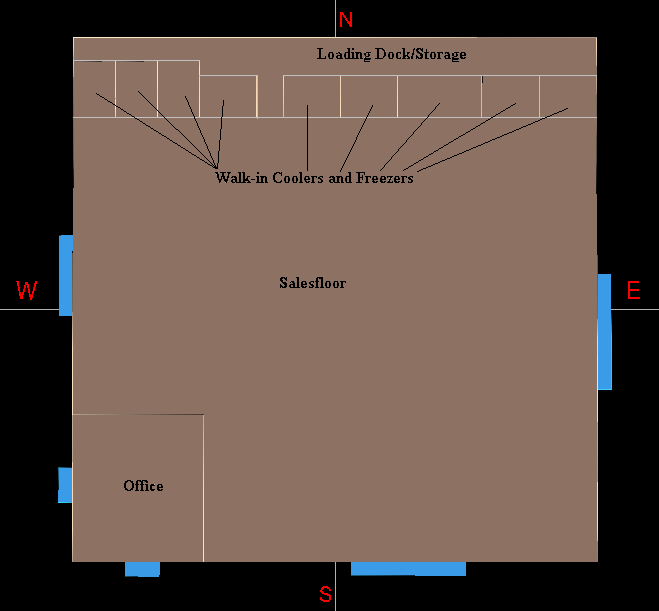
The building energy simulation model DOE-2.2R (via eQuest Refrigeration 3.61) was used to derive base case and measure case unit energy consumption.[9](#_bookmark8)

Base Case Energy Consumption Model. The base case model is designed to be representative of existing grocery building stock in California. The model shares many building and space characteristics with the DEER 2020 grocery models. The figure below displays the general site layout and orientation; the basic input values are specified in the following table.

8 Itron, Inc. 2005. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study - Final Report.* Prepared for Southern California Edison.

See Section 6 of the Itron 2004-2005 DEER Update Study for details of DEER Building Prototypes generated by eQuest. See Section 7.3 for general description for grocery refrigeration measures.

9 Pacific Gas and Electric Company (PG&E). 2019. “SWCR015-01 Model Files.zip.” PECI. (n.d.) "PECI Grocery Model: Refrigeration Base Case Description."



DOE-2.2R Model Site Layout

Basic DOE2.2R Model Inputs

|  |  |  |
| --- | --- | --- |
| Building Characteristic | Input Value | Source |
| Area | 50,000 ft2 | DEER 2020 Grocery Model |
| Shell (Walls, Windows, Roof) | Construction and 1978-85 vintage insulation | DEER 2020 Grocery Model |
| Lighting Power Density | 2.0 W/ft2 | DEER 2020 Grocery Model  National Renewable Energy Laboratory (NREL). 2008. *Technical Support Document: Development of the Advanced Energy Design Guide for Grocery Stores-50% Energy Savings.* NREL/TP-550-42829. |
| Miscellaneous Equipment | 0.5 W/ft2 | National Renewable Energy Laboratory (NREL). 2008. *Technical Support Document: Development of the Advanced Energy Design Guide for Grocery*  *Stores-50% Energy Savings.* NREL/TP-550-42829. |
| Whole Building Infiltration | 0.07 cfm/ft2 | DEER 2020 Grocery Model |
| Sales floor HVAC System Type | Package Variable Volume Variable Temperature set to Constant Volume | DEER 2020 Grocery Model |
| Sales Floor Cooling Capacity | Annual cooling peaks \*1.15 (rounded up to the nearest 5 tons with minimum size of  20 tons) | Professional judgment of PECI engineering staff |
| Sales Floor Heating Capacity | Annual heating peaks \* 1.2  (rounded up to the nearest 100,000 Btu) | Professional judgment of PECI engineering staff |
| Sales Floor Design Supply Air | 37,200 cfm (equal to 0.85 cfm/ft2) | Professional judgment of PECI engineering staff |

|  |  |  |
| --- | --- | --- |
| Building Characteristic | Input Value | Source |
| Outside Air | 15 cfm per person | American Society of Heating, Refrigerating and Air- Conditioning Engineers, Inc. (ASHRAE). 2016.  *ASHRAE Standard 62*. *Ventilation for Acceptable*  *Indoor Air Quality.* Atlanta (GA): ASHRAE. |
| Refrigeration System | Mix of multiplex and stand- alone compressors, air- cooled condensers in most  climate zones. | PECI. 2014. “Program Audit Data.” Proprietary Database. |
| Occupancy schedule | Varies throughout day with peak occupancy at 125 ft2 per person | National Renewable Energy Laboratory (NREL). 2008. *Technical Support Document: Development of the Advanced Energy Design Guide for Grocery Stores-50% Energy Savings.* NREL/TP-550-42829. |

The refrigeration system is the primary building system impacted by the measure, with secondary impacts on the HVAC system. Accordingly, the modeled refrigeration system arrangements represented current grocery building stock and the HVAC system was adequately sized to maintain a store temperature of 70 oF. This temperature setpoint is the average temperature recorded by ADM & Associates as part of its research for the 2010 High Impact Measure (HIM) report on door gaskets.[10](#_bookmark9)

The average whole-building energy use intensity (EUI) of the base case models was equal to 177 kBtu/yr- ft2. For comparison, one analysis of the CBECS data from 2003 found an average EUI of 203.6 kBtu/yr-ft2 for grocery sites within ASHRAE climate zone 3, which covers most of California.[11](#_bookmark10) Another analysis of the same data conducted by the Oakridge National Laboratory in support of the ASHRAE standard 100 -2006 revision[12](#_bookmark11) shows grocery median values in ASHRAE climate zone 3b and 3c as 163 kBtu/yr-ft2 to 169 kBtu/yr-ft2 and 178 kBtu/yr-ft2, respectively.

Measure Case Energy Consumption Model. The energy consumption of the measure case display cases was modeled with remote compressors and air-cooled condensers, except for CEC climate zones 15 and 16 where an evaporative-cooled condenser was used in the model. There was no modeling of integral units (i.e. display cases with compressor and condenser contained within case). Most of the open vertical cases are on a suction group connected to a multiplex compressor system, with the minority served by a stand-alone compressor in a condensing unit (i.e. a packaged compressor and condenser). Portland Energy Conservation, Inc. (PECI) expert staff indicated multiplex systems comprise a large share of the target market for this measure; therefore, multiplex systems were designated for the measure case modeled refrigeration systems. A survey of EnergySmart Grocer auditors and grocery store design engineers revealed that 90% of stand-alone refrigeration compressors are in condensing units and 10%

10 ADM Associates, Inc. 2010. *Commercial Facilities Contract Group 2006-2008 Direct Impact Evaluation Study ID: PUC0016.01, Final Report.* Prepared for the California Public Utilities Commission. Page 5-14. Table 5-7.

11 National Renewable Energy Laboratory (NREL). 2008. *Technical Support Document: Development of the Advanced Energy Design Guide for Grocery Stores-50% Energy Savings.* NREL/TP-550-42829. Page 24.

12 Sharp, T. (ORNL). 2010. “Developing Building Energy Use Intensity Benchmarks for Standard 100 Energy Targets.” *ASHRAE Annual Conference.* Albuquerque, NM. June 27.

are with remote compressors.[13](#_bookmark12) The stand-alone systems modeled for this measure used only compressors in condensing units with one fan.[14](#_bookmark13)

The base case and measure case models for each climate zone are identical, except for the changes detailed in the tables below.

Model Modifications – Base Case

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Input Description | DOE2.2 Components | DOE2.2 Keyword Input | Input Value | Explanation |
| Night Covers | MT\_DeliPasta MT\_Meat3 MT\_Dairy1  MT\_Dairy2 | INF-SCH | {unused} | DEER Methodology |
| Case Infiltration Load | MT\_DeliPasta MT\_Meat3 MT\_Dairy1, MT\_Dairy3 | INF-LOAD/LEN | 1306.5 | ASHRAE Handbook - Refrigeration |
| Case Conduction and Radiation Load | MT\_DeliPasta MT\_Meat3, MT\_Dairy1  MT\_Dairy4 | CONDUCTION/LEN | 217.75 | ASHRAE Handbook - Refrigeration |
| Case Lighting | MT\_DeliPasta MT\_Meat3 MT\_Dairy1 MT\_Dairy4 | CANOPY-KW/LEN | HA09: 0.01833  HAxx: 0.004171 | DEER Grocery Prototype |
| Case Temperature Setpoint | MT\_DeliPasta MT\_Meat3 MT\_Dairy1 MT\_Dairy4 | TEMP-SETPT | 31 | DEER Grocery Prototype |
| Defrost Schedule | MT\_DeliPasta MT\_Meat3 MT\_Dairy1  MT\_Dairy4 | DEFROST-SCH | "Defrost\_5\_Sche d" | DEER Grocery Prototype |

Model Modifications – Measure Case

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Input Description | DOE2.2 Components | DOE2.2 Keyword Input | Input Value | Explanation |
| Case Infiltration Load | MT\_DeliPasta MT\_Meat3 MT\_Dairy1  MT\_Dairy3 | INF-LOAD/LEN | 261.3 | 80% Reduction |

13 Reference is unknown.

14 PECI. (n.d.) "PECI Grocery Model: Refrigeration Base Case Description."

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Input Description | DOE2.2 Components | DOE2.2 Keyword Input | Input Value | Explanation |
| Case Conduction and Radiation Load | MT\_DeliPasta MT\_Meat3 MT\_Dairy1 MT\_Dairy4 | CONDUCTION/LEN | 91.45 | 58% Reduction (conduction and radiation) |
| Case Lighting | MT\_DeliPasta MT\_Meat3 MT\_Dairy1 MT\_Dairy4 | CANOPY-KW/LEN | 0.004171 | Program invoice review |
| Case Temperature Setpoint | MT\_DeliPasta MT\_Meat3 MT\_Dairy1  MT\_Dairy4 | TEMP-SETPT | 35 | Allows for proper cooling and maintain product integrity without overcooling |
| Defrost Schedule | MT\_DeliPasta MT\_Meat3 MT\_Dairy1 MT\_Dairy4 | DEFROST-SCH | "Defrost\_3\_Sche d" | Less defrost required due to less infiltration of moisture into the case |

Unit Energy Savings Calculation

The electric unit energy savings (UES) was calculated as the difference between the modeled base case and the measure case annual unit energy consumption (UEC) . The difference was divided by the number of units of measure implementation that were modeled (length of the display case line-up).

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*UES = Annual electric unit energy savings per unit (kWh/yr)*

*UECbase = Annual unit energy consumption of the base case model (kWh/yr) UECmeasure = Annual unit energy consumption of the measure case model (kWh/yr) LengthTotal Line-Up = Length of the total door line-up (len-ft)*

# PEAK ELECTRIC DEMAND REDUCTION (KW)

This measure is included in the Database for Energy Efficient Resources (DEER).[15](#_bookmark14) However, because of significant differences between the DEER measure and the measure defined herein, the unit peak demand reduction values for this measure were derived from DOE-2.2R building energy use simulations.

See Electric Savings for details of the base case and measure case simulation models.

15 Itron, Inc. 2005. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study - Final Report.* Prepared for Southern California Edison.

See Section 6 of the Itron 2004-2005 DEER Update Study for details of DEER Building Prototypes generated by eQuest. See Section 7.3 for general description for grocery refrigeration measures.

Peak demand was calculated as the average of the electrical power draw between 4:00 p.m. to 9:00 p.m. in conformance with the Database for Energy Efficiency Resources (DEER) peak definition for each climate zone.[16](#_bookmark15) Peak demand reduction is calculated as the difference between the modeled base case and measure case peak demand. The unit demand reduction was calculated as the total demand reduction divided by the total line-up length of the display case.

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*PeakDemandSavTotal Line-Up = Total peak demand reduction for the entire line-up (kW) PeakDemand = Modeled peak demand for base case and measure case units (kW) UnitPeakDemandSavLen-ft = Unit peak demand reduction (kW/Len-ft)*

*LengthTotal Line-Up = Length of the total door line-up (len-ft)*

# GAS SAVINGS (THERMS)

This measure is included in the Database for Energy Efficient Resources (DEER).[17](#_bookmark16) However, because of significant differences between the DEER measure and the measure defined herein, the gas unit energy savings (UES) for this measure were derived from DOE-2.2R building energy use simulations.

See Electric Savings for details of the base case and measure case simulation models and the UES calculation.

# 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 measure with an applicable code baseline.

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.”[18](#_bookmark17) This approach provides a reasonable RUL

16 California Public Utilities Commission (CPUC). 2018. *Resolution E-4952.* October 12.

17 Itron, Inc. 2005. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study - Final Report.* Prepared for Southern California Edison.

See Section 6 for details of DEER Building Prototypes generated by eQuest. See Section 7.3 for general description for grocery refrigeration measures.

18 California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 32.

estimate without the requiring any a priori knowledge about the age of the equipment being replaced.[19](#_bookmark18) Further, as per Resolution E-4807, the California Public Utilities Commission (CPUC) revised add-on equipment measures so that the “EUL of the measure is equal to the lower of the RUL of the modified system or equipment or the EUL of the add-on component.” [20](#_bookmark19)

The estimated life of the measure and the host equipment are specified below. The host equipment for this measure is a grocery refrigeration condenser for which the EUL was established for the 2005 version of the Database for Energy Efficient Resources (DEER 2005).

Effective Useful Life and Remaining Useful Life

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Source |
| EUL (Years) – measure | 15.0 | California Public Utilities Commission (CPUC), Energy Division. 2014. “DEER2014-EUL-table-update\_2014-02-05.xlsx” |
| EUL (years) –modified system | 15.0 | California Public Utilities Commission (CPUC), Energy Division. 2008. “EUL\_Summary\_10-1-08.xls.” |
| RUL (Years) – modified system | 5.0 | 1/3 of EUL |

# BASE CASE MATERIAL COST ($/UNIT)

Insofar as the addition of glass doors to an open vertical refrigerated display case is add-on equipment, the base case assumes that the existing refrigerated display cases are not equipped with doors.

Therefore, the base case cost is $0.

# MEASURE CASE MATERIAL COST ($/UNIT)

The direct measure material costs were calculated as the average of costs of quotes obtained in 2017 from three project quotes from two different vendors.[21](#_bookmark20)

If the costs deviated from one source to another, an average value was used. The costs of labor and materials were not shown as individual line items on the bids; thus, a separate estimation of labor hours and cost was developed for each measure component. The cost of materials is calculated as the full project cost less the estimated labor cost.

The measure material costs include doors, door frames, LED lighting, shelving, a new expansion valve, and some additional new piping. The doors, door frames, lighting and shelving is generally sold as a package by the vendor. If required, the expansion valve and piping will generally be installed by a refrigeration contractor working in coordination with the door supplier/installer. The assumptions used to generate the costs for these refrigeration components were that each 8-ft. refrigerated case will require a new

19 KEMA, Inc. 2008. "Summary of EUL-RUL Analysis for the April 2008 Update to DEER." Memorandum submitted to Itron, Inc.

20 California Public Utilities Commission (CPUC). 2016. *Resolution E-4807.* December 16. Page 13.

21 EnergySmart Grocer. (2017). “PGE3PREF116\_Costs.zip” Proprietary database.

expansion valve and 50 ft. of new copper piping. These assumptions are consistent with PECI staff discussions with a major refrigeration services contractor.

Note that these costs do not change when night covers are in place in the base case.

# LABOR COST ($/UNIT)

The estimated labor costs were calculated as the average labor cost derived from quotes from several projects in 2017 where the described measure was proposed.[22](#_bookmark21) If the costs deviated from one source to another, an average value was used. The costs of labor and materials were not shown as individual line items on the bids; a separate estimation of labor hours and cost was developed for each measure component.

The estimated labor cost includes time to scope the project, install the doors, alter the refrigeration system, and commission the refrigeration system controls to ensure proper system performance. The installation of the doors and lighting is generally included in the bid from the door vendor.

The labor cost also includes the cost for a refrigeration contractor to retrofit several system components and commission the applicable controls to maintain performance. Assumptions to develop labor costs are specified below.

Labor Cost Inputs

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Source |
| Install doors, commission refrigeration controls, optimize system ($/ft) | $35.24 | EnergySmart Grocer. (2017) “PGE3PREF116\_Costs.zip.” Proprietary Database. |
| Refrigeration Contractor Labor Rate ($/hour) for additional refrigeration system retrofit | $90.00 |
| Labor Hours (hours) for additional refrigeration system retrofit | 40.0 |
| Line-up Length (ft) | 195.0 | DOE-2.2R built-in model |

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

Net-to-Gross Ratios

22 EnergySmart Grocer. (2017). “PGE3PREF116\_Costs.zip.” Proprietary Database.

|  |  |  |
| --- | --- | --- |
| 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. |

# 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. |

# 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. The data cited by DEER is not applicable to this measure because this measure does not employ the same technology or use. Specifically, DEER Measure ID D03-206 is intended to represent retrofitting glass doors to medium-temperature, open-vertical refrigerated display cases. It differs from this measure with respect to the following:

* The DEER measure (formerly DEER ID D03-206) assumed that additional lighting and anti-sweat heaters (ASH) would be installed as part of the retrofit. This measure specifically excludes adding ASH equipment load.
* The DEER measure (formerly DEER ID D03-206) does not allow for night covers in the base case. Because night covers have gained in market acceptance since the DEER team modeled the refrigeration measures, and because significant savings potential still exists for cases with existing night covers, this measure has specific measure iterations to account for night covers in the base case.

Additional differences between the model used to develop this measure and the DEER model are noted below:

* The DEER models have a reduced case evaporator coil capacity to match the smaller load found after the measure has been implemented. Evaporator coil adjustments are not part of the retrofits currently being offered on the market, so coil capacity was not changed in the models used to develop this work paper.
* The DEER models represent a store with two multiplex refrigeration systems. The models developed in support of this work paper represent a mix of multiplex and stand-alone

compressors for the refrigeration system. The ratio of compressors for each system is based on market data collected during California EnergySmart Grocer program implementation (n=4,550).

* The DEER models reduce the differential temperature from the supply to the return air in the display case from the base to the measure case. The models, used to develop this work paper, have a reduced approach temperature between evaporator coil and supply air in the measure case runs instead. This phenomenon occurs because of the coil being designed to meet a significantly larger load. The oversized coil supplies air to display case that is closer to the coil temperature than it did before the retrofit occurred.
* This measure has two base cases. The first is equivalent to DEER base case. The second uses a reduced infiltration schedule for six hours at nighttime to model night covers in use.
* The models used to develop this measure used test data by the Southern California Edison (SCE) Research and Thermal Test Center (RTTC) and an ASHRAE research project to inform the models for changes in display case infiltration, conduction and refrigeration load for open cases versus cases with doors.
* The DEER models increased the lighting W/ft and added ASH to the retrofit doors. The terms and conditions of this measure do not allow ASH to be used and requires that total lighting power remains the same or decreases. The models used for this measure maintain a consistent auxiliary load between the base case and measure runs.

DEER Difference Summary

|  |  |
| --- | --- |
| DEER Item | Comment / Used for Workpaper |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | Yes |
| DEER Measure Case | Yes |
| DEER Building Types | Grocery |
| DEER Operating Hours | Grocery |
| DEER eQUEST Prototypes | Grocery Prototype |
| DEER Version | DEER2020 |
| Reason for Deviation from DEER | n/a |
| DEER Measure IDs Used | D03-206 |
| NTG | Source: DEER2016. The value of 0.60 is associated with NTG ID*: Com- Default>2yrs* |
| GSIA | Source: DEER READI. The value of 1.0 is associated with GSIA ID*: Def-GSIA* |
| EUL/RUL | Source: DEER2016. The EUL of 12 years is associated with EUL ID: *GrocDisp- FixtDoors*. The EUL of 15 years for the modified system is RUL ID: *GrocSys- Cndsr* |

# REVISION HISTORY

Measure Characterization Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision Number | Revision Complete Date | Primary Author, Title, Organization | Revision Summary and Rationale for Revision |
| 01 | 03/31/2018 | Jennifer Holmes Cal TF Staff | Draft of consolidated text for this statewide measure is based upon: |
|  |  |  | PGE3PREF116 Revision 2 (January 1, 2016) |
|  |  |  | SCE13RN027 Revision 9 (July 21, 2014) |
|  |  |  | Consensus reached among Cal TF members. |
|  | 06/14/2019 | Randy Kwok | Updates for: |
|  | PG&E | PGE3PREF116 Revision 3 |
|  |  | Revisions for submittal of version 01. |
|  | Jennifer Holmes |  |
|  | Cal TF Staff |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  | 7/16/2019 | Randy Kwok | Update: |
|  | PG&E | Corrected the average lighting power to 2.0 W/sf (on p.3) to match the model input.  No change in the workpaper version #. |
|  |  |  |
|  |  |  |
|  |  |  |