**Work Paper PGECOFST123**

**Reach In Refrigerators and Freezers**

**Revision # 1**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**Reach In Refrigerators and Freezers--Commercial**

**Measure Codes F171-F186**

**At-a-Glance Summary**

|  |  |
| --- | --- |
| **Applicable Measure Codes:** | **F171 to F186** |
| **Measure Description:** | Reach in Refrigerators and Freezers |
| **Energy Impact Common Units:** | Each |
| **Base Case Description:** | Varies see calculations |
| **Base Case Energy Consumption:** | Varies see calculations |
| **Measure Energy Consumption:** | Varies see calculations |
| **Energy Savings (Base Case – Measure)** | Varies by measure |
| **Costs Common Units:** | Varies by measure |
| **Base Case Equipment Cost ($/unit):** | Varies by measure |
| **Measure Equipment Cost ($/unit):** | Varies by measure |
| **Measure Incremental Cost ($/unit):** | Varies by measure |
| **Effective Useful Life (years):** | 12 Years, DEER 2014 |
| **Program Type:** | ROB |
| **Net-to-Gross Ratios:** | NTG 0.60 – Com Default > 2 yrs |
| **Important Comments:** | SCE workpaper revised 2/2014 |

|  |  |  |
| --- | --- | --- |
| PGE Measure Code | SCE Solution Code | Measure name |
| F183 | FS-13121 | < 15 cubic feet Solid-Door Reach-In Refrigerator |
| F184 | FS-42962 | 15 – 29 cubic feet Solid-Door Reach-In Refrigerator |
| F185 | FS-93044 | 30 – 49 cubic feet Solid-Door Reach-In Refrigerator |
| F186 | FS-31425 | ≥ 50 cubic feet Solid-Door Reach-In Refrigerator |
| F179 | FS-21276 | < 15 cubic feet Solid-Door Reach-In Freezer |
| F180 | FS-61432 | 15 – 29 cubic feet Solid-Door Reach-In Freezer |
| F181 | FS-86848 | 30 – 49 cubic feet Solid-Door Reach-In Freezer |
| F182 | FS-54809 | ≥ 50 cubic feet Solid-Door Reach-In Freezer |
| F171 | FS-77373 | < 15 cubic feet Glass-Door Reach-In Refrigerator |
| F172 | FS-28291 | 15 – 29 cubic feet Glass-Door Reach-In Refrigerator |
| F173 | FS-68882 | 30 – 49 cubic feet Glass-Door Reach-In Refrigerator |
| F174 | FS-44686 | ≥ 50 cubic feet Glass-Door Reach-In Refrigerator |
| F175 | FS-16170 | < 15 cubic feet Glass-Door Reach-In Freezer |
| F176 | FS-38598 | 15 – 29 cubic feet Glass-Door Reach-In Freezer |
| F177 | FS-58112 | 30 – 49 cubic feet Glass-Door Reach-In Freezer |
| F178 | FS-30794 | ≥ 50 cubic feet Glass-Door Reach-In Freezer |

**Work Paper Approvals**

The following Manager(s) approved this workpaper through the PG&E Electronic Data Routing System under Routing Requisition # \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |
| --- |
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| **Grant Brohard**  Manager, Technical Product Support |
| **Carolyn Weiner**  Manager, Appliance Products |

**Document Revision History**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Revision #** | **Revision Date** | | | **Section-by-Section Description of Revisions** | | **Author (Company)** |
| Revision 0 | | 6/8/2012 | Original work paper : from SCE | | Jim Wyatt (PG&E) | |
| Revision 1 | | 6/19/2014 | Changes to savings updated by SCE | | Charlene Spoor (PGE) | |
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**Work Paper SCE13CC001**

**Revision 1**

**Southern California Edison Company**

**Commercial Reach-In Refrigerators and Freezers**

Revised February 2014

### Core Measure Summary Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| General Measure Information | | | | | | | | PT | | 1st Baseline Period | | | | 2nd Baseline Period | | | | TOU |
| Measure Name | Measure RunID | Solution Code | CZ | Building Type | Load Shape | EUL | Unit Definition | Program Type (NEW, ROB, RET) | Applicable Code | Gross Unit Annual Electricity Savings (kWh/unit) | User Entered kW Savings per unit (kW/unit) | Gas Savings (Therms) | 1st Baseline Useful Life | kWh Saving per unit (kWh/unit) | kW Savings per unit (kW/unit) | Gas Savings (Therms) | 2nd Baseline Useful Life | % TOU |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | WPSC-Agr-w06-vNA-Rob-EM-RF-Refr-lt15cft-SldDrRI-NA-Refr-NA | FS-13121 | 06 | Agricultural | Refrigeration | 12.0 | Reach-In | ROB | No | 269.74 | 0.02771 | 0.00 | 12.00 | N/A | N/A | N/A | 0.00 | 0.00 |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | WPSC-Agr-w08-vNA-Rob-EM-RF-Refr-lt15cft-SldDrRI-NA-Refr-NA | FS-13121 | 08 | Agricultural | Refrigeration | 12.0 | Reach-In | ROB | No | 269.74 | 0.02771 | 0.00 | 12.00 | N/A | N/A | N/A | 0.00 | 0.00 |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | WPSC-Agr-w09-vNA-Rob-EM-RF-Refr-lt15cft-SldDrRI-NA-Refr-NA | FS-13121 | 09 | Agricultural | Refrigeration | 12.0 | Reach-In | ROB | No | 269.74 | 0.02771 | 0.00 | 12.00 | N/A | N/A | N/A | 0.00 | 0.00 |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | WPSC-Agr-w10-vNA-Rob-EM-RF-Refr-lt15cft-SldDrRI-NA-Refr-NA | FS-13121 | 10 | Agricultural | Refrigeration | 12.0 | Reach-In | ROB | No | 269.74 | 0.02771 | 0.00 | 12.00 | N/A | N/A | N/A | 0.00 | 0.00 |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | WPSC-Agr-w13-vNA-Rob-EM-RF-Refr-lt15cft-SldDrRI-NA-Refr-NA | FS-13121 | 13 | Agricultural | Refrigeration | 12.0 | Reach-In | ROB | No | 269.74 | 0.02771 | 0.00 | 12.00 | N/A | N/A | N/A | 0.00 | 0.00 |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | WPSC-Agr-w14-vNA-Rob-EM-RF-Refr-lt15cft-SldDrRI-NA-Refr-NA | FS-13121 | 14 | Agricultural | Refrigeration | 12.0 | Reach-In | ROB | No | 269.74 | 0.02771 | 0.00 | 12.00 | N/A | N/A | N/A | 0.00 | 0.00 |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | WPSC-Agr-w15-vNA-Rob-EM-RF-Refr-lt15cft-SldDrRI-NA-Refr-NA | FS-13121 | 15 | Agricultural | Refrigeration | 12.0 | Reach-In | ROB | No | 269.74 | 0.02771 | 0.00 | 12.00 | N/A | N/A | N/A | 0.00 | 0.00 |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | WPSC-Agr-w16-vNA-Rob-EM-RF-Refr-lt15cft-SldDrRI-NA-Refr-NA | FS-13121 | 16 | Agricultural | Refrigeration | 12.0 | Reach-In | ROB | No | 269.74 | 0.02771 | 0.00 | 12.00 | N/A | N/A | N/A | 0.00 | 0.00 |

Note: **For the complete list of Measures, refer to the attached calculation spreadsheet**

### Costing and NTG Summary Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| General Measure Information | | | | PT | | NTG | | | IR | 1st Baseline Period | 2nd Baseline Period | IMC | DIM |
| Measure Name | Solution Code | CZ | Unit Definition | Program Type (NEW, ROB, RET) | Applicable Code | NTG Non-Res. | NTG Res. | NTG Multi Family | Installation Rate | Gross Measure Cost per unit | Gross Measure Cost per unit | Incremental Measure Cost per unit | Delivery & Incentive Method |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | FS-13121 | 6 | Reach-In | ROB | No | 0.60 | N/A | N/A | 1.00 | $950.04 | $0.00 | $950.04 | Financial Support / Down-Stream Incentive - Deemed |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | FS-13121 | 8 | Reach-In | ROB | No | 0.60 | N/A | N/A | 1.00 | $1,022.11 | $0.00 | $1,022.11 | Financial Support / Down-Stream Incentive - Deemed |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | FS-13121 | 9 | Reach-In | ROB | No | 0.60 | N/A | N/A | 1.00 | $1,051.60 | $0.00 | $1,051.60 | Financial Support / Down-Stream Incentive - Deemed |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | FS-13121 | 10 | Reach-In | ROB | No | 0.60 | N/A | N/A | 1.00 | $987.17 | $0.00 | $987.17 | Financial Support / Down-Stream Incentive - Deemed |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | FS-13121 | 13 | Reach-In | ROB | No | 0.60 | N/A | N/A | 1.00 | $976.25 | $0.00 | $976.25 | Financial Support / Down-Stream Incentive - Deemed |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | FS-13121 | 14 | Reach-In | ROB | No | 0.60 | N/A | N/A | 1.00 | $959.87 | $0.00 | $959.87 | Financial Support / Down-Stream Incentive - Deemed |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | FS-13121 | 15 | Reach-In | ROB | No | 0.60 | N/A | N/A | 1.00 | $1,022.11 | $0.00 | $1,022.11 | Financial Support / Down-Stream Incentive - Deemed |
| < 15 cubic feet Solid-Door Reach-In Refrigerator | FS-13121 | 16 | Reach-In | ROB | No | 0.60 | N/A | N/A | 1.00 | $1,077.80 | $0.00 | $1,077.80 | Financial Support / Down-Stream Incentive - Deemed |

Note: **For the complete list of Measures, refer to the attached calculation spreadsheet**

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision # | MM/DD/YY | Author/Affiliation | Summary of Changes |
| 0 | 04/06/2012 | John Rossi/EMCOR | Updated to 2013-2014 Template |
| 1 | 10/03/2013 | Alfredo Gutierrez/SCE | Updated savings value (kWh and kW) for Glass-Door Reach-In Refrigerators with volume between 30-49 ft3  Savings values (kWh and kW) have been fixed for the following measures:   * < 15 cubic feet Glass-Door Reach-In Freezer (FS-16170) * 15 – 29 cubic feet Glass-Door Reach-In Freezer (FS-38598)   The following measures have been updated with a new installation type (RET) and delivery method (Midstream):   * < 15 cubic feet Glass-Door Reach-In Refrigerator (FS-77373) * 15 – 29 cubic feet Glass-Door Reach-In Refrigerator (FS-28291) * 30 – 49 cubic feet Glass-Door Reach-In Refrigerator (FS-68882) * ≥ 50 cubic feet Glass-Door Reach-In Refrigerator (FS-44686) |

# Section 1. General Measure & Baseline Data

## 1.1 Measure & Delivery Description

### 1.1a Measure Description

This work paper details the purchase of new or replacement energy efficient commercial reach-in solid and glass door refrigerators and freezers, in both vertical and chest configurations. In all categories, the refrigeration system shall be built-in (packaged). Units with remote refrigeration systems do not qualify. Used or rebuilt equipment is not eligible. Each installed equipment must meet minimum prescriptive criteria to qualify for a per unit rebate.

The following table lists the core measures associated with this work paper.

Table 1 Measure Names

|  |  |
| --- | --- |
| Solution Code | Measure name |
| FS-13121 | < 15 cubic feet Solid-Door Reach-In Refrigerator |
| FS-42962 | 15 – 29 cubic feet Solid-Door Reach-In Refrigerator |
| FS-93044 | 30 – 49 cubic feet Solid-Door Reach-In Refrigerator |
| FS-31425 | ≥ 50 cubic feet Solid-Door Reach-In Refrigerator |
| FS-21276 | < 15 cubic feet Solid-Door Reach-In Freezer |
| FS-61432 | 15 – 29 cubic feet Solid-Door Reach-In Freezer |
| FS-86848 | 30 – 49 cubic feet Solid-Door Reach-In Freezer |
| FS-54809 | ≥ 50 cubic feet Solid-Door Reach-In Freezer |
| FS-77373 | < 15 cubic feet Glass-Door Reach-In Refrigerator |
| FS-28291 | 15 – 29 cubic feet Glass-Door Reach-In Refrigerator |
| FS-68882 | 30 – 49 cubic feet Glass-Door Reach-In Refrigerator |
| FS-44686 | ≥ 50 cubic feet Glass-Door Reach-In Refrigerator |
| FS-16170 | < 15 cubic feet Glass-Door Reach-In Freezer |
| FS-38598 | 15 – 29 cubic feet Glass-Door Reach-In Freezer |
| FS-58112 | 30 – 49 cubic feet Glass-Door Reach-In Freezer |
| FS-30794 | ≥ 50 cubic feet Glass-Door Reach-In Freezer |

### 1.1b Delivery and Incentive Mechanism

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

The program type is Replace-On-Burnout (ROB) and Retrofit (RET). In the early retirement approach, functional units will be identified through the Energy Efficiency Mid-Stream Bottling Pilot program. These units will be targeted for participation through the pilot program and will be retired prematurely. The pilot program will provide incentives to the contractor for this to occur.

### 1.1c Measure Requirements

This measure is only applicable to Non-residential building types. This measure is not approved for installation in Residential Single Family, Residential Multi-Family, or Residential Mobile Home – Double Wide building types. This measure is eligible in all SCE climate zones.

## 1.2 DEER Differences Analysis

The DEER2011 database does not contain an energy-efficient reach-in refrigerator or freezer measure. The table below summarizes the DEER Difference Analysis.

Table 2 DEER Difference Summary

|  |  |
| --- | --- |
| DEER Difference Summary Table | |
| Modified DEER Methodolgy | No |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | No |
| Deviation from DEER | DEER does not contain this type of measure. |
| DEER Version | N/A |
| DEER Run ID and Measure Name (Sample) | N/A |

## 1.3 Code Analysis

Title 24 2008 [208] does not apply in this case because solid door reach-in refrigerators, solid door reach-in freezers, glass door reach-in refrigerators, and glass door reach-in freezers do not fall under the CEC Title 24, Building Energy Efficiency Standards or the Department of Energy (DOE) energy regulations.

As of January 1, 2010, the new ENERGY STAR® Version 2.0 specification [A] is effective, establishing the measure case equipment efficiencies. As of January 1, 2011, the CEC Title 20 appliance efficiency standard [B] is effective, establishing the base case equipment performance. The following table lists the applicable codes.

Measure case energy use requirements for qualifying equipment are shown in Table 3. As of January 1, 2010, the ENERGY STAR® specification was changed to the new Version 2.0 Program [A]. For the 2013 to 2014 program cycle, the new ENERGY STAR® Version 2.0 specification will be used as the requirement for the measures.

Table 3 Measure Case - Energy Star® Version 2.0 Requirements for Reach-In Refrigerators and Freezers

|  |  |  |
| --- | --- | --- |
| **Equipment Description**  **(cubic feet)** | **Daily Energy Usage (kWh/day)** | |
| **Solid-Door Reach-In Refrigerator** |  | |
| 0 < V < 15 | ≤ 0.089V + 1.411\* | |
| 15 ≤ V < 30 | ≤ 0.037V + 2.200 | |
| 30 ≤ V < 50 | ≤ 0.056V + 1.635 | |
| 50 ≤ V | ≤ 0.060V + 1.416 | |
| **Solid-Door Reach-In Freezer** |  | |
| 0 < V < 15 | ≤ 0.250V + 1.250 | |
| 15 ≤ V < 30 | ≤ 0.400V – 1.000 | |
| 30 ≤ V < 50 | ≤ 0.163V + 6.125 | |
| 50 ≤ V | ≤ 0.158V + 6.333 | |
| **Glass-Door Reach-In Refrigerator** |  | |
| 0 < V < 15 | ≤ 0.118V + 1.382 | |
| 15 ≤ V < 30 | ≤ 0.140V + 1.050 | |
| 30 ≤ V < 50 | ≤ 0.088V + 2.625 | |
| 50 ≤ V | ≤ 0.110V + 1.500 | |
| **Glass-Door Reach-In Freezer** | |  |
| 0 < V < 15 | | ≤ 0.607V + 0.893 |
| 15 ≤ V < 30 | | ≤ 0.733V - 1.000 |
| 30 ≤ V < 50 | | ≤ 0.250V + 13.500 |
| 50 ≤ V | | ≤ 0.450V + 3.500 |

\*V is the internal volume in cubic feet.

Base case energy use requirements are taken from CEC Title 20 [B] and shown in Table 4.

Table 4 Base Case - CEC Title 20Requirements for Reach-In Refrigerators and Freezers

|  |  |
| --- | --- |
| **Equipment Description**  **(cubic feet)** | **Daily Energy Usage (kWh/day)** |
| Solid-Door Reach-In Refrigerator | ≤ 0.100V+2.04\* |
| Solid-Door Reach-In Freezer | ≤ 0.400V+1.38 |
| Glass-Door Reach-In Refrigerator | ≤ 0.120V+3.34 |
| Glass-Door Reach-In Freezer | ≤ 0.750V+4.10 |

\*V is the internal volume in cubic feet.

Table 5 Code Summary

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Dates |
| CEC Title 20 (2010) | 2010 Appliance Efficiency Regulations | January 1, 2011 to Present |
| ENERGY STAR 2.0 | Commercial Refrigerators and Freezers Program Requirements | January 1, 2010 to Present |
| U.S. DOE Code of Federal Regulations | 10 CFR 431.66 | January 1, 2010 to Present |

## 1.4 Measure Effective Useful Life

DEER 2011 documentation provides EUL and RUL information to be used for the 13-14 program cycle on [www.deeresources.com](http://www.deeresources.com). The DEER documentation “Summary of EUL-RUL Analysis for the April 2008 Update to DEER” provides the RUL value as a flat 1/3 of the EUL value. The RUL value will only be applied to the first baseline period for retrofit measures that have applicable code that will affect the energy savings. In all other installation types and retrofit with no applicable code that affects the energy savings, the RUL is not applicable to either the first or second baseline period.

To obtain the EUL value the DEER11 documentation, EUL\_Summary\_10-1-08.xls [213], was consulted. Table 6 below identifies the value/methodology used for the measures in this work paper.

Table 6 DEER08 EUL Value/Methodology

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Market | Enduse | Measure | EUL (Years) | RUL (Years) | EUL ID |
| Non-Residential | Refrigeration | Commercial Reach-In Refrigerator/Freezer | 12 | 4 | Cook-SDRef |

## 1.5 Net-to-Gross Ratios for Different Program Strategies

The NTG value was obtained from the “DEER2011\_NTGR\_2012-05-16.xls” on the DEER website as required by Version 4 of the California Public Utilities Commission (CPUC) Energy Efficiency Policy Manual [132]. The relevant NTGR for this measure is shown in Table 7 below.

Table 7 Net-to-Gross Ratio

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NTGR\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID | NTG\* |
| Com-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Com | Any | All | 0.6 |

\*Denotes that the column is taken from the DEER NTG Table.

The installation rate (IR) is identified in the calculation attachment. This value is obtained from a spreadsheet created by the DEER team titled ““GrossSavingsAdjustments.xlsx”. The installation rate varies by end use, sector, technology, application, and delivery method.

## Spillage rate will also be applied to measures however the values will not be tracked in the workpapers. The spillage rate will be tracked in an external table to be supplied to the Energy Division.

## 1.6 Time-of-Use Adjustment Factor

As directed by the CPUC in decision 06-06-063 dated June 29, 2006, time-of-use (TOU) adjustment factors are to be applied for residential A/C and commercial A/C (packaged and split-system direct-expansion cooling) measures only. Since this is not an A/C measure, the TOU adjustment factor is 0. Additionally, if a measure is assigned a DEER08 load shape, i.e. the load shape starts with “DEER:” the TOU assigned to that measure should also be zero.

Table 8 TOU Summary Table

|  |  |
| --- | --- |
| Measure | % |
| Reach-In Refrigerators and Freezers | 0 |

# Section 2. Energy Savings & Demand Reduction Calculations

## 2.1 Energy Savings Estimation Methodologies

The annual energy savings are summarized in Table 9 through Table 12. The nominal size and internal volume range are based on standard widths and each standard width may include multiple (French style) doors and/or multiple sections. The calculated annual energy usage was based on 365 days per year operation, and the daily energy consumption for typical units was determined by applying the ASHRAE Standard 72-2005 as shown in Table 3 and Table 4.

A sample calculation showing the daily and annual energy savings of a glass-door refrigerator is provided below.

**Glass-Door Reach-In Refrigerator with total volume less than 15 cubic feet (0 < V < 15 ft3):**

Volume (V) = 10 ft3

Measure Case Daily Energy Usage = 0.118 \* V + 1.382 (See Table 3)

= 0.118 \* 10 + 1.382

= 2.56 kWh / day

Measure Case Annual Energy Usage = (Daily Energy Usage) \* 365 days per year

= 2.56 kWh / day \* 365 days / year

= 934 kWh / year

Base Case Daily Energy Usage = 0.120 \* V + 3.34 (See Table 4)

= 0.120 \* 10 + 3.34

= 4.54 kWh / day

Base Case Annual Energy Usage = (Daily Energy Usage) \* 365 days per year

= 4.54 kWh / day \* 365 days / year

= 1657 kWh / year

Annual Energy Savings = Base Case Annual Usage – Measure Case Annual Usage

= 1657 – 934 kWh / year

= 723 kWh / year (see Table 11)

Complete calculation methodologies for both energy savings and demand reductions are in the calculation worksheet [C].

Table 9 through Table 12 below show the energy savings associated with commercial solid and glass reach-in refrigerators and freezers.

Table 9 Energy Savings for Commercial Solid-Door Reach-in Refrigerators

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Solid-Door Reach-In Freezers  (ENERGY STAR® Version 2.0)** | | | |
| **Description** | **Under- Counter** | **Single- Door** | **Double- Door** | **Triple- Door** |
| Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | < 15 | 15-29 | 30-49 | 49 < |
| Typical Volume Used in Energy Calculations (ft3) | 10 | 24 | 44 | 72 |
| Base Case Unit Daily Energy Use (kWh/day) | 3.04 | 4.44 | 6.44 | 9.24 |
| Measure Unit Daily Energy Use (kWh/day) | 2.30 | 3.09 | 4.10 | 5.74 |
| Base Case Unit Annual Energy Use (kWh/yr) | 1110 | 1621 | 2351 | 3373 |
| Measure Unit Annual Energy Use (kWh/yr) | 840 | 1127 | 1496 | 2094 |
| Annual Energy Savings (kWh/yr) | 270 | 493 | 854 | 1279 |

Table 10 Energy Savings for Commercial Solid-Door Reach-in Freezers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Solid-Door Reach-In Freezers  (ENERGY STAR® Version 2.0)** | | | |
| **Description** | **Under- Counter** | **Single- Door** | **Double- Door** | **Triple- Door** |
| Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | < 15 | 15-29 | 30-49 | 49 < |
| Typical Volume Used in Energy Calculations (ft3) | 10 | 24 | 44 | 72 |
| Base Case Unit Daily Energy Use (kWh/day) | 5.38 | 10.98 | 18.98 | 30.18 |
| Measure Unit Daily Energy Use (kWh/day) | 3.75 | 8.6 | 13.30 | 17.71 |
| Base Case Unit Annual Energy Use (kWh/yr) | 1964 | 4008 | 6928 | 11016 |
| Measure Unit Annual Energy Use (kWh/yr) | 1369 | 3139 | 4853 | 6464 |
| Annual Energy Savings (kWh/yr) | 595 | 869 | 2074 | 4552 |

Table 11 Energy Savings for Commercial Glass-Door Reach-in Refrigerators

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Glass-Door Reach-In Refrigerators  (ENERGY STAR® Version 2.0)** | | | |
| **Description** | **Under- Counter** | **Single- Door** | **Double- Door** | **Triple- Door** |
| Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | < 15 | 15-29 | 30-49 | 49 < |
| Typical Volume Used in Energy Calculations (ft3) | 10 | 24 | 44 | 72 |
| Base Case Unit Daily Energy Use (kWh/day) | 4.54 | 6.22 | 8.62 | 11.98 |
| Measure Unit Daily Energy Use (kWh/day) | 2.56 | 4.41 | 6.50 | 9.42 |
| Base Case Unit Annual Energy Use (kWh/yr) | 1657 | 2270 | 3146 | 4373 |
| Measure Unit Annual Energy Use (kWh/yr) | 934 | 1610 | 2371 | 3438 |
| Annual Energy Savings (kWh/yr) | 723 | 661 | 775 | 934 |

Table 12 Energy Savings for Commercial Glass-Door Reach-in Freezers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Glass-Door Reach-In Freezers** **(ENERGY STAR® Version 2.0)** | | | |
| **Description** | **Under- Counter** | **Single- Door** | **Double- Door** | **Triple- Door** |
| Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | < 15 | 15-29 | 30-49 | 49 < |
| Typical Volume Used in Energy Calculations (ft3) | 10 | 24 | 44 | 72 |
| Base Case Unit Daily Energy Use (kWh/day) | 11.6 | 22.1 | 37.1 | 58.1 |
| Measure Unit Daily Energy Use (kWh/day) | 6.96 | 16.59 | 24.50 | 35.90 |
| Base Case Unit Annual Energy Use (kWh/yr) | 4234 | 8067 | 13542 | 21207 |
| Measure Unit Annual Energy Use (kWh/yr) | 2541 | 6056 | 8943 | 13104 |
| Annual Energy Savings (kWh/yr) | 1693 | 2010 | 4599 | 8103 |

## 2.2. Demand Reduction Estimation Methodologies

The demand reduction estimations are obtained by dividing the daily energy usage (Table 9 through Table 12) by 24 hours, as the units are plugged in 24/7.

The demand reduction estimation is summarized in Table 13 through Table 16.

A sample calculation showing the peak demand reduction associate with a glass-door reach-in refrigerator for the 2013-2014 program years is provided below.

**Glass-Door Reach-In Refrigerator with total volume less than 15 cubic feet (0 < V < 15 ft3):**

Volume (V) = 10 ft3

Measure Case Peak Demand Reduction = Measure Daily Energy Usage / 24 hrs

= 2.56 / 24

= 0.107 kW

Base Case Peak Demand Reduction = Base Daily Energy Usage / 24 hrs

= 4.54 / 24

= 0.189 kW

Demand Reduction Savings = (Base Reduction – Measure Reduction)

= 0.189 kW – 0.107 kW

= 0.083 kW

Peak Demand Reduction Savings = Reduction Savings \* 0.9

= 0.083 \*0.9

= 0.074 kW

A multiplier of 0.9 is used to conservatively estimate the peak demand reduction during the DEER peak period for the particular climate zone.

Table 13 through Table 16 show the demand reductions associated with commercial glass and solid door reach-in refrigerators and freezers.

Table 13 Demand Reduction for Commercial Solid-Door Reach-in Refrigerators

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Solid-Door Reach-In Refrigerators  (ENERGY STAR® Version 2.0)** | | | |
| **Description** | **Under- Counter** | **Single- Door** | **Double- Door** | **Triple- Door** |
| Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | < 15 | 15-29 | 30-49 | 49 < |
| Typical Volume Used in Energy Calculations (ft3) | 10 | 24 | 44 | 72 |
| Base Case Unit Demand (kW) | 0.127 | 0.185 | 0.268 | 0.385 |
| Measure Unit Demand (kW) | 0.096 | 0.129 | 0.171 | 0.239 |
| Demand Reduction (kW) | 0.031 | 0.056 | 0.098 | 0.146 |
| Peak Demand Reduction (kW) | 0.028 | 0.051 | 0.088 | 0.131 |

Table 14 Demand reduction for Commercial Solid-Door Reach-in Freezers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Solid-Door Reach-In Freezers  (ENERGY STAR® Version 2.0)** | | | |
| **Description** | **Under- Counter** | **Single- Door** | **Double- Door** | **Triple- Door** |
| Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | < 15 | 15-29 | 30-49 | 49 < |
| Typical Volume Used in Energy Calculations (ft3) | 10 | 24 | 44 | 72 |
| Base Case Unit Demand (kW) | 0.224 | 0.458 | 0.791 | 1.258 |
| Measure Unit Demand (kW) | 0.156 | 0.358 | 0.554 | 0.738 |
| Demand Reduction (kW) | 0.068 | 0.099 | 0.237 | 0.520 |
| Peak Demand Reduction (kW) | 0.061 | 0.089 | 0.213 | 0.468 |

Table 15 Demand reductions for Commercial Glass-Door Reach-in Refrigerators

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Glass-Door Reach-In Refrigerators  (ENERGY STAR® Version 2.0)** | | | |
| **Description** | **Under- Counter** | **Single- Door** | **Double- Door** | **Triple- Door** |
| Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | < 15 | 15-29 | 30-49 | 49 < |
| Typical Volume Used in Energy Calculations (ft3) | 10 | 24 | 44 | 72 |
| Base Case Unit Demand (kW) | 0.189 | 0.259 | 0.359 | 0.499 |
| Measure Unit Demand (kW) | 0.107 | 0.184 | 0.271 | 0.393 |
| Demand Reduction (kW) | 0.083 | 0.075 | 0.088 | 0.107 |
| Peak Demand Reduction (kW) | 0.074 | 0.068 | 0.079 | 0.096 |

Table 16 Demand reductions for Commercial Glass-Door Reach-in Freezers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Glass-Door Reach-In Freezers  (ENERGY STAR® Version 2.0)** | | | |
| **Description** | **Under- Counter** | **Single- Door** | **Double- Door** | **Triple- Door** |
| Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | < 15 | 15-29 | 30-49 | 49 < |
| Typical Volume Used in Energy Calculations (ft3) | 10 | 24 | 44 | 72 |
| Base Case Unit Demand (kW) | 0.483 | 0.921 | 1.546 | 2.421 |
| Measure Unit Demand (kW) | 0.290 | 0.691 | 1.021 | 1.496 |
| Demand Reduction (kW) | 0.193 | 0.230 | 0.525 | 0.925 |
| Peak Demand Reduction (kW) | 0.174 | 0.207 | 0.473 | 0.833 |

Please note that for all RET measures in this work paper, the savings have been mapped to the savings associated with ROB measures. The current market for existing reach-in refrigerators is unknown, so the savings are based on above code required equipment until further research can identify the current market mix of existing equipment. Once this information is known, the work paper will be updated to incorporate the true baseline found from market research.

# Section 3. Load Shapes

The difference between the base case load shape and the measure load shape would be the most appropriate load shape; however, only end-use profiles are available. Therefore, the closest load shape chosen for this measure is the Refrigeration load shape. See Table 17 for a list of all Building Types and Load Shapes. See the KEMA report [31] for a more thorough discussion regarding the load shapes for this measure.

Table 17 Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| Building Type | E3 Alt. Building Type | Load Shape |
| Agricultural | Agricultural | Refrigeration |
| Assembly | Assembly | Refrigeration |
| Education - Primary School | K\_thru\_12\_School | Refrigeration |
| Education - Secondary School | K\_thru\_12\_School | Refrigeration |
| Education - Relocatable Classroom | K\_thru\_12\_School | Refrigeration |
| Education - Community College | College\_University | Refrigeration |
| Education - University | College\_University | Refrigeration |
| Grocery | Grocery\_Store | Refrigeration |
| Food Store | Food\_Store | Refrigeration |
| Health/Medical - Hospital | Hospital | Refrigeration |
| Health/Medical - Nursing Home | Medical\_Clinic | Refrigeration |
| Health/Medical - Clinic | Medical\_Clinic | Refrigeration |
| Lodging - Hotel | Hotel\_Motel | Refrigeration |
| Lodging - Guest Rooms | Hotel\_Motel | Refrigeration |
| Lodging - Motel | Hotel\_Motel | Refrigeration |
| Manufacturing - Bio/Tech | Industrial | Refrigeration |
| Manufacturing - Light Industrial | Industrial | Refrigeration |
| Industrial | Industrial | Refrigeration |
| Misc - Commercial | Misc.\_Commercial | Refrigeration |
| Office – Large | Large\_Office | Refrigeration |
| Office – Small | Small\_Office | Refrigeration |
| Restaurant - Fast-Food | Fast\_Food\_Restaurant | Refrigeration |
| Restaurant - Sit-Down | Sit\_Down\_Restaurant | Refrigeration |
| Retail - Multistory Large | Large\_Retail\_Store | Refrigeration |
| Retail – Single-Story Large | Large\_Retail\_Store | Refrigeration |
| Retail – Small | Small\_Retail\_Store | Refrigeration |
| Storage - Conditioned | Storage\_Building | Refrigeration |
| Storage - Unconditioned | Storage\_Building | Refrigeration |
| Transportation - Communication – Utilities | Trans\_Comm\_Util | Refrigeration |
| Warehouse - Refrigerated | Refrigerated\_Warehouse | Refrigeration |

# Section 4. Base Case & Measure Costs

## 4.1 Base Case Cost

There is no additional labor or maintenance cost when comparing the measure to the base case for solid and glass door reach-in refrigerators and solid door reach-in freezers. The cost includes both material and labor, and applies to ROB and RET installations, which expects to have the same cost for all customers. The estimated equipment cost is based on manufacturer list prices and applying an industry-standard 44% discount to the published list prices [D]. The base case cost can be symbolically written as:

Base Case Cost = Base Case Equipment Cost + Base Case Installation Cost

The purchase prices for the Base Case solid- and glass-door, reach-in refrigerators and freezers are listed in Table 18.

Table 18 Base Case Refrigerator and Freezer Costs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Typical Appliance Description** | **Under-Counter** | **Single-Door** | **Double-Door** | **Triple-Door** |
| Typical Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | 0 < V < 15 | 15 ≤ V < 30 | 30 ≤ V < 50 | 50 ≤ V |
| Solid-Door Reach-In Refrigerators | $ 1,284.00 | $ 2,883.15 | $ 3,802.03 | $ 4,526.32 |
| Solid-Door Reach-In Freezers | $ 773.84 | $ 3,467.04 | $ 5,151.16 | $ 7,469.68 |
| Glass-Door Reach-In Refrigerators | $ 1,270.00  1,410.50 | $ 3,340.20 | $ 4,788.00 | $ 6,915.84 |
| Glass-Door Reach-In Freezers  (Energy Star 1.0)\*\* | $ 1,281.20 | $ 5,212.19 | $ 7,401.52 | $ 10,304.40 |

## 

## 4.2 Gross Measure Cost

The Measure costs include equipment and labor, as explained in Section 4.1. The estimated equipment cost is based on recent list cost data and applying an industry-standard 44% discount to the manufacturer published list prices [D]. The Measure Cost is symbolically written as:

Measure Cost = Measure Equipment Cost + Measure Installation Cost

Table 19 summarizes the purchase price for the Measure solid- and glass-door, reach-in refrigerators and freezers. Solid-door refrigerator and freezers purchase price are shown in Table 19.

Table 19 Measure Refrigerator and Freezer Costs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Typical Appliance Description** | **Under-Counter** | **Single-Door** | **Double-Door** | **Triple-Door** |
| Typical Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | 0 < V < 15 | 15 ≤ V < 30 | 30 ≤ V < 50 | 50 ≤ V |
| Solid-Door Reach-In Refrigerators (Energy Star 2.0) | $ 2,376.00 | $ 4,293.88 | $ 5,770.73 | $ 7,249.60 |
| Solid-Door Reach-In Freezers (Energy Star 2.0) | $ 1,031.44 | $ 4,830.22 | $ 6,707.87 | $ 9,437.71 |
| Glass-Door Reach-In Refrigerators (Energy Star 2.0) | $ 1,373.60 | $ 4,204.00 | $ 5,864.11 | $ 8,464.80 |
| Glass-Door Reach-In Freezers (Energy Star 2.0) | $ 1,306.68 | $ 5,336.22 | $ 7,615.72 | $ 11,203.70 |

## 4.3 Incremental Measure Cost

For ROB measures, DEER defines Full Measure Cost as the sum of the equipment measure cost and the labor cost to install the measure. The CPUC Standard Practice Manual recognizes additional costs that may be included in the TRC calculations such as annual maintenance costs [F]. However, in keeping with the DEER, this work paper adopts its minimalist definition. The Full Measure cost can be symbolically written as:

Full Measure Cost = Measure Equipment Cost + Measure Installation Labor Cost

The Incremental Measure Cost is the difference between the Full Measure Cost and the Full Base Case Cost and it can be symbolically written as:

Incremental Measure Cost = Full Measure Cost – Full Base Case Cost

Given that the installation labor cost is expected to be the same for the Measure and Base Case, the Incremental Measure Cost can be rewritten as:

Incremental Measure Cost = Measure Equipment Cost – Base Case Equipment Cost

Note that DEER climate zone dependent costs are not applied to the base costs shown in this summary table. The DEER climate zone multipliers are used in the Calculations [C].

The table below summarizes the Incremental Measure cost for the solid- and glass-door, reach-in refrigerators and freezers claimed as ROB. Note that DEER climate zone dependent costs are not applied to the base costs shown in this summary table. The DEER climate zone multipliers are used in the Cost Analysis section of the Calculations [C].

Table 20 Incremental Measure Refrigerator and Freezer Costs for ROB

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Description** | **Under-Counter** | **Single-Door** | **Double-Door** | **Triple-Door** |
| Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | 0 < V < 15 | 15 ≤ V < 30 | 30 ≤ V < 50 | 50 ≤ V |
| Solid-Door Reach-In Refrigerators Incremental Cost | $ 1,092.00 | $ 1,410.73 | $ 1,968.70 | $ 2,723.28 |
| Solid-Door Reach-In Freezers Incremental Cost | $ 257.60 | $ 1,363.18 | $ 1,556.71 | $ 1,968.03 |
| Glass-Door Reach-In Refrigerators Incremental Cost | $ 103.60 | $ 863.80 | $ 1,076.11 | $ 1,548.96 |
| Glass-Door Reach-In Freezers Incremental Cost | $ 25.48 | $ 124.04 | $ 214.20 | $ 899.30 |

For the RET measures, the incremental cost is represented by the equation below:

IMC = (Measure Equipment Cost + Measure Labor Cost) –

(Base Case Equipment Cost + Base Case Labor Cost)

\*Note: Unless stated otherwise the measure case labor and base case labor are assumed to be the same value reducing the equation to the following:

*IMC = Measure Equipment Cost – Base Case Equipment Cost*

Table 20 below gives the incremental cost for solid- and glass-door, reach-in refrigerators and freezers claimed as RET. Note that DEER climate zone dependent costs are not applied to the base costs shown in this summary table. The DEER climate zone multipliers are used in the Cost Analysis section of the Calculations [C].

Table 21 Incremental Measure Refrigerator and Freezer Costs for RET

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Description** | **Under-Counter** | **Single-Door** | **Double-Door** | **Triple-Door** |
| Nominal Size | 1 door | 1 door | 2 doors | 3 doors |
| Nominal Volume Range (ft3) | 0 < V < 15 | 15 ≤ V < 30 | 30 ≤ V < 50 | 50 ≤ V |
| Solid-Door Reach-In Refrigerators Incremental Cost | N/A | N/A | N/A | N/A |
| Solid-Door Reach-In Freezers Incremental Cost | N/A | N/A | N/A | N/A |
| Glass-Door Reach-In Refrigerators Incremental Cost | $ 103.60 | $ 863.80 | $ 1,076.11 | $ 1,548.96 |
| Glass-Door Reach-In Freezers Incremental Cost | N/A | N/A | N/A | N/A |

# References



[31]

[132]

[208]

[213]

[A] Attachment 2-Energy Star 2.0 Requirements

[B] California Energy Commission. (2012). 2012 Appliance Efficiency Regulations.

[C] Attachment 1-Reach-In Refrigerator and Freezer Calculations

[D] Attachment 3-Cost Calculation References

[E] Attachment 4-Reach-In Savings Calculations

[F] CPUC California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects, page 18. California Public Utilities Commission, October 2001.