**Work Paper SCE13CC007**

**Revision 1**

**Southern California Edison Company**

**Commercial Ice Machines**

# At-a-Glance Summary

|  |  |
| --- | --- |
| ****Applicable Measure Codes:**** | FS-29492, FS-34026, FS-46758, FS-15494, FS-93521 |
| **Measure Description:** | High efficiency commercial ice machine |
| **Base Case Description:** | Standard efficiency commercial ice machine |
| **Energy Impact Common Units:** | Unit |
| **Energy Savings :** | Refer to Excel Calculation Attachment |
| **Gross Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Measure Incremental Cost ($/unit):** | Refer to Excel Calculation Attachment |
| **Effective Useful Life (years):** | Cook-IceMach: 10 years |
| **Measure Application Type:** | Replace on Burnout (ROB) |
| **Net-to-Gross Ratios:** | Com Default >2 yrs: 0.6  Ind Default >2 yrs: 0.6  Agric Default >2 yrs: 0.6 |
| **Important Comments:** | This work paper document does not contain a data set in conformance with the 4/1/14 CPUC Ex Ante Database Specification; SCE will provide that data set separately. |

# Document Revision History

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Workpaper and Revision # | Tech. Revision | MM/DD/YY | Author/Affiliation | Summary of Changes |
| 0 | No | 6/3/2012 | Ricson Chude/SCE | Updates from WPSCNRCC002.2:   * Updated NTG values to DEER 2011 * Removed Energy Star and CEE criteria. * Consolidated 101-200 lb with200-300 lb, and with 301-400lb with 401-500lb ice machines * Savings based on PGECOFST108 R3 |
| 1 | No | 6/5/2014 | Ricson Chude/SCE | -Work paper updated for the reporting period, effective 7/1/14 – 12/31/14.  -All non-residential building types are included.  -All climate zones are included.  -Savings based on PGECOFST108 R4 |

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

The measure case is a high efficiency air-cooled commercial ice machine (icemaker). The base case is a standard efficiency air-cooled commercial ice machine.

Table 1 shows the measures in this work paper.

Table 1 Measure Names

|  |  |
| --- | --- |
| Solution Code | Measure name |
| FS-29492 | Commercial Ice Machines IHR 101-300 |
| FS-34026 | Commercial Ice Machines IHR 301-500 |
| FS-46758 | Commercial Ice Machines IHR 501-1,000 |
| FS-15494 | Commercial Ice Machines IHR 1,001-1,500 |
| FS-93521 | Commercial Ice Machines IHR > 1,500 |

**Eligibility Requirements**

* Only new or replacement energy efficient air-cooled ice machines are eligible; used and rebuilt equipment are not.
* Only air-cooled machines (ice-making heads, self-contained units, or remote-condensing units) are eligible. Remote machines must be purchased with a qualifying remote condenser or remote condenser/compressor unit.
* The machine must make cubed (60 grams or 2 oz, or less), flaked, crushed, or fragmented ice.
* Eligible systems must have been tested in accordance with the Air-Conditioning and Refrigeration Institute (ARI) Standard 810 [151]. The entire system must be purchased.
* Eligible models are listed on the Food Service Technology Center qualified products list.
* Customers must provide proof that the ice machine meets the energy efficiency specifications listed in Table 2.

Table 2 Efficiency Requirements for Commercial Ice Machines

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment Type | Ice Harvest Rate  (lbs ice/day) | Energy Use Limit  (kWh/100 lbs ice) | Potable Water Use Limit (gal/100 lbs ice) |
| Ice Maker Head (IMH) | < 450 | 8.72 – 0.0073 × H\* | ≤ 20 |
| ≥ 450 | 5.86 – 0.0009 × H | ≤ 20 |
| Remote Condensing Unit (RCU) without remote compressor | < 1,000 | 7.52 – 0.0032 × H | ≤ 20 |
| ≥ 1,000 | 4.34 | ≤ 20 |
| Remote Condensing Unit (RCU) with remote compressor | < 934 | 7.52 – 0.0032 × H | ≤ 20 |
| ≥ 934 | 4.51 | ≤ 20 |
| Self-Contained Unit (SCU) | < 175 | 15.3 – 0.0399 × H | ≤ 30 |
| ≥ 175 | 8.33 | ≤ 30 |

\*H = Ice Harvest Rate (IHR) for the commercial ice machine as determined by applying ARI Standard 810.

## 1.2 Technical Description

Commercial icemakers represent approximately 11 percent of all commercial refrigeration energy use, and the average annual energy use of a 500 lb/day air-cooled icemaker is 5,000 kWh. Icemakers use a substantial amount of energy in order to freeze water and maintain the ice as separate cubes. The energy use in a commercial icemaker varies from product to product, depending on the condenser and the type of ice produced. Options for reducing energy consumption include high efficiency motors in condenser fans and compressors, thicker insulation, and reduced evaporator thermal cycling. Approximately 64 percent of the commercial ice machine market is self-contained cube making units; the rest are ice making heads and remote condensing units [128].

In an analysis of the range of products currently on the market, American Council for an Energy-Efficient Economy (ACEEE) research indicated that the highest performing models on the market are 18.46 percent more efficient than the worst performing models, with a payback period of 1.1 years or less [152].

## 1.3 Measure Application Type

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

The install type is ROB (Replace on Burnout).

## 1.4 Measure and Base Case Cost Effectiveness Data

### 1.4.1 DEER Measure and Base Case Analysis

Table 3 DEER Difference Summary

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

**Net to Gross**

The NTG value was obtained from the “DEER2011\_NTGR\_2012-05-16.xls” on the DEER website as required by Version 5 of the California Public Utilities Commission (CPUC) Energy Efficiency Policy Manual [351]. The relevant NTGR for this measure is shown in Table 4 below.

Table 4 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 | Any | 0.6 |
| Ind-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Ind | Any | Any | 0.6 |
| Agric-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Ag | Any | Any | 0.6 |

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

**Installation Rate**

The installation rate (IR) is identified in the calculation attachment. This value is obtained from the support table available in READi. Currently there is no versioning on the installation rate table. To address appropriate selection of the installation rate the date of the workpaper will serve as the last date checked for updated IR values. The installation rate varies by end use, sector, technology, application, and delivery method. The relevant IR values for this measure are shown in Table 5 below.

Table 5 Installation Rate

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| GSIA\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID | GSIAValue\* |
| Def-GSIA | Default GSIA values | Any | Any | Any | 1.0 |

**Spillage Rate**

Spillage rate will also be applied to the 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.

**READi Technology Fields**

Table 6 READi Tech IDs

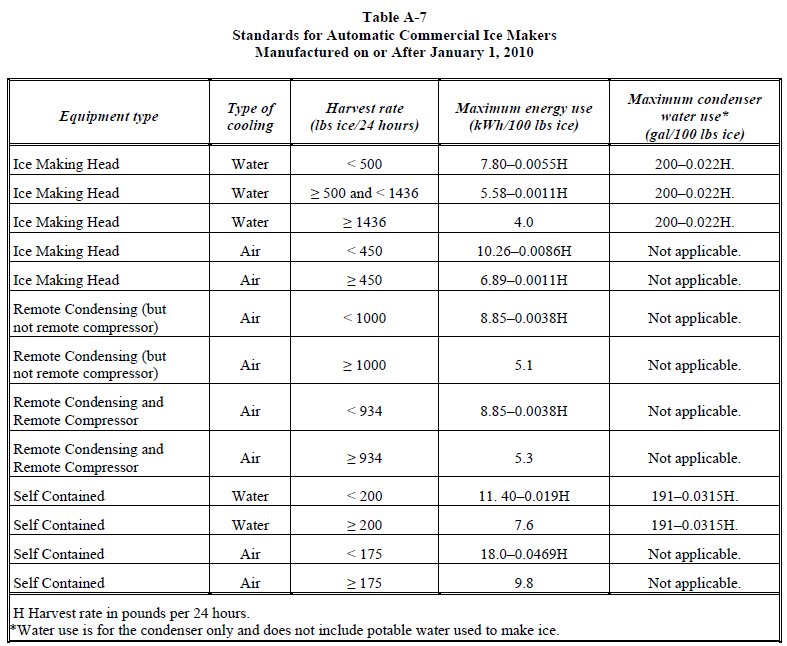
|  |  |
| --- | --- |
| READi Field Name | Values included in this workpaper |
| Measure Case UseCategory | Food Service |
| Measure Case UseSubCats | Non-DEER |
| Measure Case TechGroups | Food Service Equipment |
| Measure Case TechTypes | Non-DEER |
| Base Case TechGroups | Food Service Equipment |
| Base Case TechTypes | Non-DEER |

### 1.4.2 Codes and Standards Analysis

Table 7 Code Summary

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Dates |
| Title 20 (2014) | 1605.1 Table A-7 | July 1, 2014 |

Title 20 2014 [422] provides efficiency requirements for Automatic Commercial Ice Makers manufactured on or after January 1, 2010, in Section 1605.1 Table A-7:



ARI Standard 810, Performance Rating of Automatic Commercial Ice-Makers, is considered the industry standard for estimating commercial ice machine energy use. ARI test data were used to estimate the energy consumption of the base case and measure equipment.

Ice machine measures do not fall under Title 24 standards or Federal DOE or EPA Energy Regulations.

### 1.4.3 Non-DEER Study Review

The following non-DEER studies were referenced in this work paper:

* Energy Savings Potential for Commercial Refrigeration Equipment [128]
* Packaged Commercial Refrigeration Equipment: A Briefing Report For Program Planners And Implementers [152]

### 1.4.4 Measure and Base Case Effective Useful Life

DEER14 update documentation provides EUL and RUL information to be used for the 2015 program cycle extension on [www.deeresources.com](http://www.deeresources.com). The DEER documentation “DEER2014-EUL-table-update\_2014-02-05.xlsx” 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 DEER14 update documentation, “DEER2014-EUL-table-update\_2014-02-05.xlsx” [436], was consulted. Table 7 below identifies the value/methodology used for the measures in this work paper.

Table 7 DEER14 EUL Value/Methodology

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| READi EUL ID | Market | Enduse | Measure | EUL (Years) | RUL (Years) |
| Cook-IceMach | Non-Residential | Equipment | Ice Machine | 10 | N/A |

# Section 2. Energy Savings & Demand Reduction Calculations

The industry standard for energy use and performance of commercial ice machines is ARI Standard 810. Table 8 lists shows the estimated savings from the replacement of a standard ice machine with a high efficiency ice machine, based on ARI test data performance equations as found in Table 9 and Table 10.

Table 8 Energy Efficient Commercial Air-Cooled Ice Machine Energy Savings

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure:** | **FS-29492** | **FS-34026** | **FS-46758** | **FS-15494** | **FS-93521** |
| Equipment Type: | SCU | IMH | IMH | RCU w/o Remote Condenser | RCU w/o Remote Condenser1 |
| Ice Harvest Rate (IHR) (lbs per 24 hrs) | 101-300 | 301-500 | 501-1,000 | 1,001-1,500 | > 1,500 |
| Average IHR Used in  Energy Calculations (lbs/day) | 200 | 400 | 750 | 1,250 | 1,750 |
| Baseline Model  Energy Usage (kWh/100 lbs) | 9.80 | 6.82 | 6.07 | 5.10 | 5.10 |
| Energy Efficient Model  Energy Usage (kWh/100 lbs) | 8.33 | 5.80 | 5.19 | 4.34 | 4.34 |
| Baseline Model  Daily Energy Consumption (kWh) | 14.7 | 20.5 | 34.1 | 47.8 | 66.9 |
| Energy Efficient Model  Daily Energy Consumption (kWh) | 12.5 | 17.4 | 29.2 | 40.7 | 57.0 |
| Baseline Model  Average Demand (kW) | 0.613 | 0.853 | 1.421 | 1.992 | 2.789 |
| Energy Efficient Model  Average Demand (kW) | 0.521 | 0.725 | 1.215 | 1.695 | 2.373 |
| Estimated Demand Reduction (kW) | 0.092 | 0.128 | 0.206 | 0.297 | 0.416 |
| **Demand Savings (kW)** | **0.083** | **0.115** | **0.186** | **0.267** | **0.374** |
| Baseline Model Annual  Energy Consumption (kWh/yr) | 5,366 | 7,468 | 12,452 | 17,452 | 24,432 |
| Energy Efficient Model Annual  Energy Consumption (kWh/yr) | 4,561 | 6,351 | 10,645 | 14,851 | 20,791 |
| **Estimated Annual  Energy Savings (kWh/yr)** | **805** | **1,117** | **1,807** | **2,601** | **3,641** |

## 1 Based on savings of RCU without remote compressor.

## Table 9 and Table 10 show performance equations used for each commercial ice machine baseline and measure case based on the Ice Harvest Rate (IHR).

Table 9 Base Case Ice Machine Performance Equations

|  |  |  |
| --- | --- | --- |
| Equipment Type | Ice Harvest Rate  (lbs ice/day) | Energy Use Limit  (kWh/100 lbs ice) |
| Ice Maker Head (IMH) | < 450 | 10.26 – 0.0086 × H\* |
| ≥ 450 | 6.89 – 0.0011 × H |
| Remote Condensing Unit (RCU) without remote compressor | < 1,000 | 8.85 – 0.0038 × H |
| ≥ 1,000 | 5.10 |
| Remote Condensing Unit (RCU) with remote compressor | < 934 | 8.85 – 0.0038 × H |
| ≥ 934 | 5.30 |
| Self-Contained Unit (SCU) | < 175 | 18.0 – 0.0469 × H |
| ≥ 175 | 9.80 |

\*H = Harvest Rate (lbs ice/day)

Table 10 Measure Case Ice Machine Performance Equations

|  |  |  |
| --- | --- | --- |
| Equipment Type | Ice Harvest Rate  (lbs ice/day) | Energy Use Limit  (kWh/100 lbs ice) |
| Ice Maker Head (IMH) | < 450 | 8.72 – 0.0073 × H |
| ≥ 450 | 5.86 – 0.0009 × H |
| Remote Condensing Unit (RCU) without remote compressor | < 1,000 | 7.52 – 0.0032 × H |
| ≥ 1,000 | 4.34 |
| Remote Condensing Unit (RCU) with remote compressor | < 934 | 7.52 – 0.0032 × H |
| ≥ 934 | 4.51 |
| Self-Contained Unit (SCU) | < 175 | 15.3 – 0.0399 × H |
| ≥ 175 | 8.33 |

## Sample Energy Savings Calculation for a Self-Contained Unit with IHR of 200 lbs/day

## From Table 9,

## *Base Case Energy Use Limit = 9.80 kWh/100 lbs ice*

## *Measure Case Energy Use Limit = 8.33 kWh/100 lbs ice*

Daily energy consumption based on the individual machines operating at 75% of their rated maximum capacity is calculated as follows:

*EDay = Energy Use Limit \* 0.75 \* IHR / 100*

Annual energy savings are calculated as follows:

*kWh savings = ∆EDay \* 365 days/yr*

*= (9.80 – 8.33 kWh/100 lbs ice) \* 0.75 \* (200 lb/day) / 100 \* (365 days/yr)*

*= 805 kWh/year*

## Sample Demand Reduction Calculation for a Self-Contained Unit with IHR of 200 lbs/day

From Table 8, the demand reduction is:

*kW reduction = (0.613 – 0.521 kW) \* 0.9*

*= 0.083 kW*

A DEER coincidence factor of 0.9 is applied.

A full list of savings is in Attachment 1. Savings calculations are in Attachment 2.

# 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 11 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 11 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

## High efficiency ice machines typically list for more than standard efficiency ice machines. However, high efficiency designs are often bundled with other features such as all stainless steel construction and high quality components and controls.

## 4.1 Base Case Cost

Base case costs are calculated by applying an industry-standard 50% discount to manufacturer published list prices. It is assumed that the labor cost is the same in base and measure cases, so only equipment costs are presented here.

Equipment prices for this work paper were compiled from a number of sources including quotes, equipment sales representatives, and manufacturer sources. Since equipment pricing in food service is closely held information and prices vary widely according to buying volume and other factors, the sources for prices cannot be listed explicitly.

## 4.2 Measure Case Cost

Measure case costs are calculated by applying an industry-standard 50% discount to manufacturer published list prices.

## 4.3 Gross Measure Cost

For ROB measures, assuming the labor cost is the same in base and measure cases, the gross measure cost is determined using the following equation:

*Gross Measure Cost = Measure Case Material Cost – Base Case Material Cost*

Table 12 shows the calculation of gross measure cost:

Table 12 Gross and Incremental Cost Data for Energy Efficient Ice Machines

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Measure: | FS-29492 | FS-34026 | FS-46758 | FS-15494 | FS-93521 |
| Ice Harvest Rate (IHR) (lbs per 24 hrs.) | 101-300 | 301-500 | 501-1,000 | 1,001-1,500 | > 1,500 |
| Energy Efficient Average List Price | $ 5,549 | $ 5,346 | $ 9,121 | $ 9,375 | $ 16,259 |
| Baseline Average List Price | $ 4,927 | $ 4,814 | $ 8,624 | $ 8,197 | $ 14,382 |
| Energy Efficient Average Cost (50% of List Price) | $ 2,769 | $ 2,674 | $ 4,561 | $ 4,687 | $ 8,130 |
| Baseline Average Cost (50% of List Price) | $ 2,464 | $ 2,407 | $ 4,312 | $ 4,098 | $ 7,191 |
| **Gross and Incremental Measure Cost** | **$ 305** | **$ 267** | **$ 249** | **$ 589** | **$ 939** |

## 4.4 Incremental Measure Cost

The incremental cost is the same as the gross measure cost and is shown in Table 12.

# Attachments

1. 
2. 

# References



|  |  |
| --- | --- |
| [31] | Load Shape Update Initiative - KEMA / JJ Hirsch and Assoc. / Itron Inc. - November 17, 2006 |
| [128] | Energy Savings Potential for Commercial Refrigeration Equipment |
| [151] | ARI Standard 810: Performance Rating of Automatic Commercial Ice-Makers |
| [152] | Packaged Commercial Refrigeration Equipment: A Briefing Report For Program Planners And Implementers |
| [422] | 2014 Appliance Efficiency Regulations (Title 20) |
| [436] | 2014 DEER EUL Table - Update |

# Appendix B – SCE/ED Application Types

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SCE Program Type | ED Application Type | 1st Baseline Savings | 2nd Baseline Savings | 1st Baseline Cost | 2nd Baseline Cost | 1st Baseline Life | 2nd Baseline Life |
| New | New Construction (Nc) | Above Code/Standard | N/A | Incremental Cost | N/A | EUL | 0 |
| Replace on Burnout (ROB) | Replace on Burnout (Rob)/Normal Replacement (NR) | Above Code/Standard | N/A | Incremental Cost | N/A | EUL | 0 |
| Retrofit (RET) | Early Replacement (ER) | Above Cust. Existing | Above Code/Standard | Full Cost | Incremental Cost | RUL | EUL-RUL |
| Retrofit – First Baseline Only (REF) | Early Replacement RUL (ErRul) | Above Cust. Existing | N/A | Full Cost | N/A | EUL | 0 |
| Retrofit Add-on (REA) | N/A | Above Cust. Existing | N/A | Full Cost | N/A | EUL | 0 |