**Work Paper PGECOFST108**

**Commercial Ice Machines**

**Revision # 4**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**Commercial Ice Machines**

**Measure Codes F200, F201, F202, F203, F204**

# At-a-Glance Summary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Applicable Measure Codes:** | **F200** | **F201** | **F202** | **F203** | **F204** |
| **Measure Description:** | Commercial Ice Machines 101-300lbs/day | Commercial Ice Machines 301-500lbs/day | Commercial Ice Machines 501-1000lbs/day | Commercial Ice Machines 1001-1500lbs/day | Commercial Ice Machines >1501lbs/day |
| **Energy Impact Common Units:** | Ice Machine | Ice Machine | Ice Machine | Ice Machine | Ice Machine |
| **Base Case Description:** | Source: PG&E Calculations, Commercial Ice Machine 101-300lbs/day | Source: PG&E Calculations, Commercial Ice Machine 301-500lbs/day | Source: PG&E Calculations, Commercial Ice Machine 501-1000lbs/day | Source: PG&E Calculations, Commercial Ice Machine 1001-1500lbs/day | Source: PG&E Calculations, Commercial Ice Machine >1501lbs/day |
| **Base Case Energy Consumption:** | Source: PG&E Calculations.  5,366 kWh/yr | Source: PG&E Calculations.  7,468 kWh/yr | Source: PG&E Calculations.  12,452 kWh/yr | Source: PG&E Calculations.  17,452 kWh/yr | Source: PG&E Calculations.  24,432 kWh/yr |
| **Measure Energy Consumption:** | Source: PG&E Calculations.  4,561 kWh/yr | Source: PG&E Calculations.  6,351 kWh/yr | Source: PG&E Calculations.  10,645 kWh/yr | Source: PG&E Calculations.  14,851 kWh/yr | Source: PG&E Calculations.  20,791 kWh/yr |
| **Energy Savings**  **(Base Case – Measure):** | Source: PG&E Calculations.  805 kWh/yr | Source: PG&E Calculations.  1,117 kWh/yr | Source: PG&E Calculations.  1,807 kWh/yr | Source: PG&E Calculations.  2,601 kWh/yr | Source: PG&E Calculations.  3,641 kWh/yr |
| **Costs Common Units:** | Ice Machine | Ice Machine | Ice Machine | Ice Machine | Ice Machine |
| **Base Case Equipment Cost ($/unit):** | Source: PG&E Calculations.  $2464 | Source: PG&E Calculations.  $2407 | Source: PG&E Calculations.  $4312 | Source: PG&E Calculations.  $4098 | Source: PG&E Calculations.  $7191 |
| **Measure Equipment Cost ($/unit):** | Source: PG&E Calculations.  $2769 | Source: PG&E Calculations.  $2674 | Source: PG&E Calculations.  $4561 | Source: PG&E Calculations.  $4687 | Source: PG&E Calculations.  $8130 |
| **Gross Measure Cost ($/unit)** | Source: PG&E Calculations.  $2769 | Source: PG&E Calculations.  $2674 | Source: PG&E Calculations.  $4561 | Source: PG&E Calculations.  $4687 | Source: PG&E Calculations.  $8130 |
| **Measure Incremental Cost ($/unit):** | Source: PG&E Calculations.  $306 | Source: PG&E Calculations.  $266 | Source: PG&E Calculations.  $249 | Source: PG&E Calculations.  $589 | Source: PG&E Calculations.  $939 |
| **Effective Useful Life (years):** | 10 years -- Source: [www.Deeresources.com](http://www.Deeresources.com) EUL | 10 years -- Source: [www.Deeresources.com](http://www.Deeresources.com) EUL | 10 years -- Source: [www.Deeresources.com](http://www.Deeresources.com) EUL | 10 years -- Source: [www.Deeresources.com](http://www.Deeresources.com) EUL | 10 years -- Source: [www.Deeresources.com](http://www.Deeresources.com) EUL |
| **Measure Application Type:** | ROB/NC | ROB/NC | ROB/NC | ROB/NC | ROB/NC |
| **Net-to-Gross Ratios:** | Source: 2014 DEER COM Default > 2 yrs= 0.6 | Source: 2014 DEER COM Default > 2 yrs= 0.6 | Source: 2014 DEER COM Default > 2 yrs= 0.6 | Source: 2014 DEER COM Default > 2 yrs= 0.6 | Source: 2014 DEER COM Default > 2 yrs= 0.6 |
| **Important Comments:** |  |  |  |  |  |

# Work Paper Approvals

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

|  |
| --- |
|  |
| **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 | | 12/18/2007 | Commercial Ice Machines PGECOFST108 R0.doc | | David Zabrowski (Fisher-Nickel, inc.) | |
| Revision 1 | | 12/20/2007 | Commercial Ice Machines PGECOFST108 R1.doc Change in baseline due to Title 20 & Added a second Tier | | David Zabrowski (Fisher-Nickel, inc.) | |
| Revision 2 | | 2/10/2010 | Changes to EUL, NTG language and references due to 2008 DEER, costs updated | | David Zabrowski, Lauren Mills (Fisher-Nickel, inc.), Steve Blanc PG&E | |
| Revision 3 | | 05/30/2012  8/24/2012 | Updated NTG, EUL and savings analysis, pricing and incremental costs. Removed product codes F154-F159 for Energy Star machines. Removed Energy Star and CEE criteria. Consolidated 101-300 lb with 300-500 lb, and 501-1000lb with >1500 lb ice machines into F200 to F204 respectively.  Updated BLD, CZ and VIN to ANY per READI requirements | | Kong Sham (Fisher-Nickel, inc.)  Charlene Spoor (PG&E)  Charlene Spoor (PG&E) | |
| Revision 4 | | 6/15/2014 | Updated to new WP template, modified references to DEER2014. | | Charlene Spoor (PG&E) | |
|  |  | | |  | |  |

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# Section 1. General Measure & Baseline Data

## 1.1 Product Measure Description & Background

***Catalog Description –*** This specification covers machines generating 60 grams (2 oz.) or lighter ice cubes, as well as flaked, crushed, and fragmented ice makers. Performance data is based on testing to ARI Standard 810[[1]](#endnote-1). Only air-cooled machines (self-contained, icemaker heads, or remote condensing) are eligible. The efficiency specifications must meet the requirements listed in Table 1. Visit [www.ari.org](http://www.ari.org) for product information and testing procedures. To qualify, the entire ARI tested Ice Making system must be purchased to qualify. Remote machines must be purchased with qualifying remote condenser or remote condenser/compressor unit.

***Program Restrictions and Guidelines***

***Terms and Conditions:*** This incentive applies towards the purchase of new or replacement energy efficient Air-cooled ice machines. Used or rebuilt equipment is not eligible. Customers must provide proof that the appliance meets the energy efficiency specifications listed in Tables 1 and 2.

This specification covers machines generating 60 grams (2 oz.) or lighter ice cubes, as well as flaked, crushed, or fragmented ice machines that meet the Super Energy Efficiency thresholds by Ice harvest (IHR) rate listed in Table 1. Only air cooled machines (icemaker heads, self-contained unites, and remote condensing units) are eligible for incentives. Performance data is based on ARI Standard 810.

The rebate for measures F200 to F204 is downstream provided to the customer at the time of sale upon receipt of application and invoice. This is not a Direct install program.

***Market Applicability:*** Hospitals account for 39.4 percent of all commercial icemaker purchases, followed by hotels (22.3 percent), restaurants (13.8 percent), retail outlets (8.5 percent), schools (8.5 percent), offices (4.3 percent), and grocery stores (3.2 percent)[[2]](#endnote-2).

## 1.2 Product Technical Description

Commercial icemakers represent approximately 11 percent of all commercial refrigeration energy use. The average annual energy use of a 500 lb/day air-cooled icemaker is 5,000 kWh with a potential increase in efficiency of 15 percent (less than a two-year payback). 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. The PG&E Food Service Technology Center (FSTC) estimates that there are more than 200,000 ice machines in California, with up to 100,000 in PG&E service territory.

Icemakers use a substantial amount of energy in order to freeze water and maintain the ice as separate cubes. Reductions are possible with the use of high efficiency motors in condenser fans and compressors, thicker insulation and reduced evaporator thermal cycling. The energy use in a commercial icemaker varies from product to product, depending on the condenser and the type of ice produced.

## 1.3 Measure Application Type

2014 DEER database shows an EUL of 10 years for commercial food service ice machines[[3]](#endnote-3). Commercial ice machines are classed as suitable for ROB, and NC installations. This work paper will only deal with the ROB and NC case.

The DEER Ex Ante Database Format defines the terms as follows:

Table 1 Measure Application Type[[4]](#endnote-4)

*Identifies the measure application type in the Measure Implementation table in DEER2014.*

|  |  |  |
| --- | --- | --- |
| **Code** | **Description** | **Comment** |
| ER | Early retirement | *Measure is more efficient than code/std; Dual baseline, full measure costs required* |
| ROB | Replace on Burnout | *Single baseline (above code), incremental or full costs* |
| NC | New Construction | *Single baseline (above code), incremental or full costs* |
| REA | Retrofit Add On | *Single baseline (above pre-existing), full measure costs required* |

## 1.4 Product Base Case and Measure Case Data

## Ice Machines are governed under Title 20: State of California Title 20 Appliance Efficiency Regulation listed below in Section 1.4.2 Codes and Standards Requirements Base Case and Measure Information. This work paper uses Title 20 requirements for energy efficiency as the baseline for commercial ice machines[[5]](#endnote-5).

## 1.4.1 DEER Base Case and Measure Case Information

The DEER2014 data include: equipment useful life EUL and Net to Gross (NTG) values for energy efficient ice machine measures.

**Table 2 DEER Use and Technology Table**



**Net-to-Gross Assumption:** NTG assumptions were taken directly from DEER2014. The

DEEER 2014 database does not specifically list commercial food service appliances, therefore, the COM DEFAULT for measures offered more than 2 years is used.

The rebate for measures F200 to F204 is downstream provided to the customer at the time of sale upon receipt of application and invoice. This is not a Direct install program.

Table 3 below summarizes all applicable DEER 2014 based Net-to-Gross ratios for programs that may be used by this measure.

Table 3 DEER Net-to-Gross Ratios

|  |  |
| --- | --- |
|  |  |
| Program Approach | NTG |
| Com Default>2 yrs | 0.6 |

The NTG Ratios in Table 4 are appropriate for the measure(s) because: They are downloaded from DEER 2014 directly.

**Effective Useful Life / Remaining Useful Life:**

DEER 2014 shows an EUL of 10 years for commercial food service ice machines.

**Effective Useful Life: DEER Version and Impact IDs**

* The Effective Useful Life estimates were downloaded directly from DEER 2014, they match the intended measures for climate zones and building types and vintages.

**Table4 Estimated Useful Life**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Electric Savings Watts** | **Deer units** | **DEER Version** | **Measure Code** |
| **ANY** | **ANY** | **ANY** | **805kWh** | **Ice Machine** | **2014** | **F200** |
| **ANY** | **ANY** | **ANY** | **1117kWh** | **Ice Machine** | **2014** | **F201** |
| **ANY** | **ANY** | **ANY** | **1807kWh** | **Ice Machine** | **2014** | **F202** |
| **ANY** | **ANY** | **ANY** | **2601kWh** | **Ice Machine** | **2014** | **F203** |
| **ANY** | **ANY** | **ANY** | **3641kWh** | **Ice Machine** | **2014** | **F204** |

## 1.4.2 Codes & Standards Requirements Base Case and Measure Information

***Title 20:*** This measure does fall under Title 20 of the California Energy Regulations. Under this regulation, the following is required: **Title 20:** Under this regulation, all commercial ice machines manufactured after January 1, 2008 are required to meet the specifications outlined in Table 5.

**Table 5. Title 20 Energy Efficiency Requirements for Commercial Ice Machines.**

|  |  |  |
| --- | --- | --- |
| 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 a |
| ≥ 450 | 6.89 – 0.0011 × H a |
| Remote Condensing Unit (RCU) without remote compressor | < 1,000 | 8.85 – 0.0038 × H a |
| ≥ 1,000 | 5.10 |
| Remote Condensing Unit (RCU) with remote compressor | < 934 | 8.85 – 0.0038 × H a |
| ≥ 934 | 5.30 |
| Self Contained Unit (SCU) | < 175 | 18.0 – 0.0469 × H a |
| ≥ 175 | 9.80 |

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

***Title 24:*** This measure does not fall under Title 24 of the California Energy Regulations

***Federal Standards:*** This measure does not currently fall under Federal DOE or EPA Energy Regulations.

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

## 1.4.3 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information

There are no M&V or other studies identified that addressed cooking measures in the commercial sector. Information on base and measure case are found in the other sub-sections of 1.4.

## 1.4.4 Assumptions and Calculations from other sources—Base and Measure Cases

Assumptions other than NTG and EUL that were not taken directly from DEER 2014 are listed below.

**Energy Savings Assumption (ΔW):** The Base case for both existing units and above code savings were taken from the California Energy Commission (CEC) Title 20 regulations for commercial ice machines. As listed in section 1.4.2. Table 6 details energy savings for each measure code.

**Table 6. Super Energy Efficient Commercial Air-Cooled Ice Machine Cost Effectiveness Example**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Performance** | **F200** | **F201** | **F202** | **F203** | **F204** |
| 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 |
| 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 |
| Electric Cost ($/kWh) | $0.13 | $0.13 | $0.13 | $0.13 | $0.13 |
| Baseline Model  Annual Energy Cost ($/yr) | $698 | $971 | $1,619 | $2,269 | $3,176 |
| Energy Efficient Model  Annual Energy Cost ($/yr) | $593 | $826 | $1,384 | $1,931 | $2,703 |
| Estimated Annual Energy  Cost Savings ($/yr) | $105 | $145 | $235 | $338 | $473 |
| Estimated Incremental Cost b | SEE APPENDIX A | | | | |
| Estimated Useful Life (EUL) c | 10 | 10 | 10 | 10 | 10 |

a Incremental measure cost was determined through comparison of an average of published pricing listed in APPENDIX A.

b The estimated useful life is based on 2014 DEER EUL estimates.

**Hours of Operation**:

* The hours were calculated assuming 18 hrs a day, 365 days a year, or 6570 hrs. per year based on engineering expertise.
* Building variations are not applicable, as this is a plug and play measure.

**Table 7 Hours of Operations**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Hours of Operation hrs/yr** | **Reference** |
| **ANY** | **ANY** | **ANY** | **6570** | **Industry standard** |

**Base Case Costs and Measure Case Costs:** Super Energy Efficient ice machines typically have a higher list price than standard efficiency ice machines. Models that meet this requirement incorporate better insulation, reducing heat gain, and more efficient components such as electrically commutated (EC) evaporator fan motors and high-efficiency compressors.

The Base Case costs include only the equipment. Super Energy Efficient ice machines require no additional labor or maintenance compared to base case ice machines. Since this measure is applicable for ROB and NC installations, the installation and maintenance costs are expected to be the same for the customer. The estimated equipment cost is based on recent list cost data for ice machines and applying an industry-standard 50% discount to the manufacturer published list prices.

* Table 8 is a sample of measure case cost, the full list of cost data can be found in Appendix A
* Base case costs are averaged and found in Table 6 above.

**Table 8 Equipment Cost Data for Ice Machines**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Type** | **Make Energy Efficient** | **Model** | **Ice Harvest Rate (lb/24h)** | **List Price** | **Cost($)\*** |
| Super Efficient | Hoshizaki | KM-201BAH | 165 | $4,300 | $2,150 |
| Super Efficient | Hoshizaki | F-330BAH | 250 | $6,400 | $3,200 |
| Super Efficient | Manitowoc | SN-12 | 253 | $6,996 | $3,498 |
| Super Efficient | Scotsman | C0322SA-1# | 255 | $4,616 | $2,308 |
| Super Efficient | Scotsman | C0330MA-1# | 280 | $4,459 | $2,230 |

**Effective Useful Life:**EUL is taken directly from DEER 2014

**Net-to-Gross Assumption:** NTG is taken directly from DEER 2014

**In-service rate/first year installation rate**: Commercial Ice Machines are typically replaced on burn out or installed at the time of construction, therefore, the ISR is assumed to be 1.

***1.4.5 Time-of-Use Adjustment Factor***

We are required by CPUC decision 06-06-063 dated June 29, 2006 to apply time-of-use (TOU) adjustment factors on 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.

The specific values and results are summarized in

Table

Table 8 TOU Adjustment Factors

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | ***kWAC*** | ***kWTotal*** | **%** |
| Commercial Cooking Equipment | 0 | 0 | 0 |

***1.5 Summary of Inputs for Savings Calculations***

The following table provides references to sections that document the inputs for calculation:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Input Variable** | **Variations** | **Base Case 1 Average Value** | **Base Case 2 Average Value** | **Base Case 3 Average Value** | **Base Case 4 Average Value** | **Base Case 5 Average Value** | **Measure Case Average Value F200** | **Measure Case Average Value F201** | **Measure Case Average Value F202** | **Measure Case Average Value F203** | **Measure Case Average Value F204** | **Reference Section** |
| **Electric Savings** | None | N/A | *N/A* | *N/A* | *N/A* | *N/A* | *805* | *1117* | *1807* | *2601* | *3641* | *1.4.4* |
| **Gas Savings** | None | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1.4.4 |
| **Hours of operation** | None | 6570 | 6570 | 6570 | 6570 | 6570 | 6570 | 6570 | 6570 | 6570 | 6570 | 1.4.4 |
| **Full Cost** | None | 2464 | 2407 | 4312 | 4098 | 7191 | 2769 | 2674 | 4561 | 4687 | 8130 | 1.4.4 |
| **Incremental Cost** | None | N/A | N/A | N/A | N/A | N/A | 306 | 266 | 249 | 589 | 939 | 1.4.4 |
| **EUL /RUL** | None | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 1.4.4 |
| **NTG** | None | N/A | N/A | N/A | N/A | N/A | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 1.4.4 |
| **ISR** | None | N/A | N/A | N/A | N/A | N/A | 1 | 1 | 1 | 1 | 1 | 1.4.1 |
| **TOU Factor** | *A/C projects only* | *N/A* | *N/A* | *N/A* | *N/A* | *N/A* | *N/A* | *N/A* | *N/A* | *N/A* | *N/A* | *1.4.5* |

# Section 2. Calculation Methods

Table 7 Baseline by Measure Application Type

|  |  |  |  |
| --- | --- | --- | --- |
| ****Measure Application Type**** | ****Measure Life Basis**** | ****First Baseline Period: Energy Savings Baseline**** | ****Second Baseline Period: Energy Savings Baseline**** |
| ***ER* (early retirement)** | **EUL** | Customer Average Baseline | Code Baseline |
| ***ROB* (replace-on-burnout)** | **EUL** | Code Baseline | N/A |
| ***NC* (new construction)** | **RUL/EUL-RUL** | Code Baseline | N/A |
| ***REA (retrofit add on)*** | **EUL** | Code Baseline | N/A |

Notes:

* For ROB and REA measures, First Baseline is the baseline for the full EUL. There is no second baseline.
* For ER measures, First Baseline Period is the period for the RUL(remaining useful life),defined by the CPUC as RUL=1/3 EUL. Second baseline period for ER is Code baseline for the period EUL-RUL.

## 2.1 Electric Energy Savings Estimation Methodologies

In an analysis of the range of products currently on the market, American Council for an Energy Efficient-Economy (ACEEE) research indicates 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[[6]](#endnote-6). Manufacturers have also indicated that they have the technical capability to exceed current efficiency levels through the use of high efficiency compressors and fan motors, thicker insulation, and other measures.

The industry standard for energy use and performance of commercial ice machines is ARI Standard 810. Table 5 lists the cost effectiveness of Super Energy Efficient ice machines, based on the individual machines operating at 75% of their rated maximum capacity.

Table 5. Super Energy Efficient Commercial Air-Cooled Ice Machine Cost Effectiveness Example

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Performance** | **IHR** | **IHR** | **IHR** | **IHR** | **IHR** |
| 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 |
| 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 |
| Electric Cost ($/kWh) | $0.13 | $0.13 | $0.13 | $0.13 | $0.13 |
| Baseline Model  Annual Energy Cost ($/yr) | $698 | $971 | $1,619 | $2,269 | $3,176 |
| Energy Efficient Model  Annual Energy Cost ($/yr) | $593 | $826 | $1,384 | $1,931 | $2,703 |
| Estimated Annual Energy  Cost Savings ($/yr) | $105 | $145 | $235 | $338 | $473 |
| Estimated Incremental Cost b | SEE APPENDIX A | | | | |
| Estimated Useful Life (EUL) c | 10 | 10 | 10 | 10 | 10 |

a Incremental measure cost was determined through comparison of an average of published pricing listed in APPENDIX A.

b The estimated useful life is based on 2014 DEER EUL estimates.

Annual Electric Savings:

**EUL Energy Savings [kWh/Unit] = (EUL ∆Watts/unit) x (hours/day)x(days/year)**

**1,000 Watts / kW**

## 2.2. Demand Reduction Estimation Methodologies

* There is a demand reduction potential with this measure.
* This measure does not include HVAC interactive effects savings.
* This measure is not an Early Retirement measure

The demand reduction estimation is based on ARI reported data for standard efficiency ice machines and for high-efficiency ice machines. The measured data are derived from tests conducted under ARI Standard 810. The estimated demand reduction was based on the average demand for baseline and energy efficient model ice machines.

ARI Standard 810 provides standard conditions under which ice machine energy use is measured. The estimated demand reduction of 128 Watts for a 400-pound ice machine was based on data from tests of standard efficiency and high-efficiency ice machines. Applying a Coincidence Factor of 0.9 per the DEER methodology[[7]](#endnote-7), yields a Demand Savings of 115 Watts. Table 5 summarizes the Demand Savings for the various sizes of Super Energy Efficient ice machines.

**Table 6. Super Energy Efficient Commercial Air-Cooled Ice Machine Demand Savings**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 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  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 |

***\*****Applying a Coincidence Factor of 0.9 per the DEER methodology*

**∆Watts/unit:** The demand difference (watts per unit) is simply the difference between the electric demand of the base unit and the electric demand of the energy efficient unit.

**EUL ∆Watts/unit = EUL Base Watts/unit - Energy Efficient Unit Watts**

Where:

**EUL Base Case Watts/unit represents code/industry standard base unit demand.**

**Demand Reduction:**

**EUL Demand Reduction [kW/Unit] = (EUL ∆Watts/unit) x (DEER Peak Hour Load Share) 1,000 Watts s/ kW**

## 2.3. Gas Energy Savings Estimation Methodologies

There are no gas energy savings associated with this measure.

# *Section 3. Load Shapes*

Load Shapes are an important part of the life-cycle cost analysis of any energy efficiency program portfolio. The net benefits associated with a measure are based on the amount of energy saved and the avoided cost per unit of energy saved. For electricity, the avoided cost varies hourly over an entire year. Thus, the net benefits calculation for a measure requires both the total annual energy savings (kWh) of the measure and the distribution of that savings over the year. The distribution of savings over the year is represented by the measure’s load shape. The measure’s load shape indicates what fraction of annual energy savings occurs in each time period of the year. An hourly load shape indicates what fraction of annual savings occurs for each hour of the year. A Time-of-Use (TOU) load shape indicates what fraction occurs within five or six broad time-of-use periods, typically defined by a specific utility rate tariff. Formally, a load shape is a set of fractions summing to unity, one fraction for each hour or for each TOU period. Multiplying the measure load shape with the hourly avoided cost stream determines the average avoided cost per kWh for use in the life cycle cost analysis that determines a measure’s Total Resource Cost (TRC) benefit.

## 3.1 Base Case Load Shapes

The base case load shape would be expected to follow a typical nonresidential foodservice end use load shape.

Commercial ice machine load shapes differ among food service facilities (quick service, casual dining, hotels, college, schools, hospitals, etc.) depending on daily hours of operation, serving periods, day-of-week, and facility location (city downtown, suburban mall, access to interstate highways, etc.). Consequently, applicable average TOU and hourly load shapes for ice machines are unavailable. Commercial ice machines will generally consume more energy during operating hours, when the demand for ice is the greatest.

Table 8 Base Case Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Restaurant – Fast Food | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Office – Small | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |

## 3.2 Measure Load Shapes

For purposes of the net benefits estimates in the E3 calculator, what is required is the load shape that ideally represents the *difference* between the base equipment and the installed energy efficiency measure. This *difference* load profile is what is called the Measure Load Shape and would be the preferred load shape for use in the net benefits calculations.

The measure load shape for this measure is determined by the E3 calculator based on the applicable nonresidential market sector and the foodservice end-use.

The electric demand profile for the high-efficiency ice machines is expected to be the same as the Base Case. The profile will vary as explained in Section 3.1. The Measure Load Shape for the high-efficiency ice machine will use less energy and have a slightly lower demand profile.

Table 9 Measure Case Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Restaurant – Fast Food | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Office – Small | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |

# Section 4. Base Case & Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Measure Life Basis** | **First Baseline Period Full Measure Cost (RUL)** | **Second Baseline Period Full Measure Cost (EUL – RUL)** |
| ***NC (new construction)*** | EUL | Calculated as Incremental Measure Cost | N/A |
| ***ROB(replace on burnout)*** | EUL | Calculated as Incremental Measure Cost | N/A |
| ***ER (early retirement)*** | RUL/  EUL-RUL | Calculated as Full Gross Measure Cost | Calculated as Negative Full Gross Base Case Cost |
| ***REA (retrofit add on)*** | EUL | Calculated as Full Gross Measure Cost | N/A |

## 4.1 Base Case(s) Costs

The following Measure Application Types(s) is(are) are appropriate to this(ese) measure(s). The Base Case Costs are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Measure Application Type** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Base Case Cost** |
| F200 | ROB /NC | Industry Practice | $2464 | $0 | $0 | $2464 |
| F201 | ROB /NC | Industry Practice | $2407 | $0 | $0 | $2407 |
| F202 | ROB /NC | Industry Practice | $4312 | $0 | $0 | $4312 |
| F203 | ROB /NC | Industry Practice | $4098 | $0 | $0 | $4098 |
| F204 | ROB /NC | Industry Practice | $7191 | $0 | $0 | $7191 |

*All costs are noted as $ per measure unit*

The Base Case costs include only the equipment. Super Energy Efficient ice machines require no additional labor or maintenance compared to base case ice machines. Since this measure is applicable for ROB and NC installations, the installation and maintenance costs are expected to be the same for the customer. The estimated equipment cost is based on recent list cost data for ice machines and applying an industry-standard 50% discount to the manufacturer published list prices.

## 4.2 Measure Case Costs

The following Measure Application Types are appropriate to these measures. The Measure Case Costs are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Measure Application Type** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Measure Case Cost** |
|  | ROB/ NC | Industry Practice | $2769 | $N/A | $N/A | $2769 |
|  | ROB/ NC | Industry Practice | $2674 | $N/A | $N/A | $2674 |
|  | ROB/ NC | Industry Practice | $4561 | $N/A | $N/A | $4561 |
|  | ROB/ NC | Industry Practice | $4687 | $N/A | $N/A | $4687 |
|  | ROB/ NC | Industry Practice | $8130 | $N/A | $N/A | $8130 |

*All costs are noted as $ per measure unit*

The Measure costs include only the equipment, as explained in Section 4.1. The estimated equipment cost is based on recent list cost data and applying an industry-standard 50% discount to the manufacturer published list prices (see Appendix A).

Equipment prices for these work papers were compiled from a number of sources including, Autoquotes[[8]](#endnote-8), equipment sales reps and manufacturer sources. Since equipment pricing in food service is closely held information and prices vary widely according to buying volume and other factors, we cannot list the sources for prices specifically.

## 4.3 Incremental & Full Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Full Measure Cost**  **(RUL Period/First Baseline)** | **Full Measure Cost**  **(EUL-RUL Period/ Second Baseline)** | **Incremental Measure Cost** |
| ER | Measure Equipment Cost  +Measure Labor Cost | (-1)x(Base Equipment Cost  + Base Labor Cost) | Measure Equipment Cost  – Base Case Equipment Cost |
| ROB | Measure Equipment Cost  – Base Case Equipment Cost | N/A | Measure Equipment Cost  – Base Case Equipment Cost |
| NC | Measure Equipment Cost  – Base Case Equipment Cost | N/A | Measure Equipment Cost  – Base Case Equipment Cost |
| REA | Measure Equipment Cost  – Base Case Equipment Cost | N/A | Measure Equipment Cost  – Base Case Equipment Cost |

# *4.3.1 Full Measure Cost*

Full Measure Cost is the cost to install an energy efficient measure per the CPUC calculators. This definition implies a different meaning depending on the Measure Application type.

\*Note: Various complicated price fluctuations are not addressed in these equations, such as future costs due to inflation in labor, future costs due to deflation in material cost, and other variables that cannot be accurately described at this time.

# *4.3.2 Incremental Measure Costs*

Incremental Measure Cost is the premium cost to install an energy efficient measure over a standard efficiency measure or code baseline measure. While IMC has a straightforward definition depending on the Measure Application type, the equation does vary.

Incremental measure costs are used in the analysis.

IMC = Measure Equipment Cost – Base Case Equipment Cost

*F200: IMC = $ 2,769 per (unit) -- $ 2,464 per (unit) = $ 306 per (unit)*

*F201: IMC = $ 2,674 per (unit) -- $ 2,407 per (unit) = $ 266 per (unit)*

*F202: IMC = $ 4,561 per (unit) -- $ 4,312 per (unit) = $ 249 per (unit)*

*F203: IMC = $ 4,687 per (unit) -- $ 4,098 per (unit) = $ 589 per (unit)*

*F204: IMC = $ 8,130 per (unit) -- $ 7,191 per (unit) = $ 939 per (unit)*

# 

# References

1. Air-Conditioning & Refrigeration Institute (ARI), 2003. Standard 810 *Performance Rating of Automatic Commercial Ice-Makers*. [↑](#endnote-ref-1)
2. ADL 1996. *Energy Savings Potential for Commercial Refrigeration Equipment*, pp. 39-49. [↑](#endnote-ref-2)
3. *EUL\_Summary\_10-1-08.xls* from DEER Database for Energy-Efficient Resources; Version 2011 4.01 found at: [http://www.deeresources.com/2011](http://www.deeresources.com/index.php?option=com_content&view=article&id=68&Itemid=60) Under: DEER2011 Update Documentation linked at: [EUL/RUL Values](http://www.deeresources.com/deer0911planning/downloads/DEER_EULS_4-14-08.doc) Cells: (D82) [↑](#endnote-ref-3)
4. The DEER Measure Cost Data Users Guide found on [www.deeresources.com](http://www.deeresources.com) under *DEER2011 Database Format* hyperlink, DEER2011 for 13-14, spreadsheet *SPTdata\_format-V0.97.xls.* [↑](#endnote-ref-4)
5. 2007 California Energy Commission (CEC) Title 20 Appliance Efficiency Regulations, CEC 400-2007-016, p. 112. [↑](#endnote-ref-5)
6. American Council for an Energy-Efficient Economy (ACEEE), 2002. *Packaged Commercial Refrigeration Equipment: A Briefing Report For Program Planners And Implementers.* [↑](#endnote-ref-6)
7. 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, pp. 3-15 to 3-18, table 3-14. [↑](#endnote-ref-7)
8. AutoQuotes electronic catalog for foodservice equipment and supplies <http://www.aqnet.com/> . [↑](#endnote-ref-8)