**Work Paper SCE13CC011**

**Revision 1**

**Southern California Edison Company**

**Commercial Convection Oven**

# At-a-Glance Summary

|  |  |
| --- | --- |
| ****Applicable Measure Codes:**** | FS-68320, FS-59869, FS-78439 |
| **Measure Description:** | Energy efficient convection oven |
| **Base Case Description:** | Standard efficiency convection oven |
| **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-ElecConvOven: 12 years |
| **Measure Application Type:** | Replace on Burnout (ROB) |
| **Net-to-Gross Ratios:** | Com-Default>2yrs: 0.6  Ind-Default>2yrs: 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 |
| SCE13CC004.0 | No | 5/1/12 | Ricson Chude/ SCE | * Converted WPSCNRCC0004 into new workpaper template, and changed name to WorkPaper SCE13CC004. * Revised cost and savings based on PGECOFST102 |
| SCE13CC004.1 | No | 5/5/2014 | Ricson Chude/SCE | -Work paper updated for the reporting period, effective 7/1/14 – 12/31/14.  - Updated to include description and incorporate savings from Large Full Size ovens  -Updated all savings and costs |

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

### This work paper details the replacement of a standard efficiency commercial electric convection oven with a high efficiency commercial electric convection oven.

Table 1 Measure Names

|  |  |
| --- | --- |
| Solution Code | Measure Name |
| FS-68320 | Half-Size Convection Oven |
| FS-59869 | ≤ 5 Pans Full-Size Convection Oven |
| FS-78439 | > 5 Pans Large Full-Size Convection Oven |

**Eligibility Requirements**

* The half-size convection oven must meet ENERGY STAR® specifications or have a tested heavy load potato cooking energy efficiency ≥ 71% and idle rate ≤ 1.0 kW utilizing ASTM Standard F1496 [287].
* The full-size (≤ 5 pans) convection oven must meet ENERGY STAR® specifications or have a tested heavy load potato cooking energy efficiency ≥ 71% and idle rate ≤ 1.6 kW utilizing ASTM Standard F1496.
* The large full-size (> 5 pans) convection oven must have a tested heavy load potato cooking energy efficiency ≥ 73% and idle rate ≤ 1.9 kW utilizing ASTM Standard F1496.
* Eligible convection ovens must be on the Food Service Technology Center pre-approved list.

## 1.2 Technical Description

### Commercial convection ovens are the most widely used appliances in the food service industry. Many food service operations rely heavily on the versatility of ovens. Operators can cook varieties of foods in large quantities with a single appliance. An oven can be simply described as a fully enclosed, insulated chamber used to heat food. With competition rising among equipment manufacturers, new designs that incorporate timesaving features via sophisticated control packages are being introduced.

### Ovens represent the largest appliance category in terms of the types of units manufactured of any of the major cooking equipment categories. This versatility and diversity mean that they can be found in almost any type of food service operation. A recent US study showed that 95% of commercial (non-institutional) operations reported using at least one type of oven; 98% of noncommercial (institutional) operations reported the same. The percentage of operations, commercial and institutional, using general bake ovens was 52% and 56%, respectively. Fifty percent of the operations in the commercial sector reported using convection ovens as compared to 83% of noncommercial operations [138].

Convection oven performance is determined by applying the ASTM Standard Test Method for the Performance of Convection Ovens (F1496). The ASTM standard test method is considered to be the industry standard for quantifying the energy consumption, efficiency and cooking performance of convection ovens. In 2013, ASTM F1496 was updated to accommodate a wider range of oven cavity sizes. The Energy Star v2.1 specification for commercial ovens now references the updated ASTM standard in addition to tightening the idle rate requirements for gas full-size convection ovens.

## 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 2 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 3 below.

Table 3 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 |

\*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 4 below.

Table 4 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 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 5 READi Tech IDs

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

### 1.4.2 Codes and Standards Analysis

Table 6 Code Summary

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Dates |
| ASTM | F1496 | January 1, 2013 |

**California Title 24 2013:** These measures do not fall under Title 24 of the California Energy Regulations.

**California Title 20 2014:** State of California Title 20 Appliance Efficiency Regulation [422] has a category for cooking appliances, but minimum performance requirements for convection ovens are not included.

### ASTM Standards: ASTM Standard Test Method for the Performance of Convection Ovens (F1496) is applicable for estimating energy use and cooking performance. It was used to estimate the energy consumption of the base case and measure equipment.

**Federal Standards:** These measures do not fall under Federal DOE or EPA Energy Regulations.

### 1.4.3 Non-DEER Study Review

The Food Service Technology Center conducted an assessment of major commercial cooking appliance technologies in 2002, which included a chapter on ovens [138]. The study showed that oven efficiency varies from 10% to 80%, based on primary fuel source and oven type (convection, combination, conventional, etc.). A further Food Service Technology Center study included convection oven performance data, which suggests a baseline efficiency of 65% for electric convection ovens and 30% gas convection ovens, respectively [439].

### Since the current Title 20 regulations do not include a minimum performance requirement for convection ovens, the base case for existing models of electric convection ovens was determined from Table 3-2 in the Food Service Technology Center study.

**1.4.4 Measure and Base Case Effective Useful Life**

DEER14 update documentation provides EUL and RUL information to be used for the 2013-14 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 DEER14 update documentation, EUL\_Summary\_10-1-08.xls [213], 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-ElecConvOven | Non-Residential | Cooking | Convection Ovens | 12 | 4 |

# Section 2. Energy Savings & Demand Reduction Calculations

## 2.1 Electric Energy Savings Estimation Methodologies

This work paper uses ASTM Standard Test Method for the Performance of Convection Ovens (F1496) for calculation of energy use and demand, based on testing in an approved and qualified laboratory. In the absence of mandatory regulations for testing commercial ovens, there is little incentive on the part of equipment manufacturers to have their baseline equipment tested. Therefore, the ASTM performance parameters for baseline and measure equipment were drawn from a sample of economy grade equipment tested by the Food Service Technology Center and is summarized in Table 8 and Table 9.

Table 8 Baseline ASTM Test Results for Commercial Convection Ovens

|  |  |  |  |
| --- | --- | --- | --- |
| Convection Oven Type | Idle Energy Rate | Cooking-Energy Efficiency\* | Production Capacity\* |
| Electric Half-Size | 1,500 W | 65% | 45 lb/h |
| Electric Full-Size | 2,000 W | 65% | 70 lb/h |
| Electric Large Full-Size | 2,500 W | 65% | 100 lb/h |

\*Based on the Heavy-load potato test in ASTM F1496

Table 9 Measure Case ASTM Test Results for Commercial Convection Ovens

|  |  |  |  |
| --- | --- | --- | --- |
| Convection Oven Type | Idle Energy Rate | Cooking-Energy Efficiency\* | Production Capacity\* |
| Electric Half-Size | 880 W | 72% | 53 lb/h |
| Electric Full-Size | 1,400 W | 73% | 82 lb/h |
| Electric Large Full-Size | 1,730 W | 76% | 137 lb/h |

\*Based on the Heavy-load potato test in ASTM F1496

Table 10, Table 11, and Table 12 show the calculation results for convection ovens.

Table 10 Commercial Electric Half-Size Convection Oven Calculations

|  |  |  |
| --- | --- | --- |
| Performance | Baseline Model | Energy Efficient Model |
| Preheat Time (min) | 15 | 15 |
| Preheat Energy (kWh) | 1.00 | 0.90 |
| Idle Energy Rate (kW) | 1.5 | 0.88 |
| Heavy Load Cooking Energy Efficiency (%) | 65% | 72% |
| Production Capacity (lbs/hr) | 45 | 53 |
| Operating Hours/Day | 12 | 12 |
| Operating Days/Year | 365 | 365 |
| Number of Preheats per Day | 1 | 1 |
| Pounds of Food Cooked per Day | 100 | 100 |
| Electric Cost ($/kWh) | $0.13 | $0.13 |
| ASTM Energy to Food (kWh/lb) | 0.0732 | 0.0732 |
| Daily Energy Consumption (kWh) | 26.6 | 19.7 |
| Average Demand (kW) | 2.2 | 1.6 |
| **Estimated Demand Reduction (kW)** | **-** | **0.54** |
| Annual Energy Consumption (kWh) | 9,709 | 7,191 |
| **Estimated Energy Savings (kWh/yr)** | **-** | **2,518** |

Table 11 Commercial Electric Full-Size Convection Oven Calculations

|  |  |  |
| --- | --- | --- |
| Performance | Baseline Model | Energy Efficient Model |
| Preheat Time (min) | 15 | 15 |
| Preheat Energy (kWh) | 1.50 | 1.00 |
| Idle Energy Rate (kW) | 2.00 | 1.40 |
| Heavy Load Cooking Energy Efficiency (%) | 65% | 73% |
| Production Capacity (lbs/hr) | 70 | 82 |
| Operating Hours/Day | 12 | 12 |
| Operating Days/Year | 365 | 365 |
| Number of Preheats per Day | 1 | 1 |
| Pounds of Food Cooked per Day | 100 | 100 |
| Electric Cost ($/kWh) | $0.13 | $0.13 |
| ASTM Energy to Food (kWh/lb) | 0.0732 | 0.0732 |
| Daily Energy Consumption (kWh) | 33.4 | 25.8 |
| Average Demand (kW) | 2.8 | 2.2 |
| **Estimated Demand Reduction (kW)** | **-** | **0.54** |
| Annual Energy Consumption (kWh) | 12,191 | 9,417 |
| **Estimated Energy Savings (kWh/yr)** | **-** | **2,774** |

Table 12 Commercial Electric Large Full-Size Convection Oven Calculations

|  |  |  |
| --- | --- | --- |
| Performance | Baseline Model | Energy Efficient Model |
| Preheat Time (min) | 15 | 15 |
| Preheat Energy (kWh) | 1.70 | 1.20 |
| Idle Energy Rate (kW) | 2.50 | 1.73 |
| Heavy Load Cooking Energy Efficiency (%) | 65% | 76% |
| Production Capacity (lbs/hr) | 100 | 137 |
| Operating Hours/Day | 12 | 12 |
| Operating Days/Year | 365 | 365 |
| Number of Preheats per Day | 1 | 1 |
| Pounds of Food Cooked per Day | 100 | 100 |
| Electric Cost ($/kWh) | $0.13 | $0.13 |
| ASTM Energy to Food (kWh/lb) | 0.0732 | 0.0732 |
| Daily Energy Consumption (kWh) | 39.8 | 29.9 |
| Average Demand (kW) | 3.3 | 2.5 |
| **Estimated Demand Reduction (kW)** | **-** | **0.75** |
| Annual Energy Consumption (kWh) | 14,527 | 10,914 |
| **Estimated Energy Savings (kWh/yr)** | **-** | **3,613** |

**Daily Energy Consumption Calculation and Definitions**

EDAY = (LBFOOD x EFOOD) ÷ EFFICIENCY + [IDLERATE x (TON - LBFOOD/PC – nP x TP/60)] + nP x EP

Where:

|  |  |
| --- | --- |
| **EDAY =** | **Calculated Daily Energy Consumption (kWh/day)** |
| LBFOOD = | Estimated Pounds of Food Cooked per Day |
| EFOOD = | ASTM Energy to Food (kWh/lb) = kWh/pound of energy absorbed by food product during cooking based on ASTM F1361 |
| EFFICIENCY = | Measured Heavy Load Cooking Energy Efficiency % |
| IDLE RATE = | Measured Idle Energy Rate (kW) |
| TON = | Estimated Operating Hours/Day |
| PC = | Measured Production Capacity (lbs/hr) |
| TP = | Estimated Preheat Time (min) |
| nP = | Estimated Number of preheats/Day |
| EP = | Measured Preheat Energy (kWh) |

See Attachment 2 for all calculations. See Attachment 1 for a complete list of savings.

## 2.2. Demand Reduction Estimation Methodologies

An oven’s actual contribution to a building’s peak demand may vary significantly depending on its usage pattern in relation to that of other electric equipment in the facility (operating schedule, appliance on time, etc.). The probability of an appliance drawing its average rate during the period that the building peak is set is significantly higher than for any other input rate for that appliance. Therefore, it has been assumed that the probable contribution to the building’s peak demand is equal to the appliance’s average demand.

A coincidence factor of 0.9 from DEER 2005 [26] is applied to demand reduction; since convection ovens are not specifically addressed, the 0.9 from other foodservice measures is used. See Section 2.1 for final values.



Figure 1 DEER 2005 Cooking Coincidence Factor

# 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 DEER:Indoor\_Non-CFL\_Ltg load shape. See Table 13 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 13 Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| Building Type | E3 Alt.  Building Type | Load Shape |
| Education - Community College | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Education - Primary School | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Education - Secondary School | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Education - University | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Food Store | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Grocery | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Health/Medical – Hospital | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Health/Medical - Nursing Home | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Industrial | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Lodging - Hotel | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Lodging - Motel | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Manufacturing - Bio/Tech | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Manufacturing - Light Industrial | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Misc - Commercial | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Office - Large | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Restaurant - Fast-Food | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Restaurant - Sit-Down | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Retail - Multistory Large | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Retail – Small | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |

# Section 4. Base Case & Measure Costs

High-efficiency convection ovens typically have a higher list price than standard efficiency convection ovens. However, high-efficiency designs are often bundled with other features such as all stainless steel construction and high quality components and controls. In addition to lower operating costs, high-efficiency convection ovens exhibit better uniformity and higher production rates that increase their cost-effectiveness.

## 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 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 14 shows the calculation of gross measure cost:

Table 14 Gross and Incremental Measure Cost

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Convection Oven Type | Baseline Unit Price | Energy Efficient Unit Price | Baseline Unit Cost | Energy Efficient Unit Cost | Incremental Measure Cost (IMC) |
| Electric Half-Size | $7,209 | $8,795 | $3,605 | $4,398 | $793 |
| Electric Full-Size | $8,216 | $10,229 | $4,108 | $5,115 | $1,007 |
| Electric Large Full-Size | $14,600 | $15,899 | $7,300 | $7,949 | $649 |

\*Estimated purchase price and Incremental Measure Cost (IMC) were based on an industry-standard 50% discount off the manufacturer’s list price.

## 4.3 Incremental Measure Cost

The incremental cost is the same as the gross measure cost and is shown in Table 14.

# Attachments

1. 

1. 

# References



|  |  |
| --- | --- |
| [26] | 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study - Final Report - Itron Inc. - Dec. 2005 |
| [31] | Load Shape Update Initiative - KEMA / JJ Hirsch and Assoc. / Itron Inc. - November 17, 2006 |
| [138] | Commercial Cooking Appliance Technology Assessment |
| [213] | EUL/RUL Values Provided through Excel Spreadsheet |
| [287] | Standard Test Method for the Performance of Convection Ovens |
| [351] | Energy Efficiency Policy Manual-Version 5 |
| [422] | 2014 Appliance Efficiency Regulations (Title 20) |
| [439] | Development and Application of a Uniform Testing Procedure for Convection Ovens |

# Appendix A – 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 |