Work Paper SCE13CC011

**Revision 2**

**Southern California Edison**

**Commercial Convection Oven**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | FS-68320, FS-59869, FS-78439 |
| **Measure Description** | Energy efficient convection oven. |
| **Base Case Description** | Standard efficiency convection oven. |
| **Units** | Unit |
| **Energy Savings** | Refer to Excel Calculation Attachment |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Incremental Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Effective Useful Life** | Cook-ElecConvOven: 12 years |
| **Measure Installation Type** | Replace on Burnout (ROB) |
| **Net-to-Gross Ratio** | Com-Default>2yrs: 0.6  Ind-Default>2yrs: 0.6 |
| **Important Comments** | This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| 0 | 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 |
| 1 | 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 |
| 2 | 01/20/16 | Ajay Wadhera/Solaris | -New template update for 2016 program year  -WP effective from 1/1/2016 thru 12/31/2016  -Removed SCE building types  -No value modifications |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Cal TF website: <http://www.caltf.org/>

# 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.

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | High efficiency commercial electric oven |
| Existing Condition | Standard efficiency commercial electric oven |
| Code/Standard | N/A |
| Industry Standard Practice | N/A |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
| N/A | N/A | FS-68320 | N/A | Half-Size Convection Oven |
| N/A | N/A | FS-59869 | N/A | ≤ 5 Pans Full-Size Convection Oven |
| N/A | N/A | FS-78439 | N/A | > 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 Installation Types and Delivery Mechanisms

The install type is ROB (Replace-on-Burnout).

**Installation Type Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Replace on Burnout (ROB) | Above Code or Standard | N/A | EUL | N/A |

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

A delivery mechanism is a delivery method paired with an incentive method. Delivery mechanisms are used by programs to obtain program participation and energy savings.

**Delivery Method Descriptions**

|  |  |
| --- | --- |
| **Delivery Method** | **Description** |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |

**Incentive Method Descriptions**

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Down-Stream Incentive | The customer installs qualifying energy efficient equipment and submits an incentive application to the utility program. Upon application approval, the utility program pays an incentive to the customer. Such an incentive may be deemed or customized. |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | No |
| DEER Measure Case | No |
| DEER Building Types | No |
| DEER Operating Hours | No |
| DEER eQUEST Prototypes | No |
| DEER Version | N/A |
| Reason for Deviation from DEER | DEER does not contain this measure |
| DEER Measure IDs Used | N/A |

**Net-to-Gross Ratio**

The NTG values were obtained using the DEER READI tool. The relevant NTG values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| 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 |

**Spillage Rate**

Spillage rates are not tracked in work papers; they are tracked in an external document which will be supplied to the Commission Staff.

**Installation Rate**

The IR values were obtained using the DEER READI tool. The relevant IR values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Def-GSIA | Default GSIA values | Any | Any | Any | 1 |

**Effective and Remaining Useful Life**

The EUL and RUL values were obtained using the DEER READI tool. DEER defines the RUL as 1/3 of the EUL value. The RUL value is only applicable to the first baseline period for an RET measure with an applicable code baseline. The relevant EUL and RUL values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| Cook-ElecConvOven | Convection Oven - Electric | Com | FoodServ | 12 | 4 |

### 1.4.2 Codes and Standards Analysis

**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.

Code Summary

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

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

### 1.5.1 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.

## 1.6 Data Quality and Future Data Needs

N/A

# Section 2. Calculation Methodology

## 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 tables below.

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

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

Tables below show the calculation results for convection ovens.

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** |

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** |

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 ideal load shape for net benefits estimates would represent the difference between the base case and measure case. The closest load shapes that are applicable to the measures in this work paper are listed in the table below.

Building Types and Load Shapes

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

# Section 4. 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. Table below shows the base case cost for this technology.

**Base Case Cost**

|  |  |  |
| --- | --- | --- |
| **Convection Oven Type** | **Baseline Unit Price** | **Baseline Unit Cost** |
| Electric Half-Size | $7,209 | $3,605 |
| Electric Full-Size | $8,216 | $4,108 |
| Electric Large Full-Size | $14,600 | $7,300 |

## 4.2 Measure Case Cost

Table below shows the measure case cost for this technology.

**Measure Case Cost**

|  |  |  |
| --- | --- | --- |
| **Convection Oven Type** | **Energy Efficient Unit Price** | **Energy Efficient Unit Cost** |
| Electric Half-Size | $8,795 | $4,398 |
| Electric Full-Size | $10,229 | $5,115 |
| Electric Large Full-Size | $15,899 | $7,949 |

## 4.3 Full and Incremental Measure Cost

**Full and Incremental Measure Cost Equations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ROB | (MEC + MLC) – (BEC + BLC) | (MEC + MLC) – (BEC + BLC) | N/A |
| NEW/NC |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

BEC = Base Case Equipment Cost; BLC = Base Case Labor Cost

**Full and Incremental Costs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| Electric Half-Size | ROB | $793 | $793 | N/A |
| Electric Full-Size | ROB | $1,007 | $1,007 | N/A |
| Electric Large Full-Size | ROB | $649 | $649 | N/A |

# Attachments

1. 

1. 

# References



[26]

[138]

[287]

[422]

[439]