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**FOOD SERVICE
RACK OVEN
SWFS014-02**

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MEASURE NAME

Commercial Rack Oven, Gas

STATEWIDE MEASURE ID

SWFS014-02

TECHNOLOGY SUMMARY

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. With competition rising among equipment manufacturers, new designs that incorporate time saving features via sophisticated control packages are being introduced.

A rack oven offers high-volume production and even baking in a relatively compact footprint. A single-rack oven typically accommodates 15 pans of food product at a time, effectively replacing three full-size convection ovens. These large-capacity ovens fill the requirements of high-volume retail and baking operations. They are also ideal for reheating (“rethermalizing”) many products prepared in cook/chill systems, as well as baking and roasting. The rack oven is capable of producing thousands of identical products or many diverse menu items within the same cooking cavity.

Rack oven performance is determined by applying the American Society for Testing and Materials (ASTM) Standard Test Method for the Performance of Rack Ovens (F2093).¹ The ASTM Standard Test Method is the industry standard for quantifying the efficiency and performance of rack ovens. This measure is focused on single- and double-rack gas-fired rack ovens.

MEASURE CASE DESCRIPTION

The measure case specification represents the average values of the results of oven testing conducted by the Pacific Gas & Electric (PG&E) Food Service Technology Center, the Southern California Edison (SCE) Foodservice Technology Center and the ENERGY STAR-certified commercial oven data base. These sources were compiled and results summarized by The Southern California Gas Company in a memo and supplemental attachment.²

¹ American Society for Testing and Materials (ASTM). ASTM F2093-11, Standard Test Method for the Performance of Rack Ovens. West Conshohocken (PA): ASTM International.

² The Southern California Gas Company (SCG). 2019. “Reformulated baseline efficiencies and eligibility requirements for Commercial Rack Oven workpaper SWFS014-01.” Memorandum submitted to Peter Biermayer (Energy Division) and Sue Haselhorst (Ex Ante Review Team). September 20.

The Southern California Gas Company (SCG). 2019. “Foodservice Rack Oven Memo_092019_Attachment.”

Measure Case Specification

Oven Type	Min. Cooking Energy Efficiency	Source
Single Rack Oven (gas)	51%	The Southern California Gas Company (SCG). 2019. "Reformulated baseline efficiencies and eligibility requirements for Commercial Rack Oven workpaper SWFS014-01." Memorandum submitted to Peter Biermayer (Energy Division) and Sue Haselhorst (Ex Ante Review Team), September 20.
Double Rack Oven (gas)	58%	The Southern California Gas Company (SCG). 2019. "Foodservice Rack Oven Memo_092019_Attachment."

BASE CASE DESCRIPTION

In the absence of mandatory regulations for testing commercial rack ovens, there is little incentive for equipment manufacturers to test their base case equipment. Therefore, the ASTM performance parameters for base case equipment were drawn from a sample of economy-grade equipment tested by the Food Service Technology Center (FSTC).

Base Case Specification

Oven Type	Cooking Energy Efficiency	Source
Single Rack Oven (gas)	43%	The Southern California Gas Company (SCG). 2019. "Reformulated baseline efficiencies and eligibility requirements for Commercial Rack Oven workpaper SWFS014-01." Memorandum submitted to Peter Biermayer (Energy Division) and Sue Haselhorst (Ex Ante Review Team), September 20.
Double Rack Oven (gas)	51%	The Southern California Gas Company (SCG). 2019. "Foodservice Rack Oven Memo_092019_Attachment."

CODE REQUIREMENTS

This measure is not governed by either state or federal codes and standards.

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2014)	None.	n/a
CA Building Energy Efficiency Standards – Title 24 (2013)	None.	n/a
Federal Standards	None.	n/a

Commercial rack oven performance is determined by applying the American Society for Testing and Materials (ASTM) Standard Test Method for the Performance of Rack Ovens (F2093).³ The ASTM Standard Test Method is the industry standard for quantifying the efficiency and performance of rack ovens.

NORMALIZING UNIT

Each (oven).

PROGRAM REQUIREMENTS

Measure Implementation Eligibility

All measure application type, delivery type, and sector combinations established for this measure are specified below. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements. Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

Implementation Eligibility

Measure Application Type	Delivery Type	Sector
Normal replacement	UpDeemed	Ag
Normal replacement	UpDeemed	Ind
Normal replacement	UpDeemed	Com
Normal replacement	DnDeemed	Ag
Normal replacement	DnDeemed	Ind
Normal replacement	DnDeemed	Com
New construction	UpDeemed	Ag
New construction	UpDeemed	Ind
New construction	UpDeemed	Com
New construction	DnDeemed	Ag
New construction	DnDeemed	Ind
New construction	DnDeemed	Com

Eligible Products

This measure includes new commercial gas single and double rack ovens tested to meet or exceed baking energy efficiency of 50%.

³ American Society for Testing and Materials (ASTM). ASTM F2093-11, Standard Test Method for the Performance of Rack Ovens. West Conshohocken (PA): ASTM International.

Eligible Building Types and Vintages

This measure is applicable for any nonresidential building type of any vintage.

Eligible Climate Zones

This measure is applicable in any California climate zone.

PROGRAM EXCLUSIONS

Used or rebuilt equipment is not eligible.

DATA COLLECTION REQUIREMENTS

USE CATEGORY

Food service (FoodServ)

ELECTRIC SAVINGS (kWh)

Not applicable.

PEAK ELECTRIC DEMAND REDUCTION (KW)

Not applicable.

GAS SAVINGS (THERMS)

The annual gas unit energy saving (UES) is calculated as the difference between the measure case and baseline annual unit energy consumption (UEC).

Annual Gas Unit Energy Consumption

As shown below, the daily gas UEC (baseline or measure case) is equal to the sum of the energy required for cooking, preheat, and idle modes of fryer operation. These calculations and the inputs are provided below.

$$UEC_{DAY} = \text{cooking energy} + \text{idle energy} + \text{preheat energy}$$

Cooking energy is a function of the pounds of food cooked per day, the energy absorbed per pound of food product during cooking, and the measured heavy load cooking energy efficiency.

$$\text{cooking energy} = \left[\frac{LBFOOD \times EFOOD}{EFFICIENCY} \right]$$



<i>LBFOOD</i> =	<i>Estimated pounds of food cooked per day (lbs)</i>
<i>EFOOD</i> =	<i>ASTM energy to food ratio, the energy absorbed by food product during cooking (Btu)</i>
<i>EFFICIENCY</i> =	<i>Measured heavy load cooking efficiency (% , decimal format)</i>

Preheat energy is calculated as the product of the assumed number of preheats per day and the energy required per preheat mode.

$$\text{preheat energy} = (nP \times EP)$$

<i>nP</i> =	<i>Estimated number of preheats per day (#)</i>
<i>EP</i> =	<i>Measured preheat energy (Btu)</i>

Idle energy is a function of the idle energy rate, operating hours per day, and production capacity; idle energy does not include preheat time.

$$\text{idle energy} = \left[\text{IDLERATE} \times \left(\text{EHOURL} - \frac{\text{LBFOOD}}{\text{PC}} - (nP \times \text{TP}/60) \right) \right]$$

<i>IDLE RATE</i> =	<i>Measured idle energy rate (Btu)</i>
<i>EHOURL</i> =	<i>Estimated operating hours per day (hrs)</i>
<i>LBFOOD</i> =	<i>Estimated pounds of food cooked per day (lbs)</i>
<i>PC</i> =	<i>Measured production capacity (lbs/hr)</i>
<i>nP</i> =	<i>Estimated number of preheats per day (#/day)</i>
<i>TP</i> =	<i>Estimated preheat time (min)</i>

The **annual UEC** (baseline or measure) is calculated as the daily UEC multiplied by the number of operating days per year.

$$\text{UEC_YEAR} = \frac{\text{UEC_DAY} \times \text{EDAYS}}{\text{BtuTherm}}$$

<i>UEC_DAY</i> =	<i>Calculated daily energy consumption (Btu/day)</i>
<i>EDAYS</i> =	<i>Estimated operating days per year (days)</i>
<i>BtuTherm</i> =	<i>Btu to therm conversion factor</i>

Annual Gas Unit Energy Savings

The **annual gas UES** is calculated as the difference between the baseline and measure annual UEC.

$$\text{UES}_{\text{YEAR}} = [\text{UEC_YEAR}_{\text{Base}} - \text{UEC_YEAR}_{\text{Measure}}]$$

<i>UEC_YEAR</i> =	<i>Annual UEC, baseline or measure (therms/year)</i>
<i>UES_YEAR</i> =	<i>Annual UES (therms/year)</i>

Inputs and Assumptions

The inputs for the calculation of energy use of a single-rack oven and a double-rack oven are specified below. The California Public Utilities Commission (CPUC) disposition “Non-standard Disposition for the commercial rack oven workpaper SWFS014-01” issued in 2018 required collection and analyzing

secondary source test data for the commercial rack oven.⁴ This test data was collected from the FSTC as well as ENERGY STAR database and combined into a comprehensive spreadsheet that showed averages, median, minimum and maximum of multiple parameters. These data were analyzed to revise and verify the baseline and measure assumptions presented below.

UEC Inputs – Single Rack Oven

Parameter	Base Case Model	Measure Case Model	Source
Preheat Time (minutes)	20	20	Professional judgement.
Preheat Energy (Btu)	54,817	42,584	The Southern California Gas Company (SCG). 2019. "Reformulated baseline efficiencies and eligibility requirements for Commercial Rack Oven workpaper SWFS014-01." Memorandum submitted to Peter Biermayer (Energy Division) and Sue Haselhorst (Ex Ante Review Team). September 20.
Idle Energy Rate (Btu/hr)	25,745	19,733	
Heavy Load Cooking Energy Efficiency (%)	45%	51%	
Production Capacity (lb/hr)	145	137	The Southern California Gas Company (SCG). 2019. "Foodservice Rack Oven Memo_092019_Attachment."
Number of Preheats per Day	1	1	Base Case: Food Service Technology Center (FSTC). Proprietary database.
Pounds of Food Cooked per Day	600	600	
ASTM Energy to Food (Btu/lb)	235	235	Measure Case: Food Service Technology Center (FSTC). 2012. "Commercial Rack Oven Qualified Project List 2012.xls." As of June 1, 2012.
Operating Hours/Day	12	12	Spoor, C., D. Zabrowski, and L. Mills. 2014. <i>Characterizing the Energy Efficiency Potential of Gas-Fired Commercial Food Service Equipment</i> . Prepared for the California Energy Commission. CEC-500-2014-095. Appendix E Table E-4.
Operating Days/Year	365	365	

⁴ Biermayer, P. (CPUC, Energy Division). 2019. "Non-standard Disposition for commercial rack oven workpaper SWFS014-01." Memorandum to Henry Liu (PG&E). January 11.

UEC Inputs – Double-Rack Oven

Parameter	Base Case Model	Measure Case Model	Source
Preheat Time (minutes)	20	20	Professional judgement.
Preheat Energy (Btu)	90,009	65,758	The Southern California Gas Company (SCG). 2019. Measure Case: Weighted Averages based on rebated models from January 2017 – May 2019.
Idle Energy Rate (Btu/hr)	36,909	24,600	
Heavy Load Cooking Energy Efficiency (%)	51%	56%	
Production Capacity (lb/hr)	272	279	The Southern California Gas Company (SCG). 2019. "SWFS018-02 Rack Oven Weighted average". Base Case: FSTC and Energy Star Test Data "Rack Oven Data.xls"
Number of Preheats per Day	1	1	Base Case: Food Service Technology Center (FSTC). Proprietary database.
Pounds of Food Cooked per Day	1,200	1,200	
ASTM Energy to Food (Btu/lb)	235	235	Measure Case: Food Service Technology Center (FSTC). 2012. "Commercial Rack Oven Qualified Project List 2012.xls." As of June 1, 2012
Operating Hours/Day	12	12	Spoor, C., D. Zabrowski, and L. Mills. 2014. <i>Characterizing the Energy Efficiency Potential of Gas-Fired Commercial Food Service Equipment</i> . Prepared for the California Energy Commission. CEC-500-2014-095. Appendix E Table E-4.
Operating Days/Year	365	365	

Sample Calculations of UES_{year} for single rack ovens is provided below. $EDAY_{Base} = (600 \times 235) \div .45 + [25,745 \times (12 - 600/145 - 1 \times 20/60)] + 1 \times 54,817$

$$EDAY_{Base} = 313,333 + 193,287 + 54,817$$

$$UEC_{DAY_{Base}} = 561,978 \text{ Btu/day}$$

$$UEC_{YEAR_{Base}} = 561,978 \text{ Btu/day} \times 365 \text{ days} \times 1 \text{ therm}/100,000 \text{ Btu}$$

$$UEC_{YEAR_{Base}} = 2,051 \text{ Therms}$$

$$EDAY_{Measure} = (600 \times 235) \div .51 + [19,733 \times (12 - 600/137 - 1 \times 20/60)] + 1 \times 42,584$$

$$EDAY_{Measure} = 276,471 + 143,796 + 42,584$$

$$UEC_{DAY_{Measure}} = 462,851 \text{ Btu/day}$$

$$UEC_{YEAR_{Measure}} = 462,851 \text{ Btu/day} \times 365 \text{ days} \times 1 \text{ therm}/100,000 \text{ Btu}$$

$$UEC_{YEAR_{Measure}} = 1,689 \text{ Therms}$$

$$UES_{year} = 2,162 \text{ Therms} - 1,689 \text{ Therms}$$

$$UES_{year} = 362 \text{ therms}$$



The same methodology was followed to derive the UES for the double rack oven.

LIFE CYCLE

Effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining useful life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

The EUL and RUL specified for commercial rack ovens are specified below. Note that RUL is only applicable for add-on and accelerated replacement measures and not applicable for this measure.

Effective Useful Life and Remaining Useful Life

Parameter	Value	Source
EUL (yrs)	12	Robert Mowris & Associates. 2005. <i>Ninth Year Retention Study of the 1995 Southern California Gas Company Commercial New Construction Program</i> . Prepared for Southern California Gas Company. Study ID Number 718A. California Public Utilities Commission (CPUC), Energy Division. 2003. <i>Energy Efficiency Policy Manual v 2.0</i> . Page 18 Table 4.1.
RUL (yrs)	n/a	n/a

BASE CASE MATERIAL COST (\$/UNIT)

The estimated base case unit list price is the average of manufacturer list prices of base case single- and double-rack gas oven models.⁵ Because it is common knowledge that dealers do not pay the published list prices for equipment, it was necessary apply a discount factor to the AutoQuotes data to more accurately reflect the actual prices paid for the equipment. The discount factor of 50% was based upon professional judgement by Food Service Technology Center (FSTC) staff. Additional analysis to validate the reasonableness of this value compared AutoQuotes published prices with actual prices on invoices submitted through the Southern California Gas Company Instant Rebates! point-of-sale rebate program from 2015 through August of 2017.⁶ This verification revealed that a “list-to-actual” cost ratio for food service equipment of 50% is a reasonable average discount factor.

MEASURE CASE MATERIAL COST (\$/UNIT)

The estimated unit list price is the average of manufacturer published list prices of measure case single- and double-rack gas oven models.⁷ Because it is common knowledge that dealers do not pay the published list prices for equipment, it was necessary apply a discount factor to the AutoQuotes data to more accurately reflect the actual prices paid for the equipment. The discount factor of 50% was based

⁵ Pacific Gas and Electric (PG&E) and San Diego Gas and Electric (SDG&E). (n.d.) “Commercial Rack Oven Cost Data.xls.”

⁶ Energy Solutions. 2017. "2016 IMC Analysis - For Cal TF (Energy Solutions).xls."

⁷ Pacific Gas and Electric (PG&E) and San Diego Gas and Electric (SDG&E). (n.d.) “Commercial Rack Oven Cost Data.xls.”

upon professional judgement by Food Service Technology Center (FSTC) staff. Additional analysis to validate the reasonableness of this value compared AutoQuotes published prices with actual prices on invoices submitted through the Southern California Gas Company Instant Rebates! point-of-sale rebate program from 2015 through August of 2017.⁸ This verification revealed that a “list-to-actual” cost ratio for food service equipment of 50% is a reasonable average discount factor.

BASE CASE LABOR COST (\$/UNIT)

Since this measure is applicable for normal replacement and new construction/new capacity installations, the base case and measure case model installation costs are expected to be the same for the customer and thus not estimated for the incremental cost analysis.

MEASURE CASE LABOR COST (\$/UNIT)

A high-efficiency rack oven requires no additional installation labor or maintenance compared to base case rack ovens. Since this measure is applicable for normal replacement and new construction installations, the base case and measure case model installation costs are expected to be the same for the customer and thus not estimated for the incremental cost analysis.

NET-TO-GROSS (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. These NTG values are based upon the average of all NTG ratios for all evaluated 2006 – 2008 commercial, industrial, and agriculture programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. These sector average NTGs (“default NTGs”) are applicable to all energy efficiency measures that have been offered through commercial, industrial, and agriculture sector programs for more than two years and for which impact evaluation results are not available.

Net-to-Gross Ratios

Parameter	Value	Source
NTG – Commercial	0.60	Itron, Inc. 2011. <i>DEER Database 2011 Update Documentation</i> . Prepared for the California Public Utilities Commission. Page 15-4 Table 15-3.
NTG – Industrial	0.60	
NTG – Agriculture	0.60	

GROSS SAVINGS INSTALLATION ADJUSTMENT (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor

⁸ Energy Solutions. 2017. "2016 IMC Analysis - For Cal TF (Energy Solutions).xls."

varies by end use, sector, technology, application, and delivery method. This GSIA rate is the current “default” rate specified for measures for which an alternative GSIA has not been estimated and approved.

Gross Savings Installation Adjustment Rates

Parameter	Value	Source
GSIA	1.0	California Public Utilities Commission (CPUC), Energy Division. 2013. <i>Energy Efficiency Policy Manual Version 5</i> . Page 31.

NON-ENERGY IMPACTS

Non-energy impacts for this measure have not been quantified.

DEER DIFFERENCES ANALYSIS

The table below summarizes the inputs and methods that are and are not based upon the Database for Energy Efficient Resources (DEER).

DEER Difference Summary

DEER Item	Comment / 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 2014 does not contain these measures.
DEER Measure IDs Used	n/a
NTG	Source: DEER 2014. NTG of 0.60 is associated with NTG ID: <i>Com-Default>2yrs, Ag-Default>2yrs, Ind-Default>2yrs</i>
GSIA	Source: DEER. The value of 1.0 is associated with GSIA ID: <i>Def-GSIA</i> .
EUL/RUL	Source: DEER 2014. The value of 12 years is associated with EUL ID: <i>Cook-GasRackOven</i>

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision Effective Date and Approved By
01	12/31/2017	Jennifer Holmes Cal TF Staff	Draft of consolidated text for this statewide measure is based upon: PGECOFST109, Revision 6 (April 1, 2016) WPSDGENRCC0011, Revision 2.1 (June 27, 2014) Consensus reached among Cal TF members.
	10/11/2018 10/29/2018	Jennifer Holmes Cal TF Staff	Completed final revisions for submittal of version 01
02	09/23/2019	Jaime Lopez SoCalGas	Updates to the measure case, base cases as well as calculation assumptions were made to reflect direction given by CPUC in disposition "Non-standard Disposition for the commercial rack oven workpaper SWFS014-01"
03	12/6/2019	Jaime Lopez SoCalGas	Updates to base case calculations assumptions for single rack oven and measure case calculation assumptions for double rack oven
	12/16/2019	Adan Rosillo PG&E	Added delivery types UpDeemed and DnDeemDI to PG&E offering