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FOOD SERVICE

CONVEYOR OVEN, GAS, COMMERCIAL

SWFS008-01

CONTENTS

MEASURE NAME

Conveyor Oven, Gas, Commercial

STATEWIDE MEASURE ID

SWFS008-01

TECHNOLOGY SUMMARY

Commercial ovens are the most widely used appliances in the food service industry. Conveyor ovens are generally used for producing a limited number of products with similar cooking requirements at high production rates. A conveyor oven is a rectangular housing unit containing a baking cavity or chamber that is open on two opposing sides. A conveyor system carries the food product through the baking chamber on a wire rack. Most conveyor ovens can be outfitted with multiple conveyor belts, each of which may have a different operating speed.

Conveyor ovens are available in many different sizes and configurations. They are available in sizes small enough to satisfy low-volume and niche operations, such as kiosks, that have limited production space, and large enough to meet the demands of high-volume operations. Most conveyor ovens, both large and small, can be stacked up to three units high; significantly increasing production capacity without requiring additional floor space.

Conveyor oven performance is determined by following the American Society for Testing and Materials (ASTM) Standard Test Method for the Performance of Conveyor Ovens (F1817).[1] The ASTM Standard Test Method is the industry standard for quantifying the efficiency and performance of conveyor ovens.

The Food Service Technology Center (FSTC) assessed major commercial cooking appliance technologies, including commercial ovens, the results of which were summarized and published in 2002.[2] The study indicated that standard-efficiency gas conveyor oven cooking-energy efficiency is 10% to 20% and high-efficiency gas conveyor oven cooking-energy efficiency is 40% to 50%.

MEASURE CASE DESCRIPTION

The measure case specification was derived as the average of values drawn from lab-based commercial conveyor oven performance tests conducted by the Pacific Gas & Electric (PG&E) Food Service Technology Center, the Southern California Gas Company (SoCalGas) Food Service Equipment Center, and the Southern California Edison (SCE) Food Service Technology Center. The specifications shown below represent the average of the resultant values of equipment tested, based on the heavy-load test in ASTM F1817.

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[1] American Society for Testing and Materials (ASTM). 2003. *ASTM F1817-97, Standard Test Method for the Performance of Conveyor Ovens.* West Conshohocken (PA): ASTM International.

[2] Fisher, D. (Fisher-Nickel). 2002. *Commercial Cooking Appliance Technology Assessment. Prepared for Enbridge Gas Distribution and Pacific Gas and Electric Company.* FSTC Report # 5011.02.26. San Ramon, CA: Fisher-Nickel, Inc.

Measure Case Specification

Conveyor Oven Type	Min. Cooking Energy Efficiency	Max. Idle Energy Rate (Btu/hr)	Source
Gas Conveyor Oven-Large (> 25in. total conveyor width)	46%	40,000	Food Service Technology Center (FSTC). "Conveyor Oven Gap Analysis Review 102119" Food Service Technology Center (FSTC). Proprietary database.

BASE CASE DESCRIPTION

Since commercial gas conveyor ovens are currently not covered by state or national codes, there is little incentive for equipment manufacturers to test their baseline equipment. Therefore, the base case for existing models of gas conveyor ovens was determined from the upper range of standard gas conveyor ovens tested by the FSTC, based on the heavy-load test in ASTM F1817. The results of the performance testing of base case models are summarized in the FSTC appliance technology assessment, published in 2002.[3]

Base Case Specification

Conveyor Oven Type	Cooking Energy Efficiency	Idle Energy Rate (Btu/hr)	Source
Gas Conveyor Oven-Large (> 25in. total conveyor width)	30%	55,000	Food Service Technology Center (FSTC). "Conveyor Oven Gap Analysis Review 102119" Food Service Technology Center (FSTC). Proprietary database.

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	None.	n/a
CA Building Energy Efficiency Standards – Title 24	None.	n/a
Federal Standards	None.	n/a

[3] Fisher, D. (Fisher-Nickel). 2002. *Commercial Cooking Appliance Technology Assessment.* Prepared for Enbridge Gas Distribution and Pacific Gas and Electric Company. FSTC Report # 5011.02.26. San Ramon, CA: Fisher-Nickel, Inc. Table 7-1.

NORMALIZING UNIT

Each (oven).

PROGRAM REQUIREMENTS

Measure Implementation Eligibility

All combinations of measure application type, delivery type, and sector that are 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.

Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.

Implementation Eligibility for Investor-Owned Utilities

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 conveyor ovens that exceed baking energy efficiency of ≥42% and have an idle energy rate ≤ 57,000 Btu/h, utilizing ASTM Standard F1817.

Eligible Building Types and Vintages

This measure is applicable to any building type and 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

Data collection requirements are to be determined.

USE CATEGORY

Food service (FoodServ)

ELECTRIC SAVINGS (kWh)

Not applicable.

PEAK ELECTRIC DEMAND REDUCTION (kW)

Not applicable.

GAS SAVINGS (Therms)

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

Annual Gas Unit Energy Consumption

The daily UEC of a commercial conveyor gas oven is equal to the sum of the energy required for cooking, preheat, and idle modes of operation.[4]

$$UEC\_DAY = cooking\ energy + idle\ energy + preheat\ energy$$

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

$$cooking\ energy = \frac{(nPizzas \times EFOOD)}{EFFICIENCY}$$

$nPizzas =$	*Estimated number of pizzas cooked per day*
$EFOOD =$	*ASTM energy to food (Btu/lb) = Btu/pound of energy absorbed by food product during cooking based on ASTM F1817*
$EFFICIENCY =$	*Measured heavy load cooking energy efficiency %*

[4] American Society for Testing and Materials (ASTM). 2003. *ASTM F1817-97, Standard Test Method for the Performance of Conveyor Ovens.* West Conshohocken (PA): ASTM International.

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

$$preheat\ energy = (nP \times EP)$$

nP = *Estimated number of preheats per day (#)*
EP = *Measured preheat energy (Btu)*

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

$$idle\ energy = IDLE\ RATE \times \left(EHOURS - \frac{nPizzas}{PC}\right) - \left(nP \times \frac{TP}{60}\right)$$

IDLE RATE = *Measured idle energy rate (Btu)*
EHOURS = *Operating hours per day*
nPizzas = *Estimated number of pizzas cooked per day*
PC = *Production capacity (pizzas/hr)*
nP = *Estimated number of preheats per day (#)*
EP = *Measured preheat energy (Btu)*

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

$$UEC\_YEAR = UEC\_DAY \times EDAYS \times BtuTherm$$

UEC_YEAR= *Annual unit energy consumption*
UEC_DAY = *Daily unit energy consumption*
EDAYS= *Estimated operating days per year*
BtuTherm = *Btu to therm conversion factor*

Annual Gas Unit Energy Savings

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

Note that for measures implemented through investor-owned utility (IOU) portfolios, the calculation of the UES includes an adjustment factor as per Decision 11-07-030,[5] which states "Energy Division believes that operating hours, food production rates and baseline efficiencies contribute to overly optimistic UES calculations and recommend a 30% reduction in UES values." However, the data collection below addresses these concerns therefore the 30% reduction from the savings calculation is no longer needed for the gas savings.

$$UES_{YEAR} = [UEC\_YEAR_{Base} - UEC\_YEAR_{Measure}]$$

UES_YEAR= *Annual unit energy savings*
UEC_YEAR = *Calculated annual energy consumption (Therms/year)*

[5] California Public Utilities Commission (CPUC). 2011. D 11-07-030 in the Consolidated Application of Southern California Edison Company (U338E) for Approval of its 2009-2011 Energy Efficiency Program Plan and Associated Public Goods Charge (PGC) and Procurement Funding Requests. And Related Matters. (A.08-07-021). Issued July 14, 2011. Attachment A, page A4.

Inputs and Assumptions

The inputs and assumptions for the calculation of the UEC of a conveyor gas oven under ASTM F1817 are specified below. Preheat time is assumed to be 15 minutes, since the industry standard preheat time is 10 to 20 minutes, based upon FSTC professional judgement.

UEC Inputs

Parameter	Base Case Model	Measure Case Model	Source
Preheat Time (min)	15	15	Professional judgement.
Preheat Energy (Btu)	21,270	15,000	Food Service Technology Center (FSTC). "Gas Conveyor Oven Testing Data.xls" Food Service Technology Center (FSTC). Proprietary database.
Idle Energy Rate (Btu/h)	48,662	40,000	
Heavy Load Cooking Energy Efficiency (%)	33%	46%	
Production Capacity (pizzas/hr)	150	208	
Number of Preheats per Day	1	1	
Number of pizzas Cooked per Day	250	250	
ASTM Energy to Food (Btu/pizza)	190	190	
Operating Hours/Day (hr)	12	12	Gas Technology Institute, Fisher Nickel, Inc. published study https://ww2.energy.ca.gov/2014publications/CEC-500-2014-021/CEC-500-2014-021.pdf
Operating Days/Year (days)	365	365	

A sample calculation of daily and annual UEC of a base case model is provided below.

UEC_DAY = (250 x 190) / .33 + [48,662 x (12 - 250/150 – 1 x 15/60)]
+ (1 x 35,000)

UEC_DAY = (143,939) + (490,675) + (21,270)

UEC_DAY = 655,884 Btu/day

UEC_YEAR = (655,884 X 365)/100,000 = 2,394 therms/yr

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 specified for the commercial conveyor oven is presented below. As a proxy, the EUL for the gas convection oven is adopted for this measure. Note that RUL is only applicable for add-on and accelerated replacement measures thus not applicable for commercial conveyor ovens.

Effective Useful Life and Remaining Useful Life

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

BASE CASE MATERIAL COST ($/UNIT)

Base case unit list prices were derived as the average of the manufacturer list prices of 10 commercial conveyor oven models retrieved from the AutoQuotes online catalog for foodservice equipment and supplies, equipment sales representatives, and manufacturer sources.[6] 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 FSTC staff. Additional analysis to validate the reasonableness of this value was conducted by comparing AutoQuotes published prices with actual prices on invoices submitted through the SoCal Gas Instant Rebates! Point-of-Sale Rebate Program from 2015 through August of 2017.[7] This verification revealed that a discount factor for food service equipment of 50% is a reasonable average discount factor.

MEASURE CASE MATERIAL COST ($/UNIT)

Measure case unit list prices were derived as the average of the manufacturer list prices of seven energy efficient conveyor oven models retrieved from the AutoQuotes online catalog for foodservice equipment and supplies.[8] 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

[6] Pacific Gas and Electric (PG&E). 2016. “Work Paper PGECOFST117 Commercial Conveyor Oven-Gas Revision #6.” Appendix B.

[7] Energy Solutions. 2017. "2016 IMC Analysis - For Cal TF (Energy Solutions).xls."

[8] Pacific Gas and Electric (PG&E). 2016. “Work Paper PGECOFST117 Commercial Conveyor Oven-Gas Revision #6.” Appendix B.

the actual prices paid for the equipment. The discount factor of 50% was based upon professional judgement by FSTC staff. Additional analysis to validate the reasonableness of this value was conducted by comparing AutoQuotes published prices with actual prices on invoices submitted through the SoCal Gas Instant Rebates! Point-of-Sale Rebate Program from 2015 through August of 2017.[9] This verification revealed that a discount factor 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 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 conveyor oven does not require additional installation labor or maintenance compared to a base case model. 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 Ratio

Parameter	Value	Source
NTG – Commercial	0.60	Itron, Inc. 2011. *DEER Database 2011 Update Documentation.* 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

[9] 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 Adjustments

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

NON-ENERGY IMPACTS

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

DEER DIFFERENCES ANALYSIS

This section provides a summary of DEER-based inputs and methods, and the rationale for inputs and methods that are not DEER-based. The DEER database does not contain information on energy use or savings for an energy-efficient conveyor oven measure.

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 does not contain these measures
DEER Measure IDs Used	n/a
NTG	Source: DEER 2014. NTG of 0.60 is associated with NTG ID: *Com-Default>2yrs*, *Ag-Default>2yrs*, *Ind-Default>2yrs*
GSIA	Source: DEER. The value of 1.0 is associated with GSIA ID: *Def-GSIA*
EUL/RUL	Source: DEER 2008. The value of 12 years is associated with EUL ID: *Cook-GasConvOven*

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision Effective Date and Approved By
01	07/30/2018	Jennifer Holmes Cal TF Staff	Draft of consolidated text for this statewide measure is based upon: PGECOFST117, revision 6 (April 1, 2016)* SDGENRCC0015, revision 0 (June 15, 2012) Consensus reached among Cal TF members.
	10/25/2019	Jaime Lopez-SCG	Final revisions for submittal of version 01. Updated base and measure case calculation assumptions
	12/10/2019	Jaime Lopez-SCG	Updates to base case values
	12/16/2019	Adan Rosillo-PG&E	Added delivery types UpDeemed and DnDeemDI to PG&E offering