LBC Model LRO-2G
Gas Double-Rack Oven
Performance Test

FSTC Report # 5011.08.16

Food Service Technology Center

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Specific appreciation is extended to LBC for supplying the Food Service Technology Center with the LRO-2G oven for controlled testing in the appliance laboratory.

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Executive Summary

Roll-in rack ovens offer high volume production and even baking in a relatively compact footprint. A single rack oven typically accommodates 15 pans of product at a time, effectively replacing three full-size convection ovens; a double rack oven can bake 30 pans of product at a time. These large capacity ovens fill the requirements of high-volume retail and baking operations.

The LBC LRO-2G double-rack oven is an updated version of the LRO-2G oven tested by the Food Service Technology Center in 2005.[1] New features include improved insulation, improved baffling in the heat exchanger and flue control. The oven's other features have been retained— a fully integrated ventilation hood assembly with single point exhaust connection, the patented VertiFlow® vertical stainless steel tube heat exchanger, an automatic rack lift mechanism and fully-programmable solid-state controls. Steam is still produced by a 520-lb. thermal mass with a gravity fed, waterfall-type generator.

The Food Service Technology Center (FSTC) tested the LBC, Model LRO-2G, gas-fired double-rack oven under the tightly controlled laboratory conditions specified in the American Society for Testing and Materials' (ASTM) standard test method.[2] Rack oven performance is characterized by preheat duration and energy consumption, idle energy rate, steam performance, baking energy rate and efficiency, production capacity, and browning uniformity. The oven was tested using two different food products—frozen apple pies and white sheet cakes.

Oven steam performance is defined as the oven's ability to consistently provide sufficient steam for baking crusty breads. The steam performance of the

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[1] Zabrowski, D., Sorensen, G., 2006. *LBC BakerSeries® Gas Double-Rack Oven Performance Test.* Food Service Technology Center Report 5011.06.04, March.

[2] American Society for Testing and Materials. 2006. *Standard Test Method for the Performance of Rack Ovens.* ASTM Designation F2093-06, in *Annual Book of ASTM Standards,* West Conshohocken, PA.

Executive Summary

LBC LRO-2G double rack oven was monitored over five successive steam cycles conducted at 15-minute intervals. The results of the steam performance are summarized in Figure ES-1.

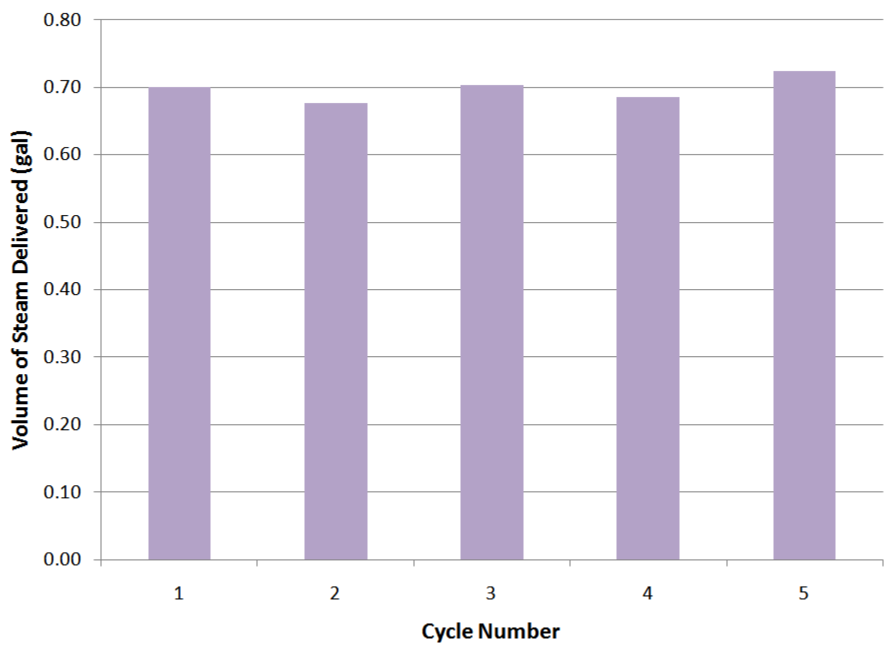

Figure ES-1.
LBC LRO-2G steam performance.

Baking-energy efficiency is a measure of how much of the energy that an appliance consumes is actually delivered to the frozen pies during the baking process. Baking-energy efficiency is therefore defined by the following relationship:

$$\text{Baking-Energy Efficiency \%} = \frac{E_{pies} + E_{pans}}{E_{oven}} \times 100\%$$

A summary of the preheat, idle and baking test results is presented in Table ES-1 along with the results from the model tested in 2005 for comparison.

Executive Summary

Table ES-1. Summary of the LBC LRO-2G Rack Oven Performance.

	2005 Model	2008 Model
Rated Energy Input Rate (Btu/h)	270,000	270,000
Measured Energy Input Rate (Btu/h)	269,095	265,270
Preheat to 400°F:		
Preheat Time (min)	15.0	17.3
Preheat Energy (Btu)	64,419	72,510
Idle Energy Rate @ 400°F (Btu/h)	47,657	23,485
Idle Fan/Control Energy Rate (kW)	0.57	1.1
Baking-Energy Efficiency (%)	47.1 ± 1.8	54.3 ± 1.7
Production Capacity (lb/h)	285.0 ± 5.9	272.8 ± 8.2

The LBC LRO-2G double rack oven performed very well during controlled laboratory testing, exhibiting an outstanding 54.3% baking-energy efficiency— a significant improvement over the 47.1% of the 2005 model. The idle energy rate was cut by over half to 23,485 Btu/h.

The improved insulation, improved baffling in the heat exchanger and flue control reduced standby losses and improved the heat retention of the oven. A slightly longer bake time than the previous generation oven is more than compensated for by the dramatic gains in efficiency and reduction in idle rate.

The cost model used the results from the application of the laboratory test to estimate the annual expenditures associated with the oven's operation. For this model, the rack oven was used to bake 1,200 pounds of food over a 12-hour day, with one preheat per day, 365 days a year. At $1.20/therm and $0.10/kWh, the LBC LRO-2G double rack oven would have an estimated annual operating cost of $3,824 under this scenario— over $1,100 less than the 2005 model's estimated yearly operating cost of $4,935.

1 Introduction

Background

Dedicated to the advancement of the food service industry, the Food Service Technology Center (FSTC) has focused on the development of standard test methods for commercial food service equipment since 1987. The test methods, approved and ratified by the American Society for Testing and Materials (ASTM), allow benchmarking of equipment such that users can make meaningful comparisons among available equipment choices.

The primary component of the FSTC is a 10,000 square-foot appliance laboratory equipped with energy monitoring and data acquisition hardware, 60 linear feet of canopy exhaust hoods integrated with utility distribution systems, appliance setup and storage areas, and a state-of-the-art demonstration and training facility. End-use customers and commercial appliance manufacturers consider the FSTC to be the national leader in commercial food service equipment testing and standards, sparking alliances with several major chain customers to date.

Rack ovens offer high volume production and even baking in a relatively compact footprint. A single rack oven typically accommodates 15 pans of product at a time, effectively replacing three full-size convection ovens; a double rack oven can bake 30 pans of product at a time. These large capacity ovens fill the requirements of high-volume retail and baking operations. They are also ideal for 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 characterized by preheat duration and energy consumption, idle energy rate, steam performance, baking energy rate and efficiency, production capacity, and browning uniformity. The ASTM test method for rack ovens (F2093-06) specifies two different food products—frozen apple pies and white sheet cakes.[1] Several FSTC reports document the application of ASTM test method to different rack ovens.[2-7]

The glossary in Appendix A is provided so that the reader has a quick reference to the terms used in this report.

Objectives

The objective of this report is to examine the operation and performance of an updated version of the LBC Bakery Equipment Model LRO-2G, gas, double-rack oven, previously tested by the FSTC in 2005.[2] The oven was tested under the controlled laboratory conditions specified in the ASTM test method. The scope of this testing is as follows:

1. Verify that the rack oven is operating at the manufacturer's rated energy input.
2. Determine the time and energy required to preheat the rack oven from room temperature to 400°F.
3. Determine the idle energy rate with the rack oven set to maintain 400°F in the baking chamber.
4. Characterize the rack oven's ability to produce steam during successive baking cycles.
5. Document the rack oven's browning uniformity using white sheet cakes.
6. Document the baking-energy consumption and baking-energy efficiency using frozen apple pies as the test product.
7. Determine the baking time and production capacity.
8. Estimate the annual operating cost for the rack oven using a standard cost model.

Appliance Description

The LBC LRO-2G double-rack oven has been updated with improved insulation, improved baffling in the heat exchanger and flue control. Other features are retained— a fully integrated ventilation hood assembly with single point exhaust connection, the patented VertiFlow® vertical stainless steel tube heat exchanger, an automatic rack lift mechanism and fully-programmable solid-state controls. Steam is produced by a 520-lb. thermal mass with a gravity fed, waterfall-type generator.

Appliance specifications are listed in Table 1-1, and the manufacturer's literature is in Appendix B. The appliance is pictured in Figure 1-1.

Figure 1-1.
The LBC LRO-2G Oven.

Table 1-1. Appliance Specifications.

Manufacturer	LBC
Model	LRO-2G
Generic Appliance Type	Double-rack gas oven
Rated Input	270,000 Btu/h
Construction	Stainless steel exterior and interior
Controls	Solid-state programmable digital controls
Pan Capacity (as tested)	30 full-size (20" x 30") sheet pans
External Dimensions (including hood)	72.25" x 108.25" x 104.8" (w×d×h)

2 Methods

Setup and Instrumentation

The LRO-2G oven was installed in accordance with the manufacturer's instructions in a conditioned test space. The room was maintained at an ambient condition of 75 ± 5°F during testing. Natural gas consumption was measured with a positive displacement-type gas meter that generated a pulse for every 0.1 ft^3 consumed. Motor and control energy were measured with a watt/watt-hour transducer that generated a pulse for each 10 Wh used. Water consumption was measured with an in-line flow sensor installed on the water inlet hose. Oven cavity temperature was monitored with 24 gauge, type K, Teflon insulated thermocouple wire located at the center of the pressure panel outlet. The transducer and thermocouples were connected to a computerized data acquisition unit that recorded data every 5 seconds.

Energy Input Rate and Thermostat Calibration

The energy input rate was determined by turning the oven on and measuring the energy consumed from the time the oven first began operating until the time when the burner first cycled off. The energy consumed and the time elapsed were used to calculate the maximum energy input rate. Thermostat calibration was verified by allowing the oven to operate with the thermostat set to the specified operating temperature of 400 ± 5°F for a period of two hours and then monitoring the oven cavity temperature for a period of one hour.

Preheat and Idle Tests

The preheat test recorded the time and energy required for the oven to increase the cavity temperature from 75 ± 5°F to a temperature of 390°F. Recording began when the oven was first turned on, so any time delay before the ignition of the burner was included in the test. Although the specified operating temperature is 400°F, research at the Food Service Technology Center has indicated that a rack oven is sufficiently preheated and ready to cook when the oven temperature is within 10°F of the oven set point.

After the oven was preheated, it was allowed to stabilize for two hours, and then idle energy was monitored for a 3-hour period.

Steam Performance Test

The steam performance test consisted of five successive baking cycles at 15-minute intervals. The rack oven was stabilized at 400°F for a minimum of two hours and the steam injection time set to 10-seconds. Water consumption and runoff were measured and recorded for each cycle. The amount of steam produced for each cycle was determined as the difference between the water into the oven and the runoff collected from the oven drain.

Baking-Energy Efficiency Tests

The baking-energy efficiency and production capacity tests consisted of baking frozen apple pies on full-size sheet pans. The 10-inch ready-to-bake apple pies weighed an average of 3.10 ± 0.15 lb and consisted of a pre-cooked apple based filling (see Figure 2-1).

Figure 2-1. Cross section of a frozen apple pie.

Three pies were placed on each baking pan and baked from 0 ± 5°F to an average temperature of 185 ± 5°F. Baked pie temperature was measured using a rig that held three thermocouples in a straight line across the diameter of the pie and fixed each sensing point in the middle of the filling (Figure 2-2).

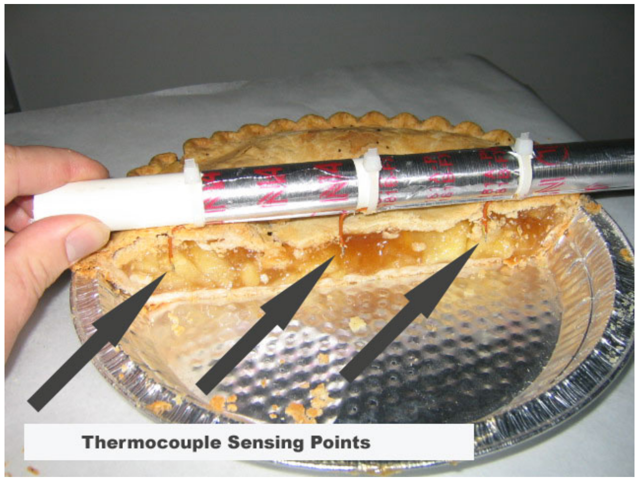

Figure 2-2. Thermocouple rig for measuring baked pie temperature.

Energy imparted to the frozen pies is the sum of the energy required to raise their temperatures from 0°F to the endpoint (sensible energy), the energy required to melt the frozen water in the pies (fusion energy), and the energy required to vaporize a portion of the water contained in the pies (vaporization energy). The rack oven's baking-energy efficiency is the amount of energy imparted to the pies, expressed as a percentage of the amount of energy consumed by the rack oven during the baking process.

The pie test was applied in triplicate and a statistical analysis of the results was performed to ensure that the reported baking-energy efficiency and production capacity results had an uncertainty of less than 10%.

Browning Uniformity Tests

The rack oven's browning uniformity was documented while baking white sheet cakes. For this test, the oven was loaded with 30 full-size sheet pans, each filled with 5 pounds of cake batter. The cakes were considered done when a wood skewer could be inserted into the cakes and removed without any particles adhering to it.

Appendix C contains the ASTM results reporting sheets for this oven.

Methods

Energy Cost Model

The oven operating cost was calculated based on a combination of test data and assumptions about typical oven usage. This provides a standard method for estimating oven energy consumption based on ASTM performance test results. The examples contained in the operating cost model are for informational purposes only, and should not be considered an absolute.

The model assumes that the rack oven was used to bake 1,200 pounds of food over a 12-hour day, with one preheat per day, 365 days a year. The idle (standby) time for the oven was determined by taking the difference between the total daily “on” time (12 hours) and the time spent baking and preheating.

3 Results

Energy Input Rate and Thermostat Calibration

The measured energy input rate was 265,270 Btu/h, which was 1.8% lower than the nameplate rate of 270,000 Btu/h, but within the 5% tolerance of the ASTM test method.

With the thermostat set to an indicated 400°F, the oven temperature at the pressure panel averaged 400°F. Therefore, no adjustment of the thermostat was necessary.

Preheat and Idle Rate Tests

Preheat Energy and Time

The oven reached 390°F in 17.3 minutes, while consuming 72,510 Btu. The electric energy consumption was 365 Wh. Figure 3-1 shows the rack oven's energy consumption and the baking cavity temperature during this preheat test.

Idle Energy Rate

The idle energy rate at 400°F was 23,485 Btu/h. The fan/control energy rate during the idle test was 1.1 kW. The results of the input rate, preheat and idle tests are shown in Table 3-1, with the results from the 2005 model testing included for comparison.

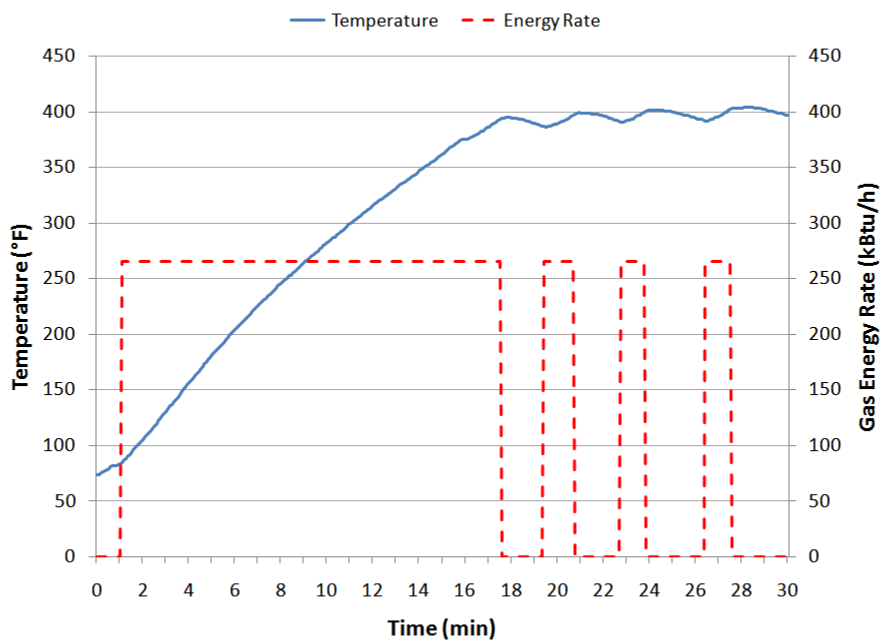

Figure 3-1. LRO-2G Preheat characteristics.

Table 3-1. Input, Preheat and Idle Test Results.

	2005 Model	2008 Model
Rated Energy Input Rate (Btu/h)	270,000	270,000
Measured Energy Input Rate (Btu/h)	269,095	265,270
Preheat to Operational Capacity:		
Time (min)	15.0	17.3
Gas Energy Consumption (Btu)	64,419	72,510
Electric Energy Consumption (Wh)	315	365
Idle Energy Rate @ 400°F (Btu/h)	47,657	23,485
Idle Fan/Control Energy Rate (kW)	0.57	1.1

Steam Performance Test

The 15-minute steam interval was chosen as representative of a high-volume bakery baking 4-loads of bread per hour. Since many bakers consider ample steam at the start of the bake an essential requirement for a hard, shiny crust, the ability of the oven to produce sufficient steam from one bake cycle to the next is an important parameter to an operator. Table 3-2 and Figure 3-2 summarize the results of the steam performance tests.

Table 3-2. Steam Performance Test Results.

Cycle number	1	2	3	4	5
Water injection time (sec)	10	10	10	10	10
Volume of water delivered (gal)	0.76	0.75	0.76	0.73	0.78
Volume of Runoff (gal)	0.06	0.07	0.06	0.04	0.06
Volume of steam delivered (gal)	0.70	0.68	0.70	0.69	0.72

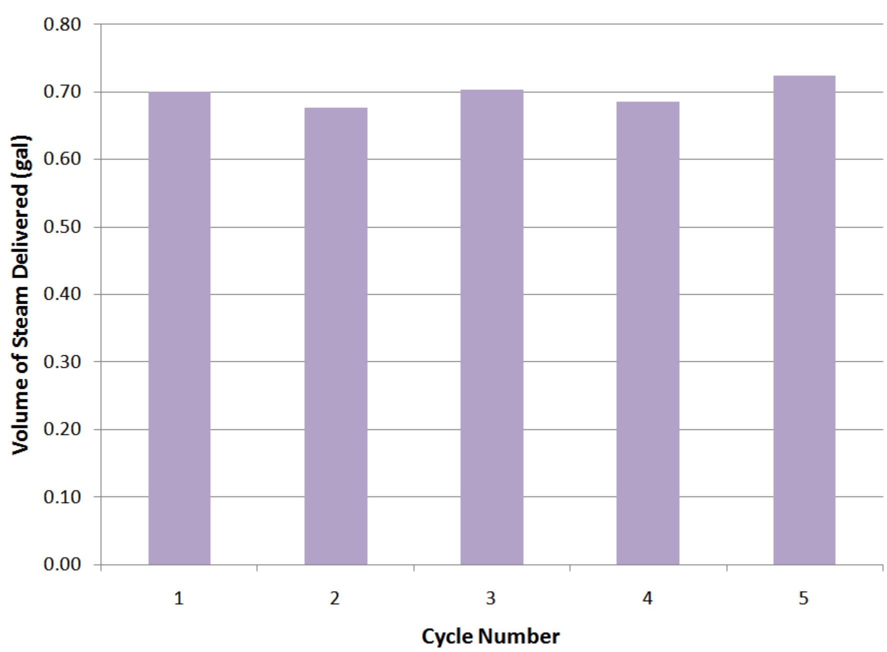

*Figure 3-2.
LRO-2G Steam production & repeatability.*

Baking Tests

Two food products were baked in the LBC rack oven: frozen apple pies and sheet cakes. The frozen pies represented a heavy load on the oven due to their large thermal mass, while the sheet cakes represented a medium load on the oven and provided distinct browning characteristics. Thirty full-size sheet pans were used for both sets of baking tests. Bake time, oven temperature and oven energy consumption were monitored during these tests.

Pie Tests

The rack oven was tested with a full load (30 pans) of frozen apple pies. The pie test was designed to reflect a rack oven's maximum performance. The large frozen load would drive down the cavity temperature and challenge the oven to recover after loading the pies. The LBC double rack oven baked a full-load of pies in 58.0 minutes, while consuming 117,530 Btu.

Baking-energy efficiency is defined as the quantity of energy consumed by the food and pans expressed as a percentage of energy consumed by the oven during the cooking test:

$$\text{Baking-Energy Efficiency \%} = \frac{E_{pies} + E_{pans}}{E_{oven}} \times 100\%$$

Energy imparted into the pies was calculated by separating the various components of the apple pies (water, fat, solids) and determining the amount of heat absorbed by each component during the baking process. Baking-energy efficiency results for the frozen pie tests were 53.5%, 54.8% and 54.5%, yielding an uncertainty of 3.1% in the test results. Table 3-3 summarizes the results of the frozen pie tests alongside the results from the 2005 model testing for comparison. Appendix D contains a synopsis of test data for each replicate of the cooking tests.

Table 3-3. Frozen Apple Pie Test Results.

	2005 Model	2008 Model
Pies per Load	90	90
Bake Time (min)	55.0	58.0
Baking Energy Rate (Btu/h)	147,475	117,830
Fan/Control Energy Rate (kW)	1.0	1.1
Oven Energy Consumption (Btu/lb)	530	446
Production Capacity (lb/h)	285.0 ± 5.9	272.8 ± 8.2
Baking-Energy Efficiency (%)	47.1 ± 1.8	54.3 ± 1.7

Sheet Cake Test

White sheet cakes provide a visual indication of the temperature uniformity of an oven while baking. The bake time was experimentally determined so that the cakes were uniformly cooked while exhibiting the greatest possible differences in color. In any oven, one can expect variations in color and texture from rack to rack, especially in the top location, since this area of the oven is usually the hottest. The results of the test are described below and visual representations of the browning are shown in Figures 3-3 through 3-5.

Overall sheet cake browning was fairly consistent from cake to cake. The first (top) rack position was noticeably darker than the others. Uniformity across the remaining cakes showed darker areas towards the inner edges, with cakes becoming lighter towards the bottom of the rack. Figures 3-3 through 3-5 show the cakes from the topmost position and two other rack positions that are indicative of the remainder of the set.

Figure 3-3
Cakes in top rack position.

Figure 3-4.
Cakes in 8th rack position from top.

Figure 3-5.
Cakes in 14th rack position from top.

Energy Cost Model

With the results obtained from the application of the laboratory test, the annual cost associated with operating the oven can be estimated. This guide can be used to project the operating cost of this rack oven based on the hours of operation, the amount of food produced, etc. Consumers can use this tool, along with the performance results to compare this appliance with other models and manufacturers.

For this model, the rack oven was used to bake 1,200 pounds of food over a 12-hour day, with one preheat per day, 365 days a year. The idle (standby) time for the oven was determined by taking the difference between the total daily "on" time (12 hours) and the time spent baking and preheating. This approach produces a more accurate estimate of the operating costs for the rack oven. Table 3-4 summarizes the energy consumption and associated operating cost for the LBC LRO-2G double rack oven under this scenario.

Table 3-4. Annual Cost Model.

	Gas (kBtu) [a]	Electricity (kWh)
Daily Preheat Energy	72.5	0.37
Daily Idle Energy	171.7	8.04
Daily Cooking Energy	518.4	4.84
Total Daily Energy	762.6	13.25
Total Operating Cost ($/yr) [b]	3,340	$484

[a] 1 kBtu = 1,000 Btu
[b] Oven energy costs are based on $1.20/therm for gas and $0.10/kWh for electricity. (1 therm =100,000 Btu).

The estimated annual operating cost of $3,824 is over $1,100 less than the 2005 model's estimated yearly operating cost of $4,935

4 Conclusions

The LBC LRO-2G double rack oven performed very well during controlled laboratory testing, exhibiting an outstanding 54.3% baking-energy efficiency— a significant improvement over the 47.1% of the 2005 model.[2] The oven also exhibited consistent and repeatable steam generation to stand up to high-volume baking while delivering enough steam to ensure a quality baked product.

The LRO-2G oven was ready to bake in just over 17 minutes, consuming 72,510 Btu of natural gas and 0.37 kWh of fan energy. The idle energy rate of 23,485 Btu/h was less than half of the 47,657 Btu/h consumed by the 2005 model.

The improved insulation, improved baffling in the heat exchanger and flue control reduced standby losses and improved the heat retention of the oven. A slightly longer bake time than the previous generation oven is more than compensated for by the dramatic gains in efficiency and reduction in idle rate.

The energy cost model used the results from the application of the laboratory test to estimate the annual expenditures associated with the oven's operation. For this model, the rack oven was used to bake 1,200 pounds of food over a 12-hour day, with one preheat per day, 365 days a year. At $1.20/therm and $0.10/kWh, the LBC LRO-2G double rack oven would have an estimated annual operating cost of $3,824 under this scenario— over $1,100 less than the 2005 model's estimated yearly operating cost of $4,935.

5 References

1. American Society for Testing and Materials, 2006. *Standard Test Method for the Performance of Rack Ovens.* ASTM Designation F2093–06. In annual book of ASTM Standards, West Conshohocken, PA.

2. Zabrowski, D., Sorensen, G., 2006. *LBC BakerSeries® Gas Double-Rack Oven Performance Test.* Food Service Technology Center Report 5011.06.04, March.

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6. Sorensen, G., 2008. *Gemini, Model V42LN Gas Double-Rack Oven Summary Report.* Food Service Technology Center Report 5012.08.10, June.

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A Glossary

Baking Energy (kWh or kBtu)

The total energy consumed by an appliance as it is used to bake a specified food product.

Baking Energy Consumption Rate
(kW or kBtu/h)

The average rate of energy consumption during the baking period.

Baking-Energy Efficiency (%)

The quantity of energy input to the food product; expressed as a percentage of the quantity of energy input to the appliance during the baking tests.

Duty Cycle (%)
Load Factor

The average energy consumption rate (based on a specified operating period for the appliance) expressed as a percentage of the measured energy input rate.

$$\text{Duty Cycle} = \frac{\text{Average Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

Energy Input Rate (kW or kBtu/h)
Energy Consumption Rate
Energy Rate

The peak rate at which an appliance will consume energy, typically reflected during preheat.

Heating Value (Btu/ft^3)
Heating Content

The quantity of heat (energy) generated by the combustion of fuel. For natural gas, this quantity varies depending on the constituents of the gas.

Idle Energy Rate (kW or Btu/h)
Idle Energy Input Rate
Idle Rate

The rate of appliance energy consumption while it is "holding" or maintaining a stabilized operating condition or temperature.

Idle Temperature (°F, Setting)

The temperature of the cooking cavity/surface (selected by the appliance operator or specified for a controlled test) that is maintained by the appliance under an idle condition.

Idle Duty Cycle (%)
Idle Energy Factor

The idle energy consumption rate expressed as a percentage of the measured energy input rate.

$$\text{Idle Duty Cycle} = \frac{\text{Idle Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

Measured Input Rate (kW or Btu/h)
Measured Energy Input Rate
Measured Peak Energy Input Rate

The maximum or peak rate at which an appliance consumes energy, typically reflected during appliance preheat (i.e., the period of operation when all burners or elements are "on").

Preheat Energy (kWh or Btu)
Preheat Energy Consumption

The total amount of energy consumed by an appliance during the preheat period.

Preheat Rate (°F/min)

The rate at which the oven cavity heats during a preheat.

Glossary

Preheat Time (minute)
Preheat Period

The time required for an appliance to heat from the ambient room temperature ($75 \pm 5°F$) to a specified (and calibrated) operating temperature or thermostat set point.

Production Capacity (lb/h)

The maximum production rate of an appliance while cooking a specified food product in accordance with the heavy-load cooking test.

Rated Energy Input Rate
(kW, W or Btu/h, Btu/h)
Input Rating (ANSI definition)
Nameplate Energy Input Rate
Rated Input

The maximum or peak rate at which an appliance consumes energy as rated by the manufacturer and specified on the nameplate.

Test Method

A definitive procedure for the identification, measurement, and evaluation of one or more qualities, characteristics, or properties of a material, product, system, or service that produces a test result.

Typical Day

A sampled day of average appliance usage based on observations and/or operator interviews, used to develop an energy cost model for the appliance.

B Appliance Specifications

Appendix B includes the product literature for the LBC LRO-2G gas-fired double-rack oven.

Item No. ____________________

Project ____________________

Quantity ____________________

BakerSeries Gas, Roll-in [Double] Rack Oven — *MODEL: LRO-2G*

Model LRO-2 Shown

(Rack not included)

MODEL / RACK CAPACITY

Maximum Capacity	
18" x 26" Full-size Sheet Pans*	40
12" x 20" x 4" Hotel Pans**	40
1 Lb. Loaves of Bread	200
1 1/2 Lb. Loaves of Bread	150

* Based on 3" spacing

** Based on 6" Spacing

Short Bid Specification:

Rack oven shall be an ***LBC Bakery Equipment Model LRO-2G*** 290,000 BTU/Hr. gas heated rotating, double rack capacity unit with; vertiflow heat exchanger; gravity feed waterfall type steam generation system; 5' thick compartment insulation rated at 0" combustible wall clearance; heavy-duty rack lift and rotate system with gear driven rotation system; simple solid state controls, with digital time-temperature readouts, 5 event menu programs for time, temperature, steam, vent and blower function, 60-menu program memory; an integrated hood meeting NFPA 96 and Type I & II construction standards, plus all the features listed:

STANDARD PRODUCT WARRANTY

One-Year Parts and Labor (contiguous US Including Alaska and Hawaii, Canada)

Construction Features

- Heavy duty stainless steel interior
- Cooking compartment insulated with 5" thick high-temp insulation
- Fully integrated hood with single point exhaust connection
- Automatic, heavy-duty "B" style lift and rotate system
- Heavy-Duty gear driven rotation system
- Cooking chamber illuminated by externally mounted florescent lamp
- Heavy-duty door with 9.75" x 57.5" viewing window
- Interior door safety release mechanism
- Accommodates two single or one double rack

Performance Features

- 200-550 Degree F temperature range
- Vertiflow heat exchanger used natural draft effect for combuation air
- Burner manifold uses inshot burners and hot surface ignition
- High volume gravity feed, waterfall type steam system
- Adjustable air circulation louvers
- Self adjusting slip clutch protects operator and prevent component damage
- Automatic rack stop and lower when door is opened
- Floor level loading without ramps

Integrated Hood Features and Performance

- Meets the construction requirements of NFPA 96 & UMC requirements for Type I & II Hoods, fire systems when required shall be by others.
- 20 Ga stainless steel body
- 8" round collar, 2,300 FPM @ 800 CFM, 1.0"wc (roof vent not included)
- 5.9 square feet of capture area, filter velocity of 120 FPM, .03" wc @ 800 CFM

Controls Package

- Digital controls with large LED readouts for Time and temperature
- Large LCD event screen for programming and oven status
- 60- Item programmable memory, with 5-events per item
- Simple manual program for time, temp., steam and vent
- Infrared port for uploading and downloading programs
- Flash type programming for revision updates without replacing PCB

Sheet Number LRO-2G v 13 (rev 10/07)

LBC Bakery Equipment, Inc. 1410 80th Street SW Everett WA 98203
TOLL FREE 888-RACKOVN (888-722-5686) FAX: 425-642-8305 www.lbcbakery.com

BakerSeries Gas Roll-in [Double] Rack Oven   MODEL: LRO-2G

INSTALLATION REQUIREMENT

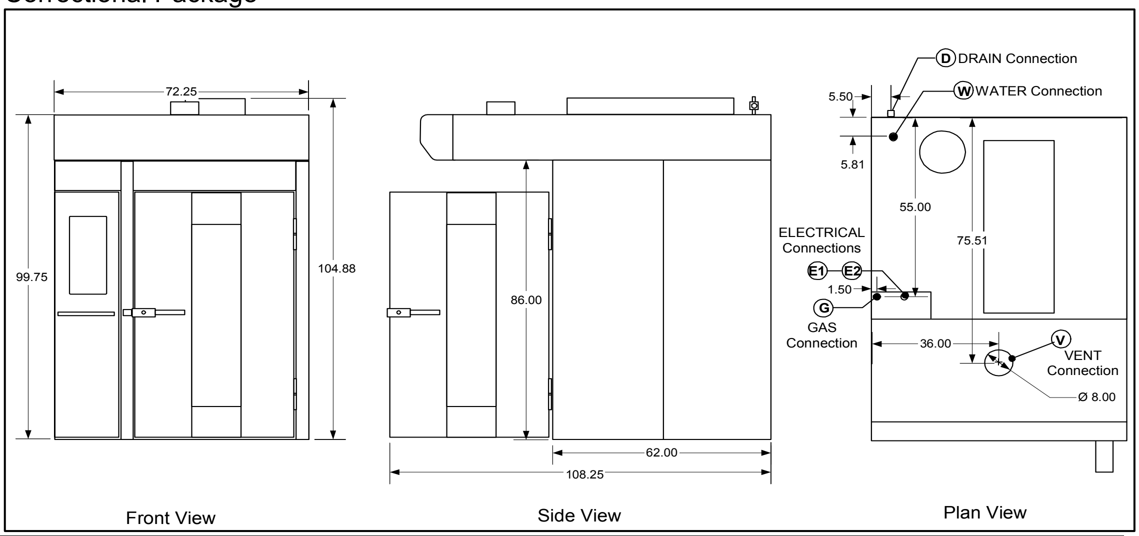
Oven ships two-piece for movement through 36" opening

Two 1/2" EMT electrical connections E1 = 120 VAC 1-Phase for controls and lift and rotate, E2 208-240 VAC 3-Phase for circulation blower

- 1/2" NPT Water Connection
- 3/4" NPT Vented drain
- 8" Round vent collar (consult local codes for installation requirements) Roof vent not included
- Specify Natural gas or LP Gas

OPTIONS & ACCESSORIES

Single and Double Oven Racks
Correctional Package



Model	Height x Width x Depth*	Clearance from combustible surfaces**	Weight		Freight Class
			Actual	Shipping	
LRO-2G	104.8" x 72.25" x 108.25"	Sides 0" Back 0"	3380	4380	70

* 112" ceiling clearance required for tip-up ** Noncombustible floor supported by Noncombustible structure

Model	Electrical Requirements					Water	Drain	Gas
	Connection	Voltage	Total kW	Phase	Amps / Line			
LRO-2G	E-1	120 VAC / 60Hz	1.5	1	12	1/2" NPT (9 GPM @ 40 PSI)	3/4" NPT (210F, 1 GPM max)	3/4" NPT 290,000 BTU/Hr
	E-2	208 VAC/60Hz	1.2	3	6			
		240 VAC/60Hz	1.2	3	5			
		480 VAC/60Hz	1.2	3	3			

IMPORTANT: Your local water conditions may damage your LBC appliance. Failure to properly treat water may result in damage and may void your warranty. Ensure that your water supply meets these minimum water quality specification.

Parameter	Unit	Value
Alkalinity	ppm	22
Aluminum	ppb	17
Calcium	ppm	3.3
Free Chlorine Residual	ppm	0.6

Parameter	Unit	Value
Magnesium	ppm	0.65
pH	s.u.	8.5
Sodium	ppm	8.5
Total Hardness	ppm	11.9

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C Results Reporting Sheets

Manufacturer: LBC
Model: LRO-2G
Date: June 2008

Test Rack Oven

Description of operational characteristics:

The LBC LRO-2G double-rack oven features stainless steel interior and exterior construction, an integrated hood And a rated input of 270,000 Btu/h. The burner system incorporates inshot burners, steam is generated by a self-contained, waterfall-type system and a digital control package handles oven operation.

Apparatus

√ Check if testing apparatus conformed to specifications in Section 6.

Energy Input Rate

Gas Heating Value (Btu/ft^3) 1023
Measured (Btu) 265,270
Rated (Btu) 270,000
Percent Difference between Measured and Rated (%) 1.8

Thermostat Calibration

As-Received:
Oven Temperature Control Setting (°F) 400
Oven Cavity Temperature (°F) 400

As-Adjusted:
Oven Temperature Control Setting (°F) N/A
Oven Cavity Temperature (°F) N/A

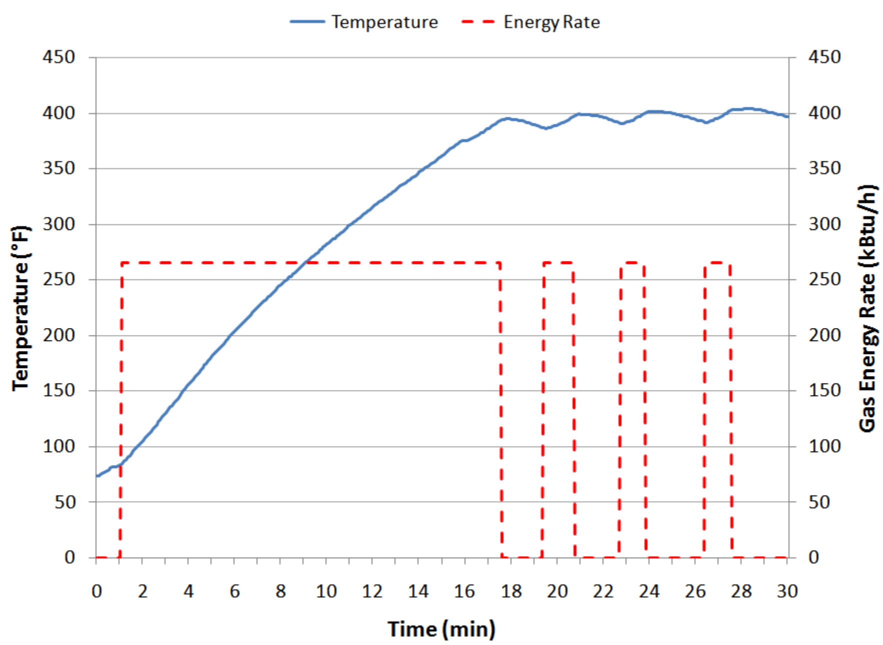
Preheat Energy and Time

Gas Heating Value (Btu/ft^3) 1023
Starting Temperature (°F) 73.6
Energy Consumption (Btu) 72,510

Electric Energy Consumption (Wh) __365__

Duration (min) __17.3__

Preheat Rate (°F/min) __18.3__



Preheat Curve

Idle Energy Rate

Gas Heating Value (Btu/ft^3) __1019__

Idle Energy Rate (Btu/h) __23,485__

Electric Energy Rate (kW) __1.1__

Browning Uniformity (White Sheet Cakes)

Description of sheet cake browning:

Overall sheet cake browning was fairly consistent from cake to cake. The first (top) rack position was noticeably darker than the others. Uniformity across the remaining cakes showed darker areas towards the inner edges, with cakes becoming lighter towards the bottom of the rack.

Gas Heating Value (Btu/ft^3) 1023
Initial Cake Temperature (°F) 68.7
Final Cake Temperature (°F) 198.9
Sheet Cake Bake Time (min) 23.0
Sheet Cake Baking Energy (Btu) 45,495
Electric Energy (Wh) 340

The following photographs show the cakes from the topmost position and two other rack positions that are indicative of the remainder of the set.

Rack Position: 1st (Top)

Rack Position: 8th from Top

Rack Position: 14th from Top

Results Reporting Sheets

Steam Performance:

	Cycle #1	Cycle #2	Cycle #3	Cycle #4	Cycle #5
Water injection time (sec)	10	10	10	10	10
Volume of water delivered per cycle (gal)	0.76	0.75	0.76	0.73	0.78
Volume of Runoff per cycle (gal)	0.06	0.07	0.06	0.04	0.06
Volume of steam delivered each cycle (gal)	0.70	0.68	0.70	0.69	0.72

Baking Energy Efficiency, Baking Energy Rate and Production Capacity

Gas Heating Value (Btu/ft^3) 1031

Baking Time (min) 58.0

Production Capacity (lbs/h) 272.8 ± 8.2

Energy To Food (Btu/lb) 227

Baking Energy Rate (Btu/h) 117,830

Electric Energy Rate (kW) 1.1

Energy per Pound of Food Cooked (Btu/lb) 446

Baking Energy Efficiency (%) 54.3 ± 1.7

D Baking-Energy Efficiency Data

Table D-1. Specific Heat and Latent Heat.

Specific Heat (Btu/lb, °F)	
Apple Pies	0.63
Aluminum (Sheet pans)	0.20
Latent Heat (Btu/lb)	
Fusion, Water	144
Vaporization, Water	970

Baking-Energy Efficiency Data

Table D-1. Full-Load Pie Test Data.

	Replication 1	Replication 2	Replication 3
Measured Values			
Bake Time (min)	58.0	58.0	58.0
Oven Energy Consumption (Btu)	115,795	113,460	112,445
Fan/Control Energy Consumption (Wh)	1090	1060	1040
Initial Temperature of Frozen Pies (°F)	-1.5	-1.5	-1.8
Final Temperature of Baked Pies (°F)	185.5	183.2	185.4
Weight of Sheet Pans (lb)	106.9	106.7	106.7
Initial Weight of Raw Frozen Pies (lb)	265.6	265.5	260.0
Final Weight of Baked Pies (lb)	256.6	255.9	250.7
Initial Moisture Content of the Apple Pies (%)	52.2	52.2	52.2
Calculated Values			
Initial Weight of Water (lb)	138.6	138.6	135.7
Weight Loss During Baking (lb)	9.0	9.6	9.3
Sensible Heat (Btu)	31,290	30,900	30,670
Latent – Heat of Fusion (Btu)	19,960	19,950	19,540
Latent – Heat of Vaporization (Btu)	8,700	9,340	9,040
Total Energy to Food (Btu)	59,950	60,190	59,245
Energy to Food (Btu/lb)	226	227	228
Energy to Pans (Btu)	4,000	3,940	3,995
Total Energy Consumed by the Rack Oven (Btu)	119,520	117,085	116,000
Energy to Oven (Btu/lb of food produced)	450	440	445
Results			
Baking Energy Rate (Btu/h)	119,790	117,375	116,320
Fan/Control Energy Rate (kW)	1. 1	1.1	1. 1
Baking-Energy Efficiency (%)	53.5	54.8	54.5
Production Capacity (lb/h)	274.7	274.7	269.0

Baking-Energy Efficiency Data

Table D-2. Baking-Energy Efficiency and Production Capacity Statistics.

	Baking-Energy Efficiency	Production Capacity
Replicate #1	53.5	274.7
Replicate #2	54.8	274.7
Replicate #3	54.5	269.0
Average	54.3	272.8
Standard Deviation	0.67	3.3
Absolute Uncertainty	1.7	8.2
Percent Uncertainty	3.1	3.0

E Energy Cost Model

Appliance test results are useful not only for benchmarking appliance performance, but also for estimating appliance energy consumption. The following procedure is a guideline for estimating rack oven energy consumption based on data obtained from applying the appropriate test method.

The intent of this Appendix is to present a standard method for estimating oven energy consumption based on ASTM performance test results. The examples contained herein are for information only and should not be considered an absolute. To obtain an accurate estimate of energy consumption for a particular operation, parameters specific to that operation should be used (e.g., operating time, and amount of food cooked under heavy-, medium-, and light-loads).

The appropriate oven performance parameters are obtained from section 11 in the test method.

The calculation will proceed as follows: First, determine the appliance operating time and total number of preheats. Then estimate the quantity of food baked during the day. Calculate the energy due to baking, using full-load equivalent baking hours and calculate the idle energy consumption. The total daily energy is the sum of these components plus the preheat energy. For simplicity, it is assumed that subsequent preheats require the same time and energy as the first preheat of the day.

Application of the test method to the LBC LRO-2G gas rack oven yielded the following results:

Table E-1: LBC LRO-2G Gas Double-Rack Oven Test Results.

Preheat Time	17.3 min
Preheat Energy	72,510 Btu + 0.37 kWh
Idle Energy Rate	23,485 Btu/h + 1.1 kW
Heavy-Load Baking Energy Rate	117,830 Btu/h + 1.1 kW
Heavy-Load Production Capacity	273 lb/h

Step *1*—The following appliance operation is assumed:

Table E-2: Oven Operation Assumptions.

Operating Time	12 h
Number of Preheats	1 preheat
Total Amount of Food Cooked	1,200 lb

Step *2*—Calculate the total heavy-load baking energy.

The total time cooking heavy-loads is as follows:

$$t_h = \frac{W}{PC},$$

$$t_h = \frac{1{,}200\ \text{lb}}{273\ \text{lb/h}},$$

$$t_h = 4.40\ h$$

The total heavy-load energy consumption is then calculated as follows:

$$E_{gas,h} = q_{gas,h} \times t_h,$$

$$E_{gas,h} = 117{,}830\ Btu/h \times 4.40\ h,$$

$$E_{gas,h} = 518{,}452\ Btu$$

$$E_{elec,h} = q_{elec,h} \times t_h,$$

$$E_{elec,h} = 1.1\ kW \times 4.40\ h,$$

$$E_{elec,h} = 4.84\ kWh$$

Step *3*—Calculate the total idle time and energy consumption.

The total idle time is determined as follows:

$$t_i = t_{on} - t_h - \frac{n_p \times t_p}{60},$$

$$t_i = 12.0\ \text{h} - 4.40\ \text{h} - \frac{1\ \text{preheat} \times 17.3\ \text{min}}{60\ \text{min/h}}$$

$$t_i = 7.31\ h$$

The idle energy consumption is then calculated as follows:

$E_{gas,i} = q_{gas,i} \times t_i,$

$E_{gas,i} = 23{,}485\ Btu/h \times 7.31\ h$

$E_{gas,i} = 171{,}675\ Btu$

$E_{elec,i} = q_{elec,i} \times t_i,$

$E_{elec,i} = 1.1\ kW \times 7.31\ h$

$E_{elec,i} = 8.04\ kWh$

Step *4*—The total daily energy consumption is calculated as follows:

$E_{gas,daily} = E_{gas,h} + E_{gas,i} + n_p \times E_{gas,p},$

$E_{gas,daily} = 518{,}452\ Btu + 171{,}675\ Btu + 1 \times 72{,}510\ Btu$

$E_{gas,daily} = 762{,}637\ Btu/day = 7.63\ therms/day$

$E_{elec,daily} = E_{elec,h} + E_{elec,i} + n_p \times E_{elec,p},$

$E_{elec,daily} = 4.84\ kWh + 8.04\ kWh + 1 \times 0.37\ kWh$

$E_{elec,daily} = 13.25\ kWh/day$

Step *5*—Calculate the average demand as follows:

$$q_{avg} = \frac{E_{elec,\ daily}}{t_{on}},$$

$$q_{avg} = \frac{13.25\ \mathrm{kWh}}{12.0\ \mathrm{h}},$$

$q_{avg} = 1.10\ kW$

Step *6*—The estimated yearly appliance energy cost may be determined as follows:

$$C_{gas,yearly} = \mathrm{r_{gas}} \times \frac{\mathrm{E_{gas,\ daily}}}{100{,}000\ \frac{\mathrm{Btu}}{\mathrm{therm}}} \times \mathrm{d_{op}}$$

$$C_{gas,yearly} = \$1.20\ \frac{\$}{\mathrm{therm}} \times \frac{762{,}637\ \frac{\mathrm{Btu}}{\mathrm{day}}}{100{,}000\ \frac{\mathrm{Btu}}{\mathrm{therm}}} \times 365\ \frac{\mathrm{days}}{\mathrm{yr}}$$

$$C_{gas,yearly} = \$3{,}340$$

$$C_{elec,yearly} = \mathrm{r_{elec}} \times \mathrm{E_{elec,\ daily}} \times \mathrm{d_{op}}$$

$$C_{elec,yearly} = \$0.10\ \frac{\$}{\mathrm{kWh}} \times 13.25\ \frac{\mathrm{kWh}}{\mathrm{day}} \times 365\ \frac{\mathrm{days}}{\mathrm{yr}}$$

$$C_{elec,yearly} = \$484$$