Emerging Technologies (ET) Energy-Efficient Commercial Foodservice—Scaled Field Placement

Food Service Technology—Efficient Equipment, Including Ice Machines and Cooking Appliances

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FOOD SERVICE TECHNOLOGY CENTER BACKGROUND

The information in this report is based on data generated at the Pacific Gas and Electric Company (PG&E) Food Service Technology Center (FSTC). Dedicated to the advancement of the foodservice industry, The FSTC has focused on the development of standard test methods for commercial foodservice equipment since 1987. The primary component of the FSTC is a 10,000 square-foot laboratory equipped with energy monitoring and data acquisition hardware, 60 linear feet of canopy exhaust hoods integrated with utility distribution systems, equipment setup and storage areas, and a state-of-the-art demonstration and training facility.

The FSTC Energy Efficiency for Foodservice Program is funded by California utility customers and administered by PG&E under the auspices of the California Public Utilities Commission (CPUC). California customers are not obligated to purchase any additional services offered by the contractor.

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- Fisher-Nickel, inc. and the FSTC do not endorse particular products or services from any specific manufacturer or service provider.

- The FSTC is strongly committed to testing foodservice equipment using the best available scientific techniques and instrumentation.

- The FSTC is neutral as to fuel and energy source. It does not, in any way, encourage or promote the use of any fuel or energy source, nor does it endorse any of the equipment tested at the FSTC.

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ABBREVIATIONS AND ACRONYMS

AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ASTM	American Society for Testing and Materials
Btu	British thermal unit
CEE	Consortium for Energy Efficiency
CT	Current Transformer
DR	Demand Response
FNi	Fisher-Nickel, inc.
FSTC	Food Service Technology Center
h	Hour
lb	Pound
IMH-A	Ice-Making Head—Air-cooled
kW	Kilowatt
kWh	Kilowatt-hour
Mtherms	Million therms
PG&E	Pacific Gas & Electric
PLS	Permanent Load Shifting
RCU-A	Remote Condensing Unit—Air-cooled
SC-A	Self-Contained—Air-cooled
SCE	Southern California Edison
TOU	Time Of Use
TVP	Time Varying Pricing

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EXECUTIVE SUMMARY

Commercial foodservice establishments have historically utilized equipment that require high amounts of energy consumption in their operations—for cooking, refrigerating, ventilating, warewashing, and water heating. Most commercial foodservice establishments currently in production are using older equipment that consume more energy than is necessary for their operations; many of which are also operating their equipment in a way that results in more energy being used, and higher energy bills as a result.

Due to the high capital costs of most foodservice equipment, and because of relatively low margins in the foodservice business as a general rule, restaurants demand a high level of consistency in their operations, and are thus reluctant to upgrade equipment to more efficient models. Rather, they have historically tended to use existing equipment for as long as it will reliably function—despite the fact that continuing to use that equipment will result in higher annual energy costs than replacing it with more efficient models. A typical restaurant is more than six times more energy intensive per square foot then other retail establishments, and poor energy utilization is a primary contributor to this market segment's high energy bills.

Pacific Gas and Electric Company's Food Service Technology Center (FSTC), a program devoted to energy-efficiency in commercial foodservice, has developed standardized test methods to determine performance of the major equipment typically found in foodservice operations. As a result of extensive, regimented testing on a multitude of equipment, the FSTC has been able to develop criteria to differentiate between low-, standard-, and high-efficiency foodservice equipment. This supports the California utilities' Energy Wise monetary incentives for energy-efficient foodservice equipment paid directly to commercial customers when purchasing qualified models. Using this performance data, the FSTC helps restaurants to identify and assess their energy needs—working onsite with restaurants that that have traditionally operated low- and standard- efficiency foodservice equipment, monitoring that equipment in their operations, and assisting with the planning and execution for replacing equipment with high-efficiency models.

PROJECT GOAL

The primary objective of this Emerging Technologies project is to promote the California Energy Wise program through onsite monitoring at several different commercial foodservice establishments, comparing the energy use and cost differences when existing equipment in production kitchens are replaced with more energy-efficient models. A secondary objective is to explore the possibility of including an incentive for timers to be included in the California Energy Wise program for the purpose of load-shifting ice machines to non-peak periods.

To achieve these objectives, this project has three specific goals:

a) Identify sites to demonstrate and quantify the benefit of replacing equipment of low-or standard efficiency with high-efficiency, rebate-qualified models of similar size and production capacity.

b) Upsize the production and storage capacity of existing ice machines at selected sites to more energy-efficient models.

c) Demonstrate the potential of ice machine load-shifting at sites where ice machines were upsized, which also provided increased storage capacity to allow for ice production to be shifted to non-peak periods.

The results of the last two aspects of this initiative could be used as a catalyst for the California electric utilities to develop a financial incentive that will accelerate market adoption in a very sizable appliance sector. The FSTC estimates an installed base in California of 300,000 ice machines (not counting bulk ice production). An estimated 10,000 cube-making machines are sold annually in the state of California alone.

Key to the vision for load-shifting ice machines is the fact that the energy consumption per 100-lb of ice decreases as the production capacity (ice harvest rate) increases—especially with respect to smaller machines. Representative of this characteristic is the fact that under-counter machines (e.g., 200-lb/24-h capacity) can use twice the energy of a free-standing ice machine (e.g., 400-lb/24-h capacity) to make the same amount of ice. Also key to the campaign for reduced energy use by this equipment type is the fact that the energy-efficiency has increased, across the board, since ENERGY STAR® was introduced for this category of equipment. A historical review of AHRI data for nominally 400-lb/24-h capacity ice machines confirmed that the average energy consumption decreased very little, only 2%, from 1994 to 2005 (pre-ENERGY STAR® & utility incentives) but by 14% from 2005 to 2012 (with ENERGY STAR® & incentives).

PROJECT DESCRIPTION

This demonstration project entailed the replacement of relatively low-efficiency ice machines in five facilities with energy-efficient models, while load-shifting the ice machine operation exclusively to non-peak utility periods. The energy use and the load profile of each machine were data-logged for at least two weeks and then analyzed to determine appropriate replacement machine capacity and to calculate projected energy and cost savings. In addition, the project called for dissemination of ice machine energy-efficiency knowledge and educational and promotional material through foodservice industry outreach events. The FSTC hosted a focus group meeting among utility, manufacturer, end-user, and installer/maintenance personnel to present the results of this field study and to outline a program for effective market transformation, with a goal to solicit buy-in and future participation from the ice machine industry.

In addition to the five sites identified for ice machine monitoring, assessment, replacement, and load-shifting, five additional sites were identified to assess the performance of cooking equipment. Four of these sites had at least two weeks of baseline monitoring and at least two weeks of replacement monitoring; one site (Artisan Bistro) used calculated values based on FSTC laboratory testing.

One site was identified to assess the performance of a door-type warewasher. This study lost momentum at the customer and design level for this particular ET project, but what has come out of this study to date sets the stage for a future hot water systems project.

Table ES-1 below describes each site, as well as the technological differences between the pre-existing equipment and the replacement equipment. All replacement equipment was selected from the California Energy Wise program's list of energy-efficient commercial foodservice equipment. All ice machine production was based on AHRI specifications: Ice production over 24-hour period, with 90°F (32.2°C) air temperature entering the condenser, and 70° F (21.1°C) incoming water temperature.

TABLE ES-1. RESTAURANT NAME, LOCATION, AND REPLACEMENT APPLIANCE

Site	Location	Type	Existing Equipment	Replacement Equipment
Artisan Bistro	Lafayette, CA	Fine dining	One 40-lb deep-fat fryer	One 35-lb deep-fat fryer. Tube heat exchanger with internal baffles, optimized atmospheric natural gas burners.
Bridges	Danville, CA	Fine dining	One RCU-A cube ice machine. 770-lb/day ice production.	One RCU-A cube ice machine with programmable timer. 1,180-lb/day ice production.
Del Taco	Fairfield, CA	Quick-service restaurant	One manually controlled four-foot griddle, natural gas atmospheric burners.	One thermostatically-controlled four-foot griddle, natural gas atmospheric burners.
Lisa V's Hot Dogs	Concord, CA	Quick-service restaurant	One IMH-A cube ice machine. 220-lb/day ice production. One customized hot dog bun steamer - open burner range with steel box.	One IMH-A cube ice machine with programmable timer. 230-lb/day ice production. Double-stacked connectionless steamer (six pans each). metered steam generation, condensate drain, optional on-demand water connection, and atmospheric natural gas burners.
Mexxi's	San Ramon, CA	Casual dining	One IMH-A cube ice machine. 365-lb/day ice production.	One RCU-A cube ice machine with programmable timer. 530-lb/day ice production.
Norm's Place	Danville, CA	Casual dining	One 40-lb deep-fat fryer.	One 35-lb deep-fat fryer. Tube heat exchanger with internal baffles, optimized atmospheric natural gas burners.
Oakland Museum	Oakland, CA	Institution	One IMH-A cube ice machine. 220-lb/day ice production.	One IMH-A cube ice machine with programmable timer. 555-lb/day ice production.
The Counter	San Mateo, CA	Casual dining	High-temperature door-type warewasher.	High-temperature door-type warewasher with heat recovery and built-in booster heater.

Trueburger	Oakland, CA	Casual dining	One undercounter SC-A cube ice machine. 147-lb/day ice production. One 40-lb deep-fat fryer with baffles mounted in tube heat exchanger.	One IMH-A cube ice machine with programmable timer. 410-lb/day ice production. One 35-lb deep-fat fryer. Tube heat exchanger with internal baffles, optimized atmospheric natural gas burners.

PROJECT FINDINGS/RESULTS: ICE MACHINE REPLACEMENT

The project demonstrated effective energy reduction through the use of more efficient ice machines. Average projected annual energy reduction for the demonstration sites was in the range of 35%. Furthermore, there was a successful coincident peak-period demand reduction at each site, which ranged from 0.52 kW for the smallest capacity machine to 2.0 kW for the largest capacity machine. The calculated annual electricity cost saving based on the applicable rate for each facility ranged from $48 to $903 and average reduction was in the order of 50%. There was very favorable feedback from the facility operators regarding improved performance and energy-efficiency.

TABLE ES-2. RESULTS SUMMARY—BRIDGES ICE MACHINE

	PRE-EXISTING MACHINE	REPLACEMENT MACHINE
AHRI Ice Harvest Rate (lb/24-h)	772	1,180
AHRI Energy Consumption Rate (kWh/100 lb)	6.4	4.62
Bin Capacity (lb)	550	710
Normalized Ice Use (lb/d)	600	600
Normalized Duty Cycle (%)	81.5	51.9
Normalized Operating Time (h/d)	19.6	12.5
Ice Machine Power (kW)	2.0	2.2
Normalized Annual Energy Use (kWh/yr)	14,310	10,040
Annual Energy Reduction (kWh/yr)	4,270	
Percent Energy Reduction (%)	29.8	
Average Coincident Peak Reduction (kW)	2.0	
Annual Energy Charges ($)	1,215	767
Annual Demand Charges ($)	50	47
Total Annual Electricity Cost ($)	1,717	814
Net Annual Electricity Cost Reduction ($)	903	
Net Annual Electricity Cost Reduction (%)	52.6	

TABLE ES-3. RESULTS SUMMARY—TRUEBURGER ICE MACHINE

	PRE-EXISTING MACHINE	REPLACEMENT MACHINE
AHRI Ice Harvest Rate (lb/24-h)	147	410
AHRI Energy Consumption Rate (kWh/100 lb)	10.27	5.73
Bin Capacity (lb)	80	290
Normalized Ice Use (lb/d)	130	130
Normalized Duty Cycle (%)	96.1	31.9
Normalized Operating Time (h/d)	23.1	7.7
Ice Machine Power (kW)	0.521	0.975
Normalized Annual Energy Use (kWh/yr)	4,390	2,740
Annual Energy Reduction (kWh/yr)	1,650	
Percent Energy Reduction (%)	37.6	
Average Coincident Peak Reduction (kW)	0.521	
Annual Energy Charges ($)	754	465
Annual Demand Charges ($)	N/A	N/A
Total Annual Electricity Cost ($)	754	465
Net Annual Electricity Cost Reduction ($)	289	
Net Annual Electricity Cost Reduction (%)	38.3	

TABLE ES-4. RESULTS SUMMARY—MEXXI'S ICE MACHINE

	PRE-EXISTING MACHINE	REPLACEMENT MACHINE
AHRI Ice Harvest Rate (lb/24-h)	365	530
AHRI Energy Consumption Rate (kWh/100 lb)	6.30	5.54
Adjusted Energy Consumption Rate (kWh/100 lb)	11.7	N/A
Bin Capacity (lb)	310	430
Normalized Ice Use (lb/d)	150	150
Normalized Duty Cycle (%)	64.8	26.9
Normalized Operating Time (h/d)	15.6	6.5
Ice Machine Power (kW)	1.13	1.22
Normalized Annual Energy Use (kWh/yr)	6,430	2,890
Annual Energy Reduction (kWh/yr)	3,540	
Percent Energy Reduction (%)	55.1	
Average Coincident Peak Reduction (kW)	1.13	
Annual Energy Charges ($)	1,117	491
Annual Demand Charges ($)	N/A	N/A
Total Annual Electricity Cost ($)	1,117	491
Net Annual Electricity Cost Reduction ($)	626	
Net Annual Electricity Cost Reduction (%)	56.0	

TABLE ES-5. RESULTS SUMMARY—OAKLAND MUSEUM CAFETERIA ICE MACHINE

	PRE-EXISTING MACHINE	REPLACEMENT MACHINE
AHRI Ice Harvest Rate (lb/24-h)	220	555
AHRI Energy Consumption Rate (kWh/100 lb)	8.53	5.29
Bin Capacity (lb)	210	430
Normalized Ice Use (lb/d)	110	110
Normalized Duty Cycle (%)	58.9	20.8
Normalized Operating Time (h/d)	14.1	5.0
Ice Machine Power (kW)	0.564	1.02
Normalized Annual Energy Use (kWh/yr)	2,900	1,860
Annual Energy Reduction (kWh/yr)	1,040	
Percent Energy Reduction (%)	35.9	
Average Coincident Peak Reduction (kW)	0.564	
Annual Energy Charges ($)	259	140
Annual Demand Charges ($)	141	22
Total Annual Electricity Cost ($)	400	162
Net Annual Electricity Cost Reduction ($)	238	
Net Annual Electricity Cost Reduction (%)	59.5	

TABLE ES-6. RESULTS SUMMARY—LISA V'S HOT DOGS ICE MACHINE

	PRE-EXISTING MACHINE	REPLACEMENT MACHINE
AHRI Ice Harvest Rate (lb/24-h)	220	230
AHRI Energy Consumption Rate (kWh/100 lb)	7.90	7.20
Bin Capacity (lb)	250	250
Normalized Ice Use (lb/d)	100	100
Normalized Duty Cycle (%)	45.5	42.0
Normalized Operating Time (h/d)	10.9	10.1
Ice Machine Power (kW)	0.724	0.708
Normalized Annual Energy Use (kWh/yr)	2,880	2,610
Annual Energy Reduction (kWh/yr)	270	
Percent Energy Reduction (%)	9.4	
Average Coincident Peak Reduction (kW)	0.506	
Annual Energy Charges ($)	501	453
Annual Demand Charges ($)	N/A	N/A
Total Annual Electricity Cost ($)	501	453
Net Annual Electricity Cost Reduction ($)	48	
Net Annual Electricity Cost Reduction (%)	9.6	

PROJECT FINDINGS/RESULTS: COOKING EQUIPMENT REPLACEMENT

Overall, equipment operators at the monitored locations reported improved performance when using the energy-efficient equipment. Cooking appliance replacements that resulted in energy and cost reductions saw energy savings ranging from 31.1% to 52.8%. Only one appliance—a thermostatically controlled griddle—saw energy consumption increase as a result of the replacement. This increase was due to the griddle's input rate during cooking, when the amount of food cooked at the restaurant was relatively low for the production capacity of the equipment. When energy use was calculated for the two griddles based on a square foot per hour basis, the thermostatic griddle's energy use decreased by 6.5%.

TABLE ES-7. ANNUAL ENERGY USE, ENERGY SAVINGS, AND OPERATING COST SAVINGS

Restaurant	Appliance	Estimated Pre-Existing Appliance Annual Energy Use (Therms)	Estimated Replacement Appliance Annual Energy Use (Therms)	Estimated Annual Energy Savings (Therms)	Estimated Annual Operating Cost Savings ($)
Artisan Bistro	Fryer	763	360	403	343
Del Taco	Griddle	295	337	-42	-36
Lisa V's Hot Dogs	Steamer	786	470	317	269
Norm's Place	Fryer	898	610	288	244
Trueburger	Fryer	1,038	676	362	308

**Annual operating cost savings based on a natural gas utility rate of $0.85/therm*

PROJECT RECOMMENDATIONS

When selecting ice machines, production and storage capacity and the highest available efficiency must carefully be determined and be balanced with cost—especially when those ice machines will be load-shifted. Operators must be trained to understand load-shifted ice production schedules while coordinating ice bin draw schedules. by pulling ice early in the morning to ensure that ice is harvested to refill the bin until noon when the machine is switched off. Operators should also be familiar with how to program the integrated timer, and to be able temporarily override the load-shifting function unexpected high demands on the machine require additional ice production.

The campaign for installing energy-efficient equipment and ice machine load-shifting will be accelerated by a targeted incentive program by the California electric utilities. Although the economics of upsizing and load-shifting confirmed in this study will inherently drive customers towards this goal, the educational component and financial stimulus of an incentive program will be critical to rapid market adoption.

Installing energy-efficient equipment that is appropriately sized for a facility's needs can result in significant energy and cost savings in a relatively short timeframe. However, knowing the production rate and capacity needs of the food cooked in a restaurant's operating environment is important when specifying the size and input rates of cooking appliances. Equipment that performs at a higher input rate than necessary can result in energy-efficient cooking appliances ultimately consuming more energy than appliances of lower-rated efficiency. Additionally, equipment with a larger capacity than a restaurant's production needs require may save energy, but its higher initial costs could ultimately result in a longer simple payback period on that energy saving.

SECTION 1: ICE MACHINES

INTRODUCTION

Ice machines are installed throughout the foodservice and hospitality industry—from bars, delis and restaurants, to hotels, casinos, and other institutional kitchens. Nearly every foodservice operation has at least one ice machine. They also are found in other commercial building types such as offices, laboratories, nursing homes and hospitals. Even supermarkets, with their large refrigeration plants, utilize separate ice machines to supply ice for their meat and seafood displays. Ranging from cube-type, to nugget- and flake-type machines, together this installed base represents one of the largest inventories of foodservice equipment.

The study of ice machines have become one of the more concentrated efforts by the PG&E Food Service Technology Center (FSTC), based on the potential for energy efficiency and non-peak utility period operation. In 2007 the FSTC conducted its first ice machine field study, which characterized the water and energy use of eight individual ice-cube machines in commercial foodservice operations and documented the estimated water- and energy-saving potential that would be realized by replacing a given unit with a more water/energy-efficient model [1]. In addition, the measured duty cycles combined with the actual electric load profiles reflected the ice utilization patterns while providing insight into the potential for peak load-shifting of each machine. In continuation of the first study, a second field investigation was conducted in 2011 [2]. The project centered on replacing an older ice machine with a newer, ENERGY STAR®-qualified ice machine with a slightly larger production capacity and bin size. The goal was to quantify the resulting energy, water and associated utility cost savings—as well as the additional electricity cost saving by load-shifting ice production exclusively to non-peak periods. Following encouraging results of both studies and eagerness to promote market penetration of high-efficiency equipment, this targeted field placement project was set forth to further demonstrate and highlight energy-efficient replacement machines in concert with permanent load shifting (PLS).

BACKGROUND

Energy Efficiency Improvements

The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) provides a Directory of Certified Automatic Commercial Ice Machines and Ice Storage Bins containing ice harvest rate (i.e., production capacity), energy consumption rate, and water use rate data for current models that can be utilized by specifiers and end-users to select energy- and water-efficient models [3]. It can also be used by utilities as a basis for financial incentives to promote equipment that is more efficient. Specific energy consumption thresholds are listed in the ENERGY STAR® Program Requirements Product Specification for Automatic Commercial Ice Makers [4] and also in The Consortium for Energy Efficiency (CEE) High Efficiency Specifications for Commercial Ice Makers (CEE Tier 2 and Tier 3 criteria are used for the California Joint Utility Partners current rebate program) [5]. While technological advancements have steadily facilitated lower energy and water consumption rates, in recent years the introduction of the ENERGY STAR® classification for ice machines (January 1, 2008) has provided the industry a catalyst for even greater progress.

Upon inspection of the listings, it becomes evident that higher capacity ice machines are inherently more energy-efficient than lower capacity units. When considering only capacity, a general sizing guideline has been to choose a unit that would operate with an average duty cycle of approximately 75% based on the ice harvest rate and the assumed daily ice requirement, which balances machine size and cost with the reserve capacity needed for high ice-demand days. When energy consumption is also taken into consideration, a higher capacity model with higher efficiency can yield considerable energy savings.

The Department of Energy published two studies that focused on the energy saving potential and R&D opportunities for Commercial Refrigeration. One was published in 1996 and conducted by Arthur D. Little, Inc. [6]; the other was published in 2009 and conducted by Navigant Consulting, Inc. [7]. Both reports describe the different types of ice machines and provide insight into design strategies and technologies that could be applied to increase efficiency. Both recognize the fundamental fact that larger machines consume less energy on a per-unit-ice basis than smaller machines. It is interesting to note that neither study suggested that the replacement of an older ice machine with a new machine of a larger capacity was an energy efficiency strategy to consider. Nor was there any reference by the two studies for the potential to shift the operation of an ice machine to non-peak periods.

Figure 1 is a plot as reported in the first DOE study using 1994 ARI (predating AHRI) ice-cube machine data, and Figure 2 is a plot representing 2005 ARI data as a comparison to the 1994 plot. Both plots illustrate the energy use vs. ice harvest rate performance relationship and denote the visually-intersected average energy consumption rate for a 400 lb/24-h capacity ice machine—one of the most popular sizes. The drop from 7.75 down to 7.5 was only a 2% difference (likely within the margin of error). Figure 3 represents 2012 data, compared to the 2005 value of 7.5. The drop down to 6.1 is a 19% decrease in energy use. This marked historical difference reflects the value that ENERGY STAR® has created and the importance of utility-sponsored incentive programs to stimulate early retirement of older ice machines.

Furthermore, within the 2012 graph, if the machine selection process is optimized to the best-in-class with some upsizing to the 500-600 lb/24-h range, the 2012 data reflects an additional 18% reduction in energy use over the average 400 lb/24-h capacity machine.

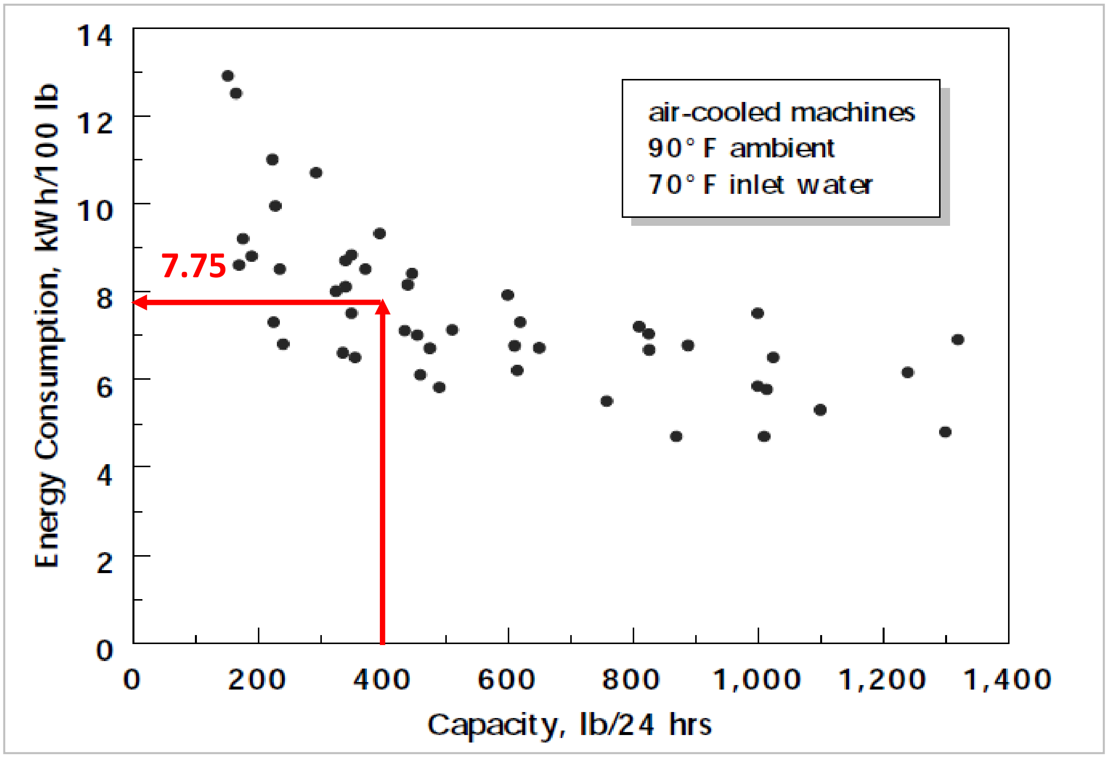


FIGURE 1. 1994 ARI DATA—ENERGY CONSUMPTION VS. CAPACITY—REFERENCE DOE

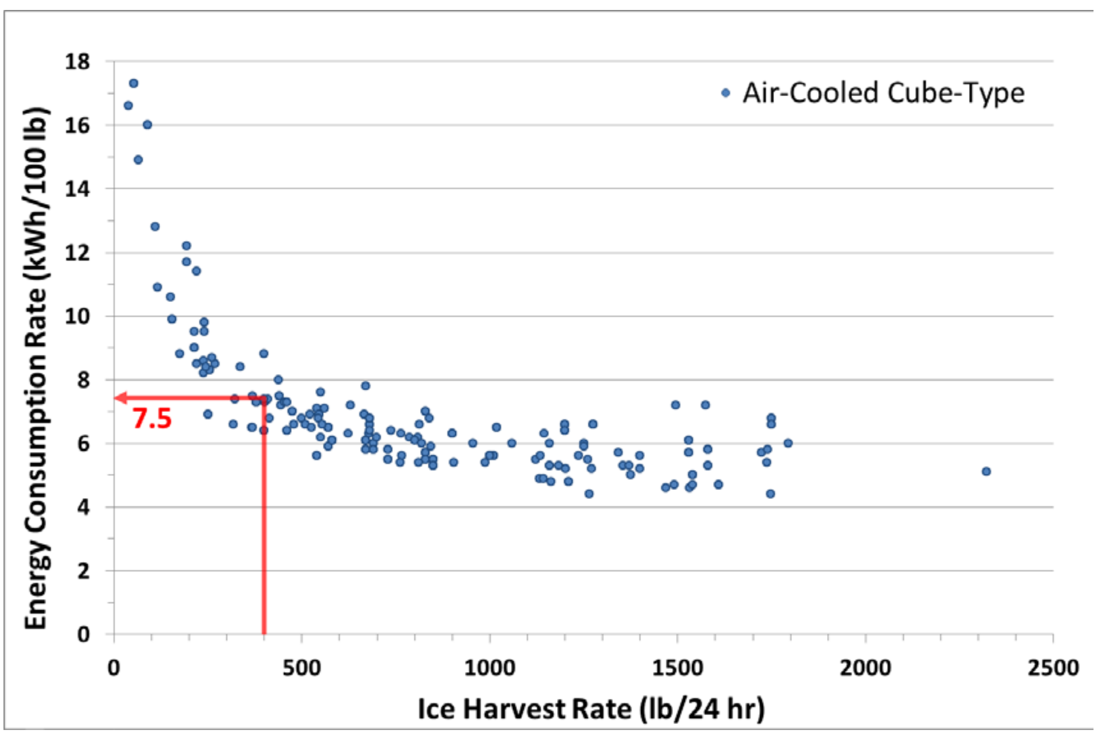


FIGURE 2. 2005 ARI DATA—ENERGY CONSUMPTION RATE VS. ICE HARVEST RATE

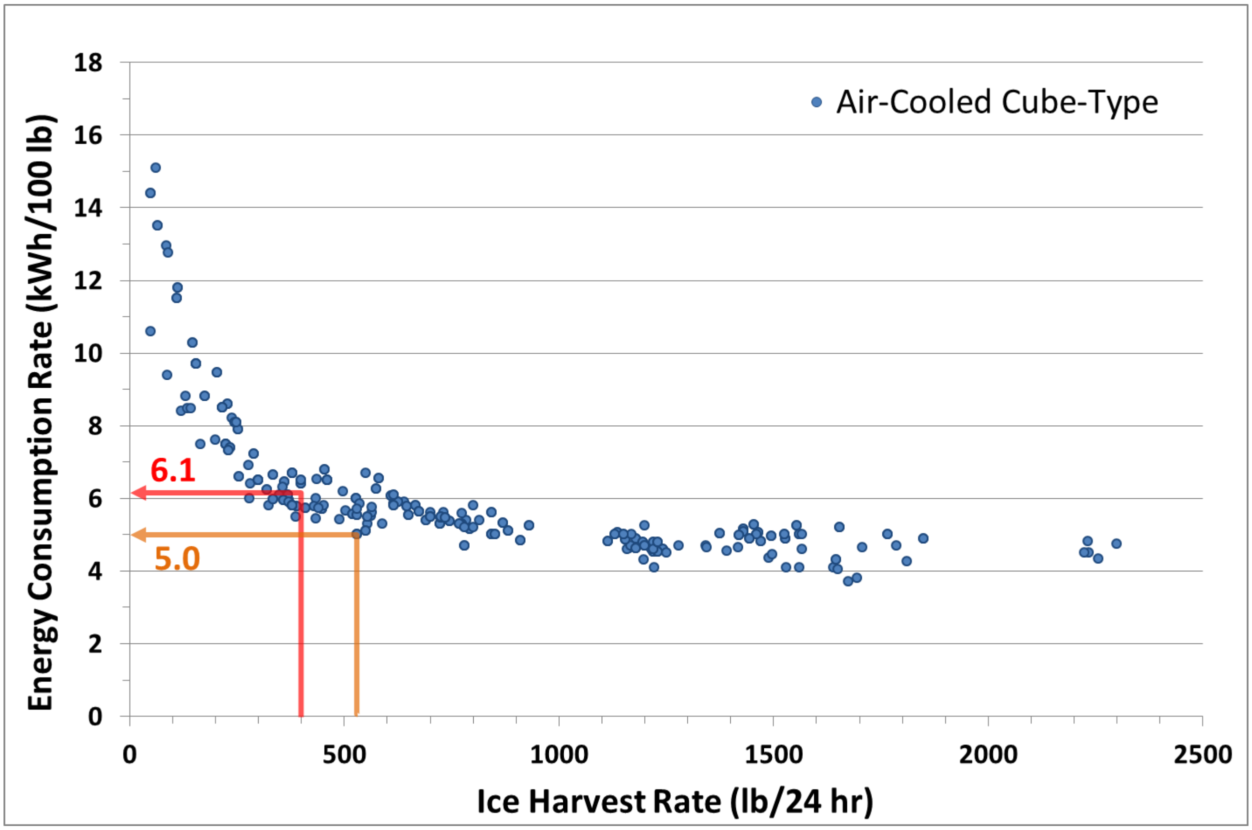


FIGURE 3. 2012 AHRI DATA—ENERGY CONSUMPTION RATE VS ICE HARVEST RATE

National Ice Machine Inventory and Energy Load Estimate

The 1996 DOE study estimated the 1993 installed base of ice machines to be 1.2 million units, with new shipments in 1993 totaling 188,000 units. The 2009 DOE study reported a 2008 inventory of 1.5 million with new shipments in 2003 totaling 197,000 units. The North American Association of Food Equipment Manufacturers (NAFEM) reported sales in 2008 of 216,000 units [8]. Assuming a 7 to 10 year life (also referenced by both DOE studies), the replacement unit sales alone would suggest that the inventory in 2012 is well in excess of 2 million.

From another approximation perspective, the FSTC, in a 2010 PIER study, inventoried 93,000 commercial and institutional foodservice facilities in California in 2010 [8]. With California representing approximately 10% of the U.S. market, the nominal number of foodservice facilities is in the order of one million. Recognizing that many foodservice operations have more than one ice machine, the total inventory of ice machines in foodservice facilities should exceed one million units by a good margin. An unpublished inventory of ice machines compiled by the FSTC as an adjunct to the referenced PIER study estimated 155,000 ice machines in California foodservice operations. Adding in the other commercial and institutional sectors that utilize ice machines, it is plausible that the total ice machine inventory in the U.S. is in the range of 2.5 to 3 million. For the purpose of this paper and high-level energy load projection, the authors have assumed an installed base of 2.5 million ice machines in the U.S. and 300,000 ice machines in California.

The first DOE study projected the electricity used by the 1.2 million ice machines at 9.4 TWh/yr. The second DOE study estimated the electricity consumption of the 1.5 million units to be 8.1 TWh/yr and reported an energy use of 5,429 kWh/yr per unit to calculate the nationwide use. Prorating the second DOE study estimate of 8.1 TWh/yr for an inventory of 2.5 million units, the annual electricity consumed by ice machines in the U.S. is estimated to be in the order of 13.5 TWh/year.

In addition to the potential energy use reduction, with average power consumption in the range of 1,000 watts per 500-lb ice machine capacity, the authors estimate the peak demand of 2.5 million units to be in the order of 2,500 MW. The associated peak reduction in electricity generation by shifting the operation of ice machines to non-peak periods would be very significant.

OBJECTIVES

The foundation of this ET project was to select five foodservice facilities to participate in an ice machine assessment and demonstration study, ideally choosing sites using inefficient equipment and/or needing more ice production capacity. The goal was to demonstrate improved energy-efficiency when a) replacing ice machines at selected sites with more energy-efficient models while upsizing the production and bin capacities, and b) provide load-shifting capabilities by installing an ice machine with an integrated programmable timer.

Outlined below are the project's procedural goals:

- Selecting local sites that would qualify as candidates for the project.
- Monitor the energy use of the pre-existing ice machine, noting ice usage and duty cycle.
- Provide replacement machine selection assistance at selected sites, using a mechanical engineer knowledgeable in restaurant design.
- Provide equipment selection as requested, as well as assistance with installing that equipment per code requirements.
- Monitor energy consumption and duty cycle of the replacement machine. Quantify ice machine energy-efficiency benefit and load-shifting potential to be used as a catalyst for the California electric utilities to develop a financial incentive that will accelerate market adoption.
- Conduct an open house/showcase at participating sites. Conduct a FSTC seminar describing all case studies and ice machine knowledge research and to date.
- Hold a focus group meeting for interested manufacturers, suppliers, end-users and service and installation personnel.
- Assemble a one-page success-story case study for each site that can be used for future marketing material. Include the case studies in FSTC outreach programs.
- Provide an ice machine seminar summarizing the results.
- Facilitate a focus group to present the results of this field study and outline a program for effective market transformation, with a goal to solicit endorsement from the ice machine industry.

SCOPE

The project focused exclusively on air-cooled, cube-type machines because they comprise the majority of the installed base and therefore offer the most potential for future energy saving and peak load-shifting (additionally, water-cooled machines are not applicable to the California Joint Utility Partner rebate program). Facilities with ice machines exhibiting a combination of relatively low production capacity and high ice usage were selected for the study. Facilities with large capacity and relatively efficient machines operating with low duty cycles would have little energy saving potential. While these machines could be load-shifted, this study focuses on replacing standard-efficiency ice machines with energy-efficient models; load-shifting existing machines is outside the scope of this project.

MONITORING AND EVALUATION APPROACH

The five sites selected for this ice machine replacement study were identified in the normal course of FSTC site survey and auditing work after determining the ice machine suitability for replacement and proposing the evaluation plan to the facility owners or operators. The basis for selecting the customer sites for study centered on the general criteria of operator willingness, and the combination of relatively low production capacity and high ice usage.

Upon the start of each evaluation, the pre-existing ice machine's rated machine production capacity and rated bin capacity were noted. The machine was instrumented and monitored to determine baseline energy consumption, demand and duty cycle. Based on the site assessment and at least two weeks of baseline data, it was determined whether the ice machine was suitable for replacement.

Working with the ice machine suppliers, the FSTC provided guidance on replacement machine specifying, selection and installation. The specification sheets for each replacement machine are shown in Appendix 1. Each of the new machines was equipped with an integrated programmable controller that included a timer function, which was set to shut the machine off through the duration of the utility peak period (noon to 6:00 pm). Upon installation, monitoring was repeated for the new machines. Adequate daily ice production as well as ice accessibility (i.e., a comfortably reachable ice height in the bin) was verified by the kitchen staff and confirmed through the duty cycle data results.

INSTRUMENTATION

Electrical metering used for the Bridges site was a DENT Instruments ElitePro power logger configured to record average power at 30-second intervals. The rated accuracy is better than 1% of reading (<0.5% typical). For the other four sites, Continental Control Systems, WattNode pulse-output watt-hour transducers were used. The resolution is 0.025 Wh/pulse/CT rated amp and the rated accuracy is ±0.5% of reading. The pulses were counted and logged with an Onset Corporation HOBO UX-90-001M pulse logger. The recording interval was set to 30 seconds.

Accompanying current transformers (CTs) used for the electric metering were Dent Instruments CTHSC series, 20A or 50A (depending on the circuit load) CTs. They have a rated accuracy of <0.5%.

Metering accuracy was verified prior to field deployment with calibrated revenue-grade energy meters used for appliance energy-efficiency compliance testing in the FSTC laboratory.

FIELD ANALYSIS AND RESULTS

For each of the following test sites, a brief site description and assessment is included, accompanied by photographs of the pre-existing and replacement ice machines. A data collection and analysis section follows, comprising a data summary table and a typical operating profile for each of the ice machines. A customer feedback section and finally a recommendations section concludes the ice machine portion of this study.

The data summary table outlines the pre-existing and replacement ice machines' rated performance specifications and bin capacity, normalized duty cycle, normalized energy use, load-shifted demand reduction, and operating cost comparisons. The figures following each summary table illustrate typical (three-consecutive-day) operating profiles for the machines while highlighting the machine state during the utility peak period of 12:00 noon – 6:00 pm.

DATA ANALYSIS METHODOLOGY

For each monitored ice machine, the energy consumption and corresponding duty cycle were compared to the AHRI-rated specifications for ice production capacity and energy use rate. If the duty cycle and energy consumption were within 10% of the expected values, the machine performance was considered acceptable for estimation purposes, and the AHRI rating values were then used for ice use normalizations and energy use projections. Ice production was normalized to a nominal value approximating the average ice usage throughout the entire monitoring period of both machines combined. Normalized daily operating time was determined by dividing the normalized production by the rated production capacity.

Actual ice machine production can only be determined by weighing several ice harvest cycles and averaging them to establish the per-cycle production weight and multiplying by the cycles-per-day to determine total daily production. Because this process is intrusive in an operating foodservice facility, for this project it was performed only when measured energy and duty cycle did not correspond with AHRI specifications, which was the case in one facility (Mexxi's).

It was observed in the data sets that there was considerable variability in ice usage between many days and weeks of operation. Because the monitoring period was relatively short with possible seasonal variations not accounted for, for straightforwardness, a uniform daily ice usage was assumed for the projected energy calculations. The measured average cycle power was multiplied by the normalized daily operating time applied evenly across each day of the week to calculate annual energy use, and then to the applicable rate schedule (accounting for different rates during peak, partial peak, and off-peak periods on weekdays, weekends and holidays) to calculate energy and demand charges and saving. The pre-existing ice machines consistently operated during all six hours of the peak utility period (except one site, Lisa V's, which exhibited 4.2 hours of coincident peak usage). The coincident peak reduction was based on the pre-existing ice machine power, and the partial-peak usage was determined from the load profile data.

BRIDGES RESTAURANT AND BAR (DANVILLE, CA)

SITE DESCRIPTION

Bridges Restaurant and Bar is a 5,000-square-foot, fine dining restaurant located in the East Bay of the San Francisco Bay Area with a 107 seat dining room, 26 seat bar and 48 seat patio. The restaurant has been in operation for approximately 25 years and occupies a building that is several years older and has had prior restaurants as tenants. The restaurant also operates a wine bar and wine retailer, The Vine, which occupies a nearby adjacent building of approximately 1,000 square feet.

A single, modular ice machine provided ice for the restaurant and The Vine. Bridges was selected as a study site after an energy audit conducted by Food Service Technology Center energy analysts, which analyzed each of the facility's energy using systems. Furthermore, following the audit, restaurant management participated in third-party partnership programs for lighting and refrigeration, which upgraded older, inefficient systems at a small capital expense—less than $2,000.

SITE ASSESSMENT

Energy auditors identified the machine as an older, non–ENERGY STAR® unit with a nominal 800-pound daily ice-making capacity. Anecdotal evidence provided by the operator indicated that the machine struggled to meet ice demands during busy service periods. On the busiest of warm-weather days, the bin was frequently emptied and the operator had to purchase additional ice. Auditors also determined that a new energy-efficient machine with significantly higher ice-making capacity along with a higher capacity storage bin could fit in the same space as the existing unit.

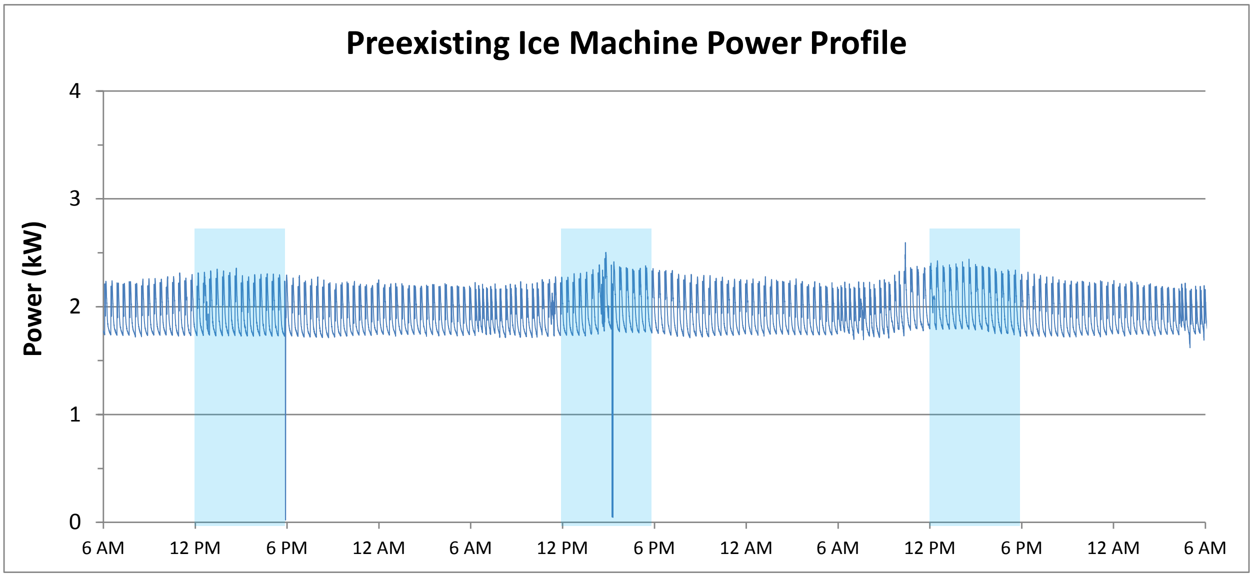
FIGURE 4. BRIDGES PRE-EXISTING AND REPLACEMENT ICE MACHINES

DATA COLLECTION AND ANALYSIS RESULTS

TABLE 1. BRIDGES RESULTS SUMMARY

	PRE-EXISTING MACHINE	REPLACEMENT MACHINE
Ice Machine Type	RCU-A	RCU-A
AHRI Ice Harvest Rate (lb/24-h)	772	1,180
AHRI Energy Consumption Rate (kWh/100 lb)	6.4	4.62
Bin Capacity (lb)	550	710
Normalized Ice Use (lb/d)	600	600
Normalized Duty Cycle (%)	81.5	51.9
Normalized Operating Time (h/d)	19.6	12.5
Ice Machine Power (kW)	2.0	2.2
Normalized Annual Energy Use (kWh/yr)	14,310	10,040
Annual Energy Reduction (kWh/yr)	4,270	
Percent Energy Reduction (%)	29.8	
Average Coincident Peak Reduction (kW)	2.0	
Peak Reduction Time (h/d)	6	
Annual Energy Charges ($)*	1,215	767
Annual Demand Charges ($)*	502	47
Total Annual Electricity Cost ($)	1,717	814
Net Annual Electricity Cost Reduction ($)	903	
Net Annual Electricity Cost Reduction (%)	52.6	

**Based on PG&E E-19 rate schedule*



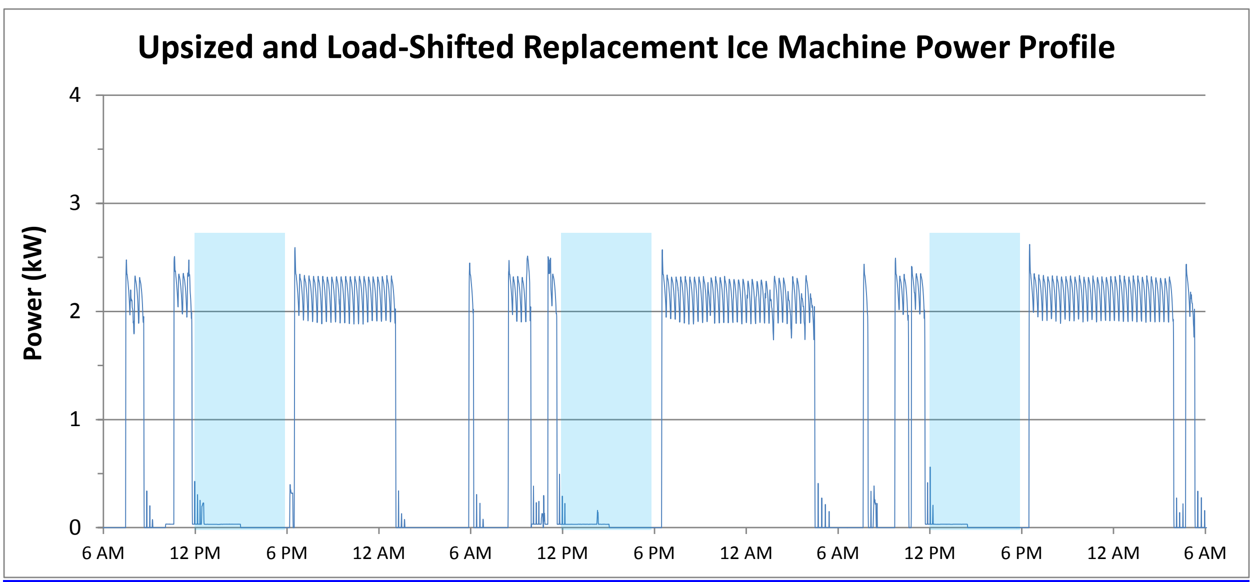


FIGURE 5. BRIDGES PRE-EXISTING AND REPLACEMENT ICE MACHINE POWER PROFILES

OBSERVATIONS AND RECOMMENDATIONS

Installation of the new ice machine was a success and delivered increased ice-making capacity as well as significant energy savings. Due to its ample ice-making and storage capacity, the unit was turned off for the entire six hours of the peak utility rate period with no adverse effects experienced by the operators.

The single exception to this was on the first day that the load shift time schedule was programmed into the machine—coincidently on a popular street fair day when the restaurant experienced a peak service volume day. Demand for ice was extremely high in the mid- to late-afternoon hours when the machine was shut off and the ice bin was drawn down to near its bottom. While the operator did not run out of ice, the draw-down was significant enough that he expressed concern about the possibility.

As a result of this experience, FSTC researchers and the ice machine distributor returned to the restaurant to explain proper daily ice management and familiarize the staff with the machine's program bypass feature. In this case, proper ice management entails pulling ice from the bin earlier in the morning, allowing the machine to harvest more ice and refill the bin before the system shuts off at noon. Furthermore, operators were instructed to "level" the ice in the bin to ensure that the ice isn't piled up near the bin sensor.

The actual installation of the ice machine was an involved process due to the remote condensing unit. In these circumstances, installers must consider the refrigerant line set penetration of the roof, rooftop accessibility, hoisting the condensing unit onto the roof, and electrical service requirements of the new machine.

CUSTOMER FEEDBACK

The operator was very satisfied with the replacement machine, as it produces significantly more ice than the original. The new machine is able to meet the maximum ice demands of the restaurant itself and that of the adjacent wine bar, The Vine. Prior to the new machine's installation, the operator had to purchase additional ice during busy summertime service periods. Furthermore, the operator noted that the back of house area is much quieter because the new machine's compressor is housed within the remote condensing unit on the roof (as opposed to within the ice-making head as in the original unit).

BRIDGES SHOWCASE (10/23/2012)

A showcase event to illustrate the improved performance of energy-efficient ice machines in a production kitchen was held at Bridges on October 23, 2012. The event was held between the hours of 1:30 pm and 3:30 pm to accommodate the busy schedule of the audience. The event was promoted through flyer distribution to vendor customers, local FSTC database contacts, restaurant contacts in the Tri-Valley area, and to friends of the restaurant owner. The event was also promoted on FSTC's website (fishnick.com) and Facebook page, as well as through the Golden Gate Restaurant Association (GGRA) newsletter. PG&E sent mailers and e-mails to restaurants in nearby zip codes, and FSTC and PG&E staff canvassed the Danville area on the day of the event.

FIGURE 6. BRIDGES SHOWCASE (10/23/2012)

Twenty-one guests attended the event, as well as 17 representatives from ten vendors, including the East Bay Municipal Utility District, Contra Costa County Green Business program, Contra Costa County Environmental Health, and vendor representatives for energy-efficient lighting and ice-making products.

The event was held on a Tuesday to allow owner/operators the ability to have staff cover for them on a slower day of the week. Most attendees came to the event either at the beginning or towards the end of the showcase. Both setup and cleanup had to be quick to avoid interfering with Bridge's normal operations.

The layout for the Bridges showcase included tables for vendors, two digital displays to illustrate Bridges' energy saving story, and one TV display to highlight the rebate story. A storyboard and flyers for the Bridges case study were included, as was the Bridges chef's bio. Flyers for rebates, seminars, FSTC contacts, and estimated ROI as a result of replacing existing equipment were also included, as were seminar calendars and lists of qualifying foodservice equipment. A Manitowoc ice machine with the integrated timer was on display at the event.

The Bridges case study can be found in Appendix 2, and a list of attendees for the Bridges showcase event can be found in Appendix 3.

Some feedback collected and insight gained from the Bridges showcase included the following:

- The layout at Bridges worked well. Registration was set up outside, and patio doors were used as the main entrance. It was a smaller space, but it made it feel like there was more activity.
- Feedback from attendees indicated that the Bridges display looked nice and was a focal part of the event as people walked in. Vendors were very pleased with the event and felt that it also gave them a better opportunity to understand the programs offered to restaurants through PG&E, and how they could promote these programs to help their customers/clients as well.

The Bridges demonstration project was also a central element of the FSTC booth at the annual US Foods Show in Pleasanton, CA.

TRUEBURGER (OAKLAND, CA)

SITE DESCRIPTION

Trueburger is a 1,000-square-foot, fast-casual restaurant located in the central business district of Oakland, a city in the San Francisco Bay Area with a population of 396,000. The restaurant is on a busy thoroughfare and has a 40-seat dining room. Much of the restaurant's business is devoted to take-out orders. Ice was provided by a self-contained under-counter ice machine with an integrated bin.

A FSTC energy analyst was involved in the build-out of the restaurant and reviewed equipment schedules and mechanical drawings to help the owners mitigate energy use through the specification of energy-efficient appliances and equipment. An under-counter ice machine was selected due to space constraints in the kitchen.

SITE ASSESSMENT

Researchers contacted the operator during the course of the study as they sought to identify sites with an under-counter unit, which if replaced with a larger, energy-efficient model could yield significant energy savings and potential to turn the machine completely off during the peak utility rate period. The existing machine was ENERGY STAR®-qualified, but inherently exhibited higher energy use relative to the ice production. The operator also advised that the existing machine was inadequate for the restaurant ice demands and that ice had to be purchased on busy service days—usually once or twice per week. Installation of the new larger modular unit with an ice-making head and accompanying bin required FSTC researchers and the operator to modify the kitchen space to accommodate the unit. This included removal of an underutilized work surface and replacement of a two-compartment utility sink with a single-compartment sink.

FIGURE 7. TRUEBURGER PRE-EXISTING AND REPLACEMENT ICE MACHINES

DATA COLLECTION AND ANALYSIS RESULTS

TABLE 2. TRUEBURGER RESULTS SUMMARY

	PRE-EXISTING MACHINE	REPLACEMENT MACHINE
Ice Machine Type	SC-A	IMH-A
AHRI Ice Harvest Rate (lb/24-h)	147	410
AHRI Energy Consumption Rate (kWh/100 lb)	10.27	5.73
Bin Capacity (lb)	80	290
Normalized Ice Use (lb/d)	130	130
Normalized Duty Cycle (%)	96.1	31.9
Normalized Operating Time (h/d)	23.1	7.7
Ice Machine Power (kW)	0.521	0.975
Normalized Annual Energy Use (kWh/yr)	4,390	2,740
Annual Energy Reduction (kWh/yr)	1,650	
Percent Energy Reduction (%)	37.6	
Average Coincident Peak Reduction (kW)	0.521	
Peak Reduction Time (h/d)	6	
Annual Energy Charges ($)*	754	465
Annual Demand Charges ($)*	N/A	N/A
Total Annual Electricity Cost ($)	754	465
Net Annual Electricity Cost Reduction ($)	289	
Net Annual Electricity Cost Reduction Percentage (%)	38.3	

**Based on PG&E A-1 TOU rate schedule*

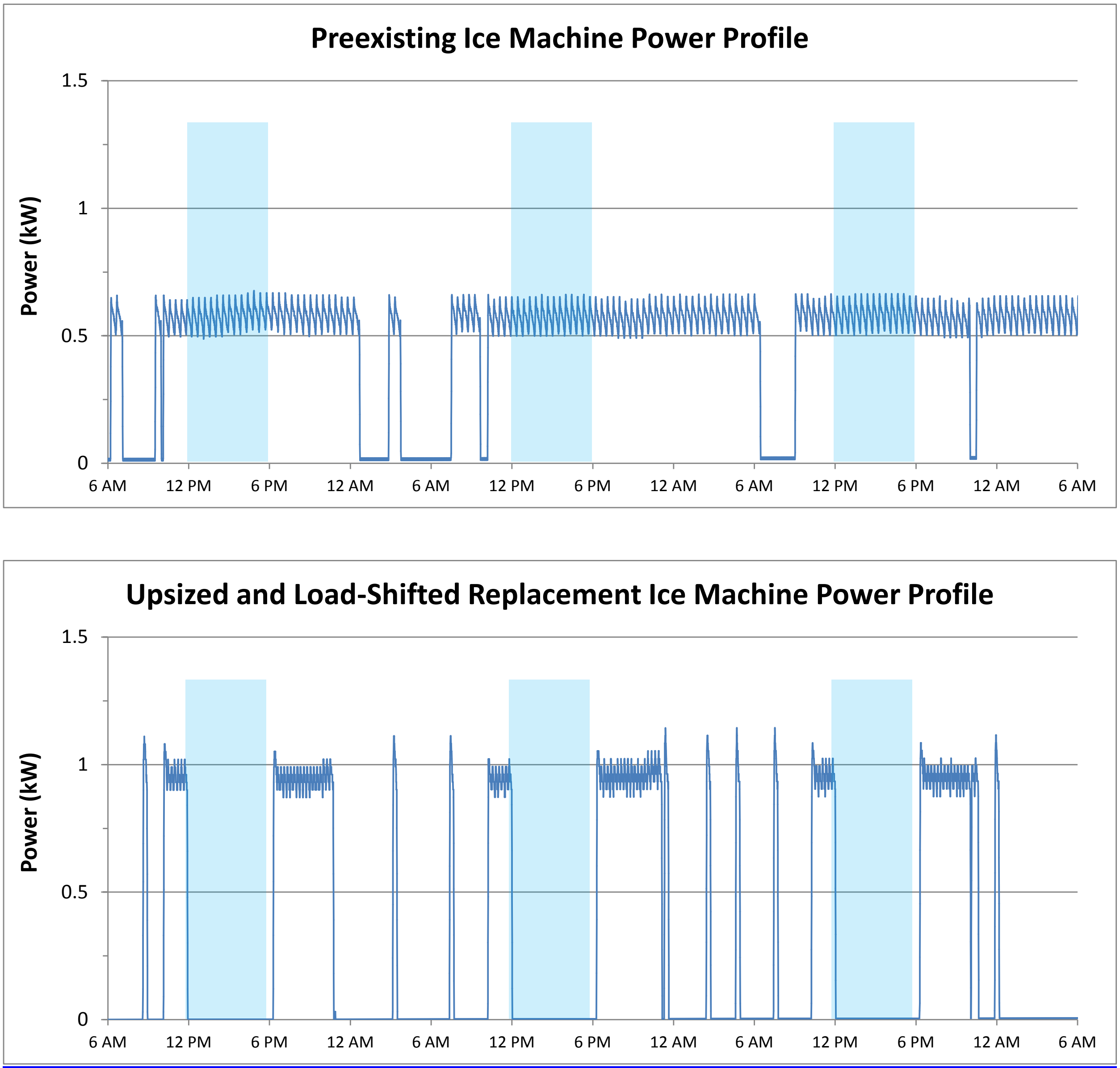


FIGURE 8. TRUEBURGER PRE-EXISTING AND REPLACEMENT ICE MACHINE POWER PROFILES

OBSERVATIONS AND RECOMMENDATIONS

Installation of the new ice machine was a success and delivered increased ice-making capacity as well as significant reduction in energy use. Due to its ample ice-making capacity, the unit was set to turn off for the entire peak utility rate period with no adverse effects experienced by the operator. Furthermore, the machine has enough capacity to be shut off during part-peak hours during late morning and early evening.

CUSTOMER FEEDBACK

The operator has been extremely pleased with the new machine as it now provides sufficient ice for service periods and does not operate during the busiest part of the day, thus avoiding the added noise and heat in the kitchen.

MEXXI'S (SAN RAMON, CA)

SITE DESCRIPTION

Mexxi's Restaurant is a 900-square-foot, casual dining restaurant located in a multi-unit commercial development in San Ramon, a suburban city in the San Francisco Bay Area with a population of 73,000.

A single, modular ice machine provides ice for the restaurant. In addition to the ice used for beverages, ice is also used for cooling in a condiments station. Mexxi's was selected as a study site after an energy audit conducted by FSTC energy analysts, which examined each of the facility's energy-using systems.

SITE ASSESSMENT

The energy auditor determined that the existing machine had a relatively low production capacity and thus a relatively low efficiency, even though the machine was ENERGY STAR®-qualified when new. It appeared to be producing excessive heat from the condensing unit, which was an indication of possible mechanical problems. The operator advised that the machine frequently ran out of ice—due in some part to the excess heat around the machine (that in turn decreases production capacity). The site presented the opportunity to replace the existing machine with a larger capacity, energy-efficient, remote condensing unit model, which would eliminate the heat load on the interior space and result in a more comfortable and quiet work environment.

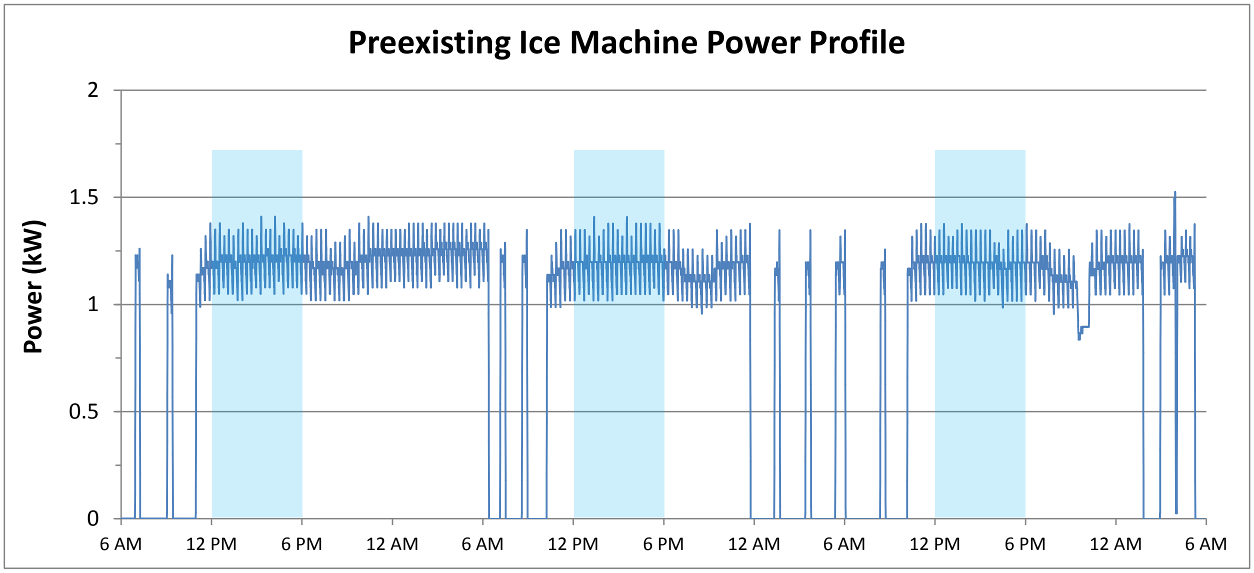
FIGURE 9. MEXXI'S PRE-EXISTING AND REPLACEMENT ICE MACHINES

DATA COLLECTION AND ANALYSIS RESULTS

TABLE 3. MEXXI'S RESULTS SUMMARY

	PRE-EXISTING MACHINE	REPLACEMENT MACHINE
Ice Machine Type	IMH-A	RCU-A
AHRI Ice Harvest Rate (lb/24-h)	365	530
AHRI Energy Consumption Rate (kWh/100 lb)	6.30	5.54
Actual Energy Consumption Rate (kWh/100 lb)	11.7	N/A
Bin Capacity (lb)	310	430
Normalized Ice Use (lb/d)	150	150
Normalized Duty Cycle (%)	64.8	26.9
Normalized Operating Time (h/d)	15.6	6.5
Ice Machine Power (kW)	1.13	1.22
Normalized Annual Energy Use (kWh/yr)	6,430	2,890
Annual Energy Reduction (kWh/yr)	3,540	
Percent Energy Reduction (%)	55.1	
Average Coincident Peak Reduction (kW)	1.13	
Peak Reduction Time (h/d)	6	
Annual Energy Charges ($)*	1,117	491
Annual Demand Charges ($)*	N/A	N/A
Total Annual Electricity Cost ($)	1,117	491
Net Annual Electricity Cost Reduction ($)	626	
Net Annual Electricity Cost Reduction Percentage (%)	56.0	

**Based on PG&E A-1 TOU rate schedule*



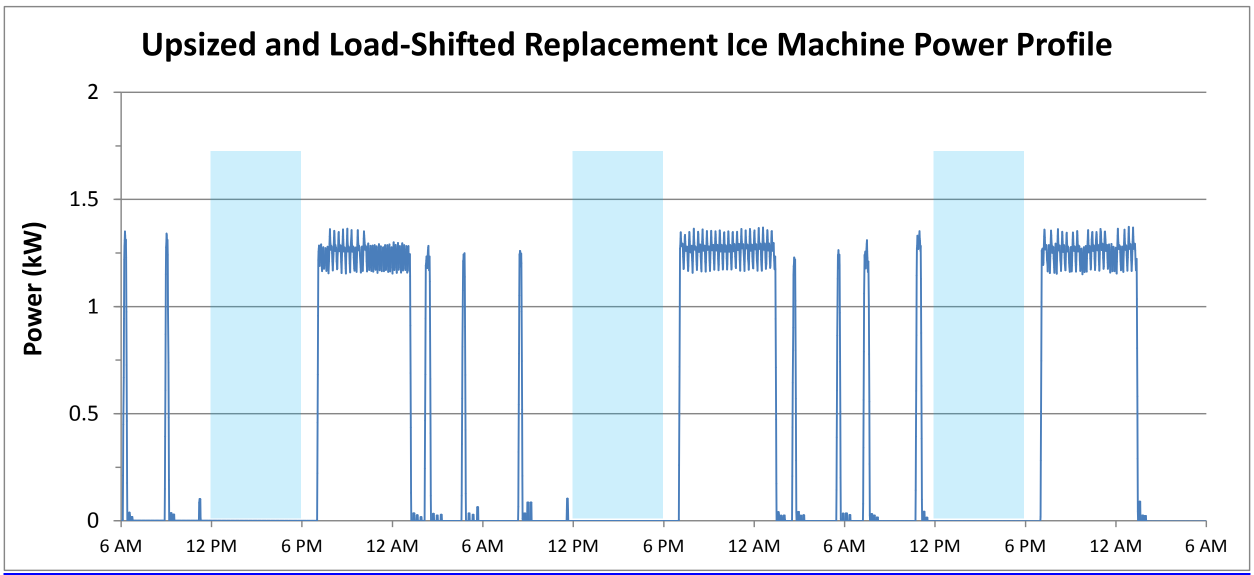


FIGURE 10. MEXXI'S PRE-EXISTING AND REPLACEMENT ICE MACHINE POWER PROFILES

OBSERVATIONS AND RECOMMENDATIONS

Installation of the new ice machine was a success and delivered increased ice-making capacity as well as significant reduction in energy use. Due to its ample ice-making capacity, the unit was set to turn off for the entire peak utility rate period with no adverse effects experienced by the operator.

CUSTOMER FEEDBACK

The operator is very satisfied with the replacement machine as it now provides sufficient ice for service periods but does not operate during the busiest part of the day, thus avoiding the added noise and heat in the kitchen.

OAKLAND MUSEUM CAFETERIA (OAKLAND, CA)

SITE DESCRIPTION AND ASSESSMENT

The cafeteria is a 75-seat dining facility serving museum patrons and staff. The museum is located in the Oakland, a city in the San Francisco Bay Area with an approximate population of 396,000. The Oakland Museum was selected as a study site after an energy audit conducted by Food Service Technology Center energy analysts. A single modular ice machine provides ice used for the self-serve soda machine, and occasionally for remote ice tubs holding canned and bottled beverages during special events.

The pre-existing ice machine was identified as an older model (about ten years old) with relatively low ice-making capacity and relatively high energy consumption rate specifications. It had adequate ice-making capacity and storage for the facility's current needs, but would be insufficient to make up for the six hours of peak period shut-off time on busy days. The replacement machine has a considerably higher production capacity and a larger storage bin. Ice machine parameters, energy use, demand, and post-replacement savings values are included in the following summary table.

FIGURE 11. OAKLAND MUSEUM CAFETERIA PRE-EXISTING AND REPLACEMENT ICE MACHINES

DATA COLLECTION AND ANALYSIS RESULTS

TABLE 4. OAKLAND MUSEUM CAFETERIA RESULTS SUMMARY

	PRE-EXISTING MACHINE	REPLACEMENT MACHINE
Ice Machine Type	IMH-A	IMH-A
AHRI Ice Harvest Rate (lb/24-h)	220	555
AHRI Energy Consumption Rate (kWh/100 lb)	7.90	5.29
Actual Energy Consumption Rate (kWh/100 lb)	8.53	N/A
Bin Capacity (lb)	210	430
Normalized Ice Use (lb/d)	110	110
Normalized Duty Cycle (%)	58.9	20.8
Normalized Operating Time (h/d)	14.1	5.0
Ice Machine Power (kW)	0.564	1.020
Normalized Annual Energy Use (kWh/yr)	2,900	1,860
Annual Energy Reduction (kWh/yr)	1,040	
Percent Energy Reduction (%)	35.9	
Average Coincident Peak Demand Reduction (kW)	0.564	
Peak Demand Reduction Time (h/d)	6	
Annual Energy Charges ($)*	259	140
Annual Demand Charges ($)*	141	22
Total Annual Electricity Cost ($)	400	162
Net Annual Electricity Cost Reduction ($)	238	
Net Annual Electricity Cost Reduction Percentage (%)	59.5	

**Based on PG&E E-19 rate schedule*

OBSERVATIONS AND RECOMMENDATIONS

Installation of the new ice machine was a success and delivered increased ice-making capacity as well as significant reduction in energy use. Due to its ample ice-making capacity, the unit was set to turn off for the entire peak and most of the partial-peak utility rate periods, from 8:00 am to 8:00 pm, with no adverse effects experienced by the operator.

CUSTOMER FEEDBACK

The operator has been extremely pleased with the new machine as it now provides sufficient ice for service periods and does not operate during the busiest part of the day, thus avoiding the added noise and heat in the kitchen.

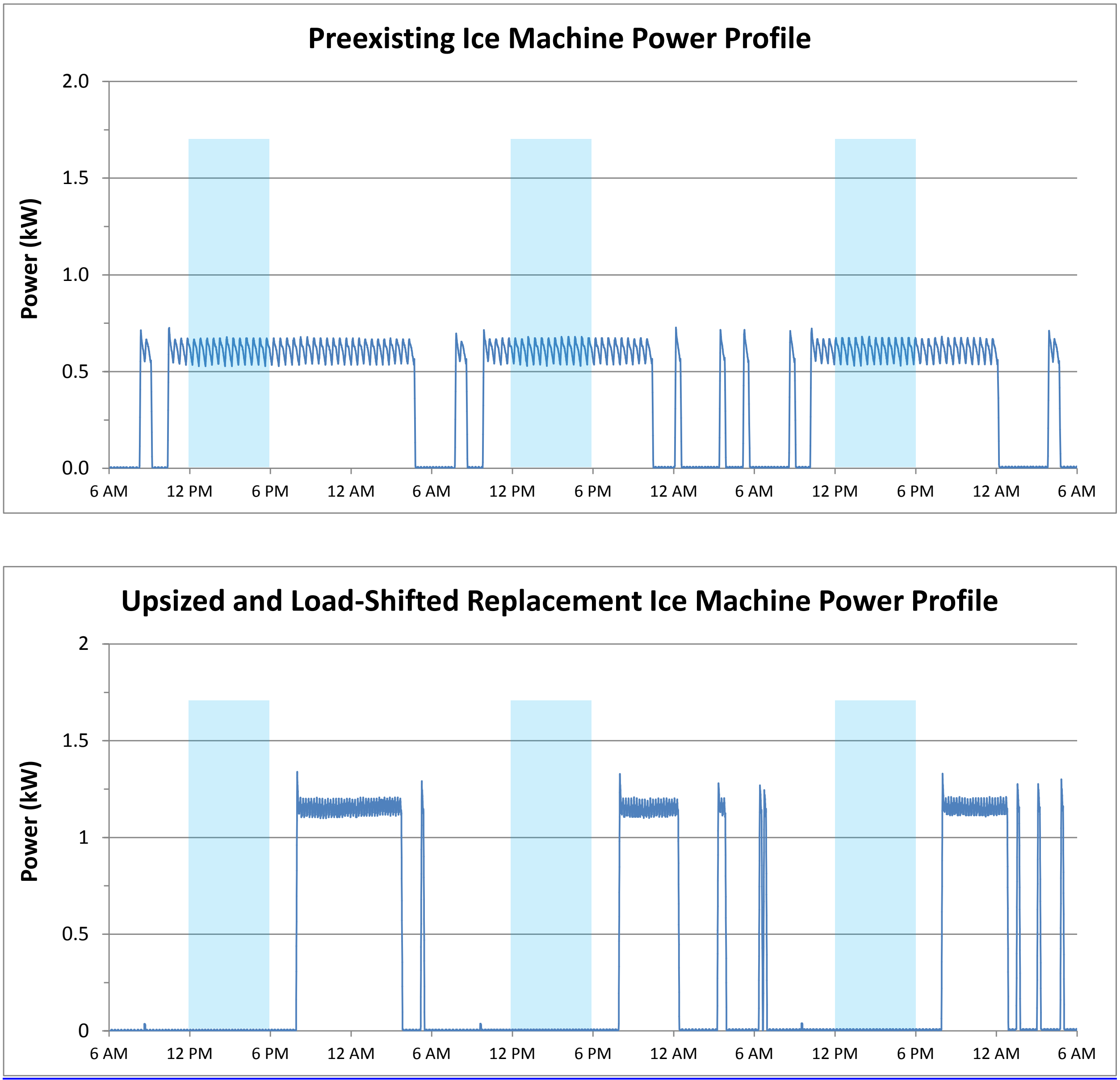


FIGURE 12. OAKLAND MUSEUM CAFETERIA—PRE-EXISTING AND REPLACEMENT ICE MACHINE POWER PROFILES

LISA V'S HOT DOGS (CONCORD, CA)

SITE DESCRIPTION AND ASSESSMENT

Established in 1982, Lisa V's Hot dogs is a short-order restaurant with a six-seat dining room and a two-seat patio located in a multi-unit retail complex, with a menu specializing in hot dogs, salads, and burritos. Concord is a city located in the East Bay of the San Francisco

Bay Area with an approximate population of 122,000.

The original ice machine was an IMH-A cube ice machine with a 220-lb/24-hr rated ice production capacity. The unit ceased to function during the baseline monitoring period, which prevented validating the measured data against AHRI performance data; estimated annual energy use was calculated based exclusively on normalized ice usage of the new machine and AHRI data. The replacement ice machine, an IMH-A with a programmable timer and a production rate of 225 lb/24-h, was a slightly more efficient replacement for its size while meeting the restaurant's needed capacity for shifting ice production to non-peak hours. A higher-efficiency machine would have been preferable; however, the available option had a larger footprint, and would not fit over the existing dispenser.

Lisa V's is currently on a PG&E A-1 Standard rate schedule. Since the restaurant will eventually shift to a time-of-use (TOU) rate schedule, cost savings were calculated based on both the A-1 Standard rate schedule and the A-1 TOU schedule.

FIGURE 13. LISA V'S REPLACEMENT ICE MACHINE

Data Collection and Analysis Results

Monitoring was conducted on replacement ice machines at Lisa V's over a period of 13 days. Data was collected for the monitoring period before the machine was load-shifted to produce ice during non-peak hours. Based on the energy profile built from this data, the time that the machine was on during hours of peak and partial-peak demand was determined, and the amount of energy that could be shifted from peak to non-peak, as well as the associated costs, were calculated.

Table 5. Lisa V's Hot Dogs Results Summary

	Pre-existing Machine	Replacement Machine
Ice Machine Type	IMH-A	IMH-A
AHRI Ice Harvest Rate (lb/24-h)	220	230
AHRI Energy Consumption Rate (kWh/100 lb)	7.90	7.32
Bin Capacity (lb)	250	250
Normalized Ice Use (lb/d)	100	100
Normalized Duty Cycle (%)	45.5	42.0
Normalized Operating Time (h/d)	10.9	10.1
Ice Machine Power (kW)	0.724	0.708
Normalized Annual Energy Use (kWh/yr)	2,880	2,610
Annual Energy Reduction (kWh/yr)	270	
Percent Energy Reduction (%)	9.4	
Average Coincident Peak Demand Reduction (kW)	0.724	
Peak Demand Reduction Time (h/d)	4.2	
Under A-1 Standard rate schedule (Current):		
Annual Energy Charges ($)	501	453
Annual Demand Charges ($)	N/A	N/A
Total Annual Electricity Cost ($)	501	453
Annual Electricity Cost Reduction ($)	48	
Annual Electricity Cost Reduction Percentage (%)	9.6	
Under A-1 TOU rate schedule (Projected):		
Annual Energy Charges ($)	504	447
Annual Demand Charges ($)	N/A	N/A
Total Annual Electricity Cost ($)	504	447
Net Annual Electricity Cost Reduction ($)	57	
Net Annual Electricity Cost Reduction Percentage (%)	11.3	

Observations and Recommendations

The replacement machine functioned as expected, and was successfully load-shifted, though at the time this report was written not enough data had been accumulated after load-shifting to provide an accurate enough analysis to report. Figure 14 below illustrates Lisa V's ice machine power profile, with the periods of load-shifting potential highlighted in blue. Despite concerns about the load-shifting potential for beverage dispensers in general due to their limited bin capacity, ice demand at Lisa V's appears low enough to accommodate the afternoon off-time. However, the ice machine at this site would have to remain load-shifted for a longer interval to ensure that this is the case.

CUSTOMER FEEDBACK

The customer has not experienced any problems with the ice production to the beverage dispenser.

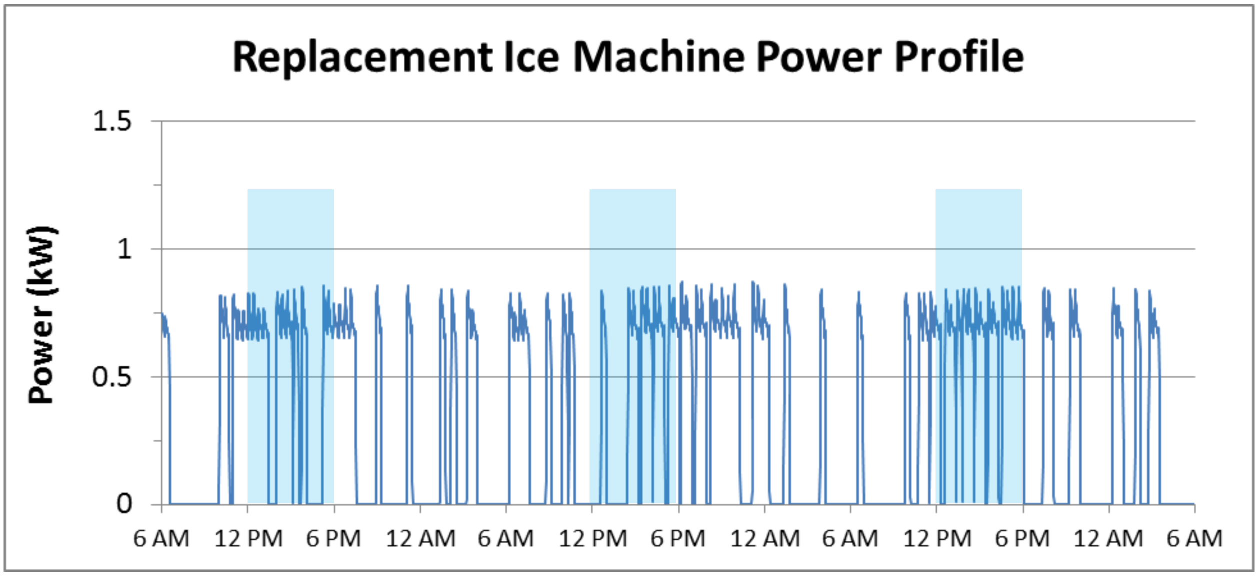


FIGURE 14. LISA V'S HOT DOGS—REPLACEMENT ICE MACHINE POWER PROFILE (NOT LOAD-SHIFTED)

SHOWCASE AT COMAL RESTAURANT (10/4/2012)

The showcase demonstrating ice machine performance was held at Comal Restaurant located in Berkeley, CA on October 4, 2012 between the hours of 10:00 am and noon. The event was promoted through flyer distribution by the City of Berkeley to over 600 restaurants and foodservice establishments, to local FSTC database contacts, to vendor customers, and to friends of the restaurant owner. The event was also promoted on FSTC's website (fishnick.com) and Facebook site, as well as through the newsletters of both the GGRA and the San Ramon Chamber of Commerce. PG&E sent mailers and e-mails to restaurants in nearby zip codes, and PG&E's area representative canvassed the area on the day of the event.

Twenty-nine guests attended the event, as well as 19 representatives from 12 vendors including the East Bay Municipal Utility District, Alameda County Green Business program, and vendor representatives for energy-efficient lighting and ice-making products.

The layout for the Comal showcase included 12 tables for the vendors and the FSTC. There were two digital displays to illustrate Comal's energy saving story, a storyboard and flyers for the Comal case study, and screenshots of Comal's PG&E bill during the monitoring period to show how their energy use had been reduced. Flyers for rebates, seminars, FSTC contacts, and estimated ROI as a result of replacing existing equipment were also included, as were seminar calendars and lists of qualifying foodservice equipment.

Comal incorporates three ice makers in their operation: two stacked cube-type machines over a single bin, and a separate flake-type machine. They were determined to have a low enough duty cycle for load-shifting.

FIGURE 15. COMAL SHOWCASE (10/4/2012)

SECTION 2: COOKING APPLIANCES

INTRODUCTION

The energy required to generate the heat necessary for cooking food through broiling, grilling, steaming, frying, and other methods represents a large percentage of the energy and associated costs of production in commercial foodservice. California restaurants are incredibly energy-intensive, using an average of 347 kBtu per square foot for both gas and electric—more than six times as much as other retail establishments. Of that, 189 kBtu/ft^2—more than half of the energy consumed in these restaurants—is used solely for cooking [9].

The foodservice industry consumes a large portion of the energy in the state as well. In 2006, California restaurants used a total of 516.9 million therms (Mtherms) of gas and electric energy—14.5% of all energy consumed across all commercial sectors in the state. Of that, 281.0 Mtherms in those restaurants were used by cooking appliances [9].

Much of this energy consumption is due to the nature of the cooking appliances currently found in production kitchens. Many appliances in restaurants are older, less-efficient models, and even those appliances that are energy-efficient by design are operated in ways that do not fully maximize their available efficiency and performance.

BACKGROUND

PG&E's ET program was created to fund field placement studies of energy-efficient commercial foodservice equipment in the PG&E service territory. The primary objective of the ET program is to promote the California Energy Wise rebate program by highlighting the performance of rebate-qualified equipment in real-world operating situations. The program involves replacing low- or standard-efficiency existing equipment in targeted foodservice establishments based on a site assessment, and measuring pre- and post-replacement energy use and calculating savings.

This particular ET project utilized recent findings in a PIER study completed by Fisher-Nickel, inc (FNi) which characterized the inventory, energy load, and energy-efficiency potential of various primary cooking appliances found in commercial and institutional foodservice sectors in the state of California [8]. The goal of the PIER study was to identify energy-efficient needs in the restaurant industry; identify equipment with the highest energy loads; and outline specific strategies to stimulate RD&D improvements in energy efficiency and performance to support regulatory and utility-based incentive programs around this equipment. This ET program augments the PIER study by demonstrating "proof-of-concept" in live kitchens for implementing these energy reduction strategies to support current and future utility-based incentives for more efficient equipment. It will also help increase awareness in the foodservice industry of the real-world performance of energy-efficient equipment, further driving manufacturer research and development as demand for this type of equipment continues to grow.

OBJECTIVES

The primary project goals of this ET project/assessment were as follows:

- Select local sites with the potential for replacing standard- and low-efficiency cooking equipment with energy-efficient equipment which are ENERGY STAR®-qualified, and are eligible for use in the California Energy Wise incentive program.
- Provide assessment of existing equipment.
- Establish energy and cost baselines with existing equipment.
- Provide assistance with equipment selection and installation.
- Measure data to calculate energy and cost savings using replacement equipment.

SCOPE

Five sites were selected for the cooking appliance section of the project based on several factors: Whether the existing cooking equipment at the site was standard- or low-efficiency; the site's relationship with the FSTC (e.g. the site had participated in an energy audit or design consultation with an FSTC energy analyst, or an operator at the site had attended one of the Center's energy-efficiency seminars); and the site's willingness to participate in this ET project. Cooking equipment at selected sites was replaced with equipment of comparable size and production capacity.

FIELD ANALYSIS AND RESULTS

ARTISAN BISTRO (LAFAYETTE, CA)

TECHNICAL APPROACH

SITE DESCRIPTION

Artisan Bistro is a 1200-square-foot fine dining establishment specializing in contemporary California French cuisine. Lafayette is located in the East Bay of the San Francisco Bay Area with an approximate population of almost 24,000. Artisan Bistro was selected as a study site after an energy audit conducted by FSTC energy analysts, who evaluated the facility's ventilation and other energy-using systems.

SITE ASSESSMENT

After assessing the cooking equipment at Artisan Bistro, energy analysts identified for replacement a 35-pound deep-fat gas fryer. Based on the FSTC's online cost calculator, the fryer was estimated to consume 18,500 Btu during preheat, with an idle energy rate of 17,000 Btu/h, production capacity of 75 lb/h, and 35.0% cooking-energy efficiency.

Site Objectives

The objective of this study was to demonstrate the energy savings associated with replacing the standard-efficiency fryer at Artisan Bistro with an ENERGY STAR®-listed fryer of comparable size and production capacity, one which would also qualify for the California Energy Wise rebate program.

Evaluation Plan

The appliance's energy use was calculated using the FSTC's web-based life cycle cost calculator. The calculator effectively models the fryer energy use using assumptions specific to restaurant operations—including average amount of food that Artisan Bistro cooks in their fryer on any given day, number of hours of daily operation, total number of preheats per day, and the number of days per year that the restaurant is open.

Other fryer performance assumptions were based on data generated from the implementation of standard ASTM test methods. The fryer test method (ASTM F1361-07) determines fryer preheat time and energy, idle energy rate, cooking-energy efficiency and production capacity. Preheat performance is a measure of the amount of time and energy the fryer requires to reach a fully-operational set point where the fry vat oil reaches 350°F. Time and energy is expressed in minutes and Btu's, respectively. The idle energy rate, Btu/h, is the amount energy the fryer consumes while in a standby condition, not cooking and maintaining the fry vat oil at 350°F. Cooking-energy efficiency is the calculated percentage of the energy to the appliance that is actually transferred to the test food product; a three-pound load of shoestring French fries. Lastly, production capacity (lb/h) is determined through the successive cooking of the standardized loads of fries to a pre-determined done condition. Production capacity is essentially a measure of the fryers' ability to recover after each load of raw fries is introduced into the cooking media.

Results

Data Collection and Analysis

Table 6 documents the fryer life cycle cost calculator assumptions used to determine the energy use of both the pre-existing and replacement fryer.

TABLE 6. FRYER OPERATING ASSUMPTIONS: ARTISAN BISTRO

	Pre-existing Fryer Assumptions	Replacement Fryer Assumptions
Preheat Energy (Btu)	16,000	9,456
Idle Energy Rate (Btu/h)	14,000	7,349
Cooking-Energy Efficiency (%)	35.0	50.0
Production Capacity (lb/h)	60	58.7
Days of Operation	310	310
Hours of Operation per Day	12	12
Pounds of Food Cooked per Day	50	50

Tables 7 and 8 document the calculated energy use of the pre-existing and replacement natural gas fryer and the associated operating cost savings.

TABLE 7. CALCULATED FRYER ENERGY USE: ARTISAN BISTRO

Pre-existing Fryer Calculated Annual Energy Use (therms)	Replacement Fryer Calculated Annual Energy Use (therms)	Replacement Fryer Calculated Annual Energy Savings (therms)
776	455	321

TABLE 8. PROJECTED FRYER OPERATING COSTS AND SAVINGS: ARTISAN BISTRO

Pre-existing Fryer Annual Operating Cost ($)	Replacement Fryer Annual Operating Cost ($)	Replacement Fryer Annual Operating Cost Savings ($)*
659	387	272

**Annual operating cost savings based on gas utility rates of $0.85/therm*

Figure 16 illustrates Artisan Bistro's cooking line after the fryer (shown far right) was replaced.

FIGURE 16. ARTISAN BISTRO'S COOKING LINE (REPLACEMENT FRYER ON FAR RIGHT)

CUSTOMER FEEDBACK

The customer is pleased with the fryer performance, and with the energy and cost savings.

CONCLUSIONS AND RECOMMENDATIONS

Replacing the fryer represented a 52.8% reduction in annual energy consumption and operating costs. However, the calculated savings represent 2.9-year simple payback when using the list price of the fryer after the $749 rebate. Actual savings may be greater or less based on fryer use and operating conditions.

DEL TACO (FAIRFIELD, CA)

TECHNICAL APPROACH

SITE DESCRIPTION

Del Taco is a franchisee-owned, quick-service restaurant specializing in American-style Mexican cuisine. The location was selected as a study site after an energy audit conducted by FSTC energy analysts, who evaluated each of the facility's energy-using systems. Fairfield, a city with a population of approximately 108,300, is considered the midpoint between Sacramento and San Francisco. Del Taco is open from 9 am to 10 pm, and the drive-through window is open until 11 pm. There is generally a heavier demand on the drive-through than on the dining room.

SITE ASSESSMENT

The energy analyst performing the audit noticed that Del Taco was using a manually-controlled, non-thermostatic griddle, which holds a consistent input rate whether cooking or idle. As a result, manually-controlled griddles are generally less energy-efficient than thermostatic griddles, which allow for improved control of the griddle surface temperature. FSTC determined an appropriate replacement from the rebate list based on first cost and FSTC lab data. The cooking surface area of the two were comparable; the pre-existing griddle with 6.83 square feet of surface area was replaced with a griddle with 7.50 square feet of surface area.

SITE OBJECTIVES

The objective for monitoring this site was to compare energy use between the manually-controlled, standard-efficiency griddle at Del Taco and an ENERGY STAR®-listed, thermostatically-controlled replacement griddle of comparable size and production capacity, one which would also qualify for the California Energy Wise rebate program.

MONITORING AND EVALUATION PLAN

Gas meters with a resolution of one cubic foot per minute and data loggers recording at 1-minute intervals were installed to monitor both griddles' gas consumption. Because the heating value, gas temperature, gas pressure, and barometric pressure was not measured at the monitoring location, one cubic foot of gas was assumed to contain 1,000 Btu of energy.

Baseline and replacement monitoring were to take place over a minimum of two weeks each. Griddle surface temperatures were also to be captured. It was assumed that the production conditions and operating hours would remain the same between the two griddles.

RESULTS

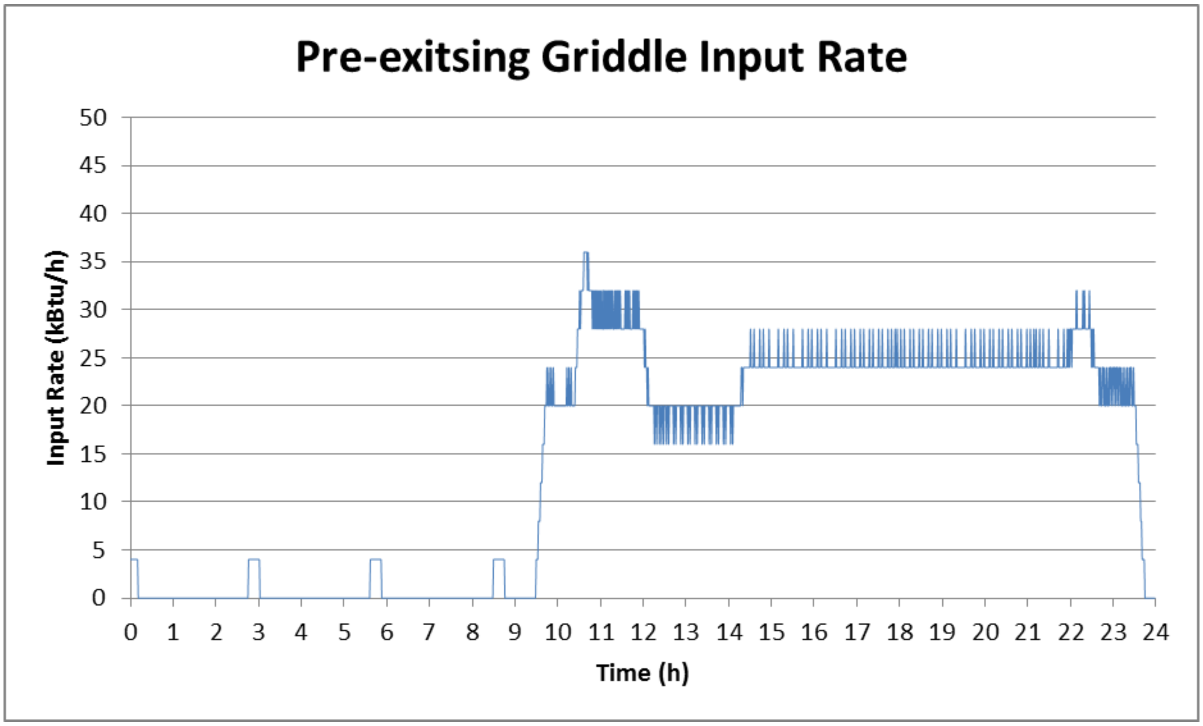
DATA COLLECTION AND ANALYSIS

The pre-existing griddle was monitored over a period of 80 days. The replacement griddle was monitored over a period of 38 days. After the data was collected for each griddle, the energy profiles for each were averaged every 15 minutes to determine the respective average input rate.

Griddle input rate was calculated by using a moving average: Adding the gas consumption over 15-minute intervals, and multiplying the total by four. Anything under 5 kBtu/h, was considered to be consuming pilot energy only; anything over 5 kBtu/h was considered a period of griddle on-time. The input rate profiles for the pre-existing and replacement griddles are illustrated in Figure 17 below.

Surface temperatures of the pre-existing and replacement griddles were monitored over three locations side-to-side, and these three locations averaged. Surface temperatures for the pre-existing griddle were taken in the FSTC lab based on settings marked on the griddle controls, and averaged 410°F. Surface temperature readings for the replacement griddle were taken onsite on a Tuesday at 11 am in anticipation of the lunch rush, and averaged 304°F.

The monitored energy data for both griddles was normalized based on gas consumption per hour of operation for each griddle. On-time averaged 15.48 for the baseline griddle and 17.23 for the replacement griddle. Gas consumption per hour of operation was then normalized to the energy use per square foot for each griddle to calculate the final energy savings. For the pre-existing griddle and replacement griddle, Table 9 documents the measured daily energy and the energy use per cubic foot of surface area per operating hour.



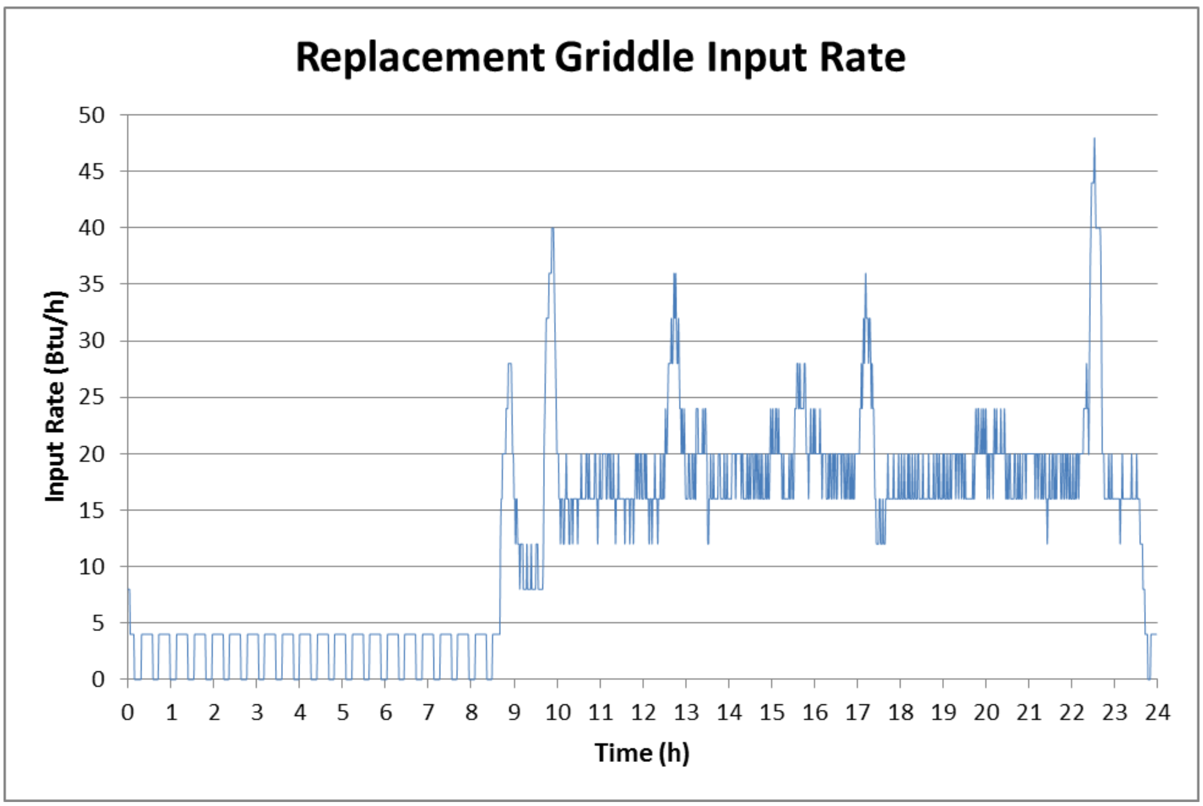


FIGURE 17. DEL TACO—PRE-EXISTING AND REPLACEMENT GRIDDLE INPUT RATES

TABLE 9. PRE-EXISTING GRIDDLE ENERGY USE: DEL TACO

Appliance	Pre-existing Griddle Measured Daily Energy Use (kBtu)	Pre-existing Griddle Average Energy Use per Hour of Operation (kBtu/h)	Pre-existing Griddle Average Hourly Energy Use per Square Foot (kBtu per sq ft/h)
Pre-existing Griddle	295	19.06	2.79

TABLE 10. REPLACEMENT GRIDDLE ENERGY USE: DEL TACO

Appliance	Replacement Griddle Measured Daily Energy Use (kBtu)	Replacement Griddle Average Energy Use per Hour of Operation (kBtu/h)	Replacement Griddle Average Hourly Energy Use per Square Foot(kBtu per sq ft/h)
Replacement Griddle	337	19.56	2.61

TABLE 11. PROJECTED GRIDDLE ENERGY AND OPERATING COST DIFFERENCE: DEL TACO

Appliance	Replacement Griddle Annual Energy Savings (therms)	Replacement Griddle Annual Operating Cost Savings ($)*
Griddle	-42	-35.70

**Annual operating cost difference based on a natural gas utility rate of $0.85/therm*

While the replacement griddle exhibited higher overall energy usage than the preexisting griddle, the normalized energy usage (Btu/h per square foot) was lower.

Since the usage patterns varied between the preexisting griddle and the replacement griddle, standardized laboratory tests were used to compare the performance of the two appliances, based on established test protocols outlined in the ASTM Standard Test Method for the Performance of Griddles.

The pre-existing griddle was brought into the FSTC lab, and energy consumption production rates under various cooking temperatures were compared between the pre-existing griddle and the replacement griddle. Existing FSTC lab data was used for the replacement griddle.

Using the ASTM standard as the basis for testing, Del Taco's pre-existing non-thermostatic griddle was set to maintain an average cooking surface temperature of 375°F. Non-cooking idle energy rate while maintaining 375°F was 18.8 kBtu/h. Using the same temperature setpoint, one load of 24 frozen ¼-lb burgers was cooked in 50 minutes. Since the manually-controlled griddle operates at a constant input rate unless the operator adjusts the controls, the cooking input rate remained the same as the idle rate of 18.8 kBtu/h during the test. At this setting, the griddle required more than 40 minutes to recover to a minimum temperature of 350°F after cooking a load of frozen hamburgers.

The temperature profile shown in Figure 18 illustrates the pre-existing non-thermostatic griddle's performance at 375°F.

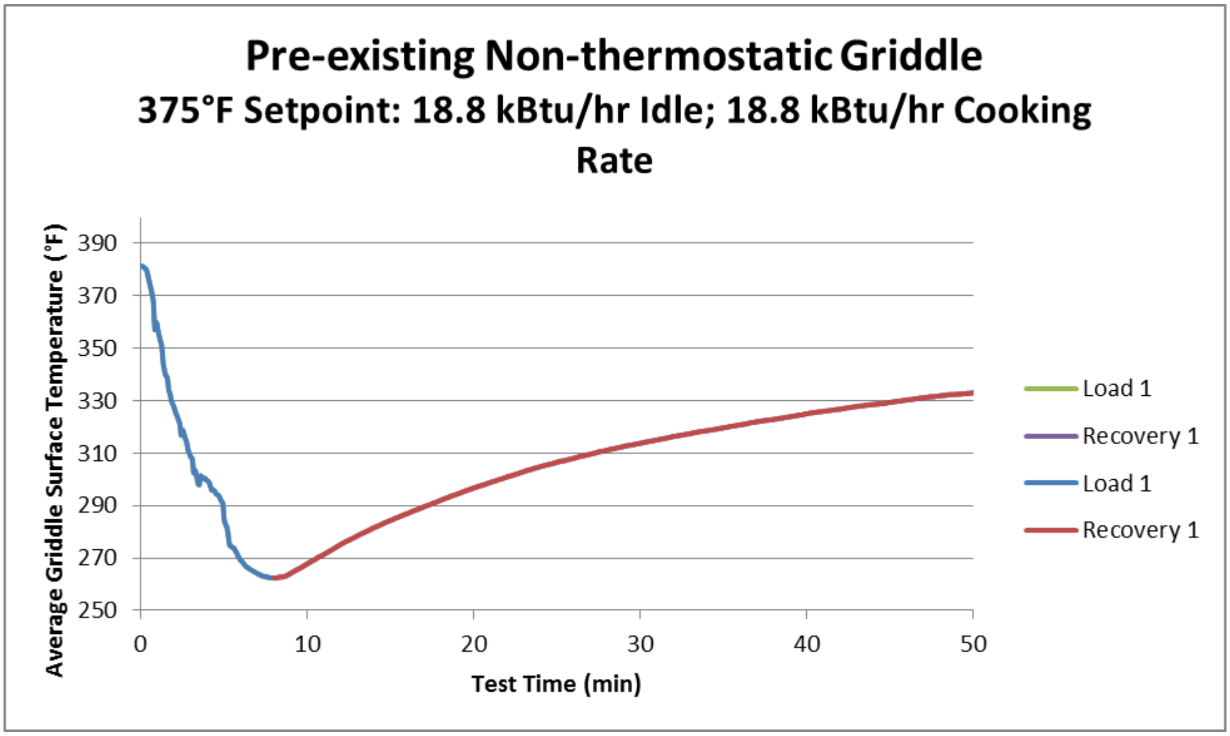


FIGURE 18. DEL TACO'S PRE-EXISTING NON-THERMOSTATIC GRIDDLE: TEMPERATURE PROFILE UNDER HEAVY LOAD AT 375°F

This slow recovery was caused by the relatively low burner setting used to hold the 375°F cooking surface temperature, which was not able to keep up with the heat loss during the cooking process. To evaluate recovery performance with the controls turned up, the griddle controls were adjusted to achieve an average surface temperature of 400°F. The energy consumption rate while maintaining 400°F was 30.3 kBtu/h. The cooking test was repeated at the higher control settings, resulting in a somewhat faster time to recover back to a 350° reload temperature. These tests show that heavy cooking would require operators to constantly adjust the control settings to achieve any performance on the griddle.

The temperature profile shown in Figure 19 illustrates the pre-existing non-thermostatic griddle's performance at 400°F.

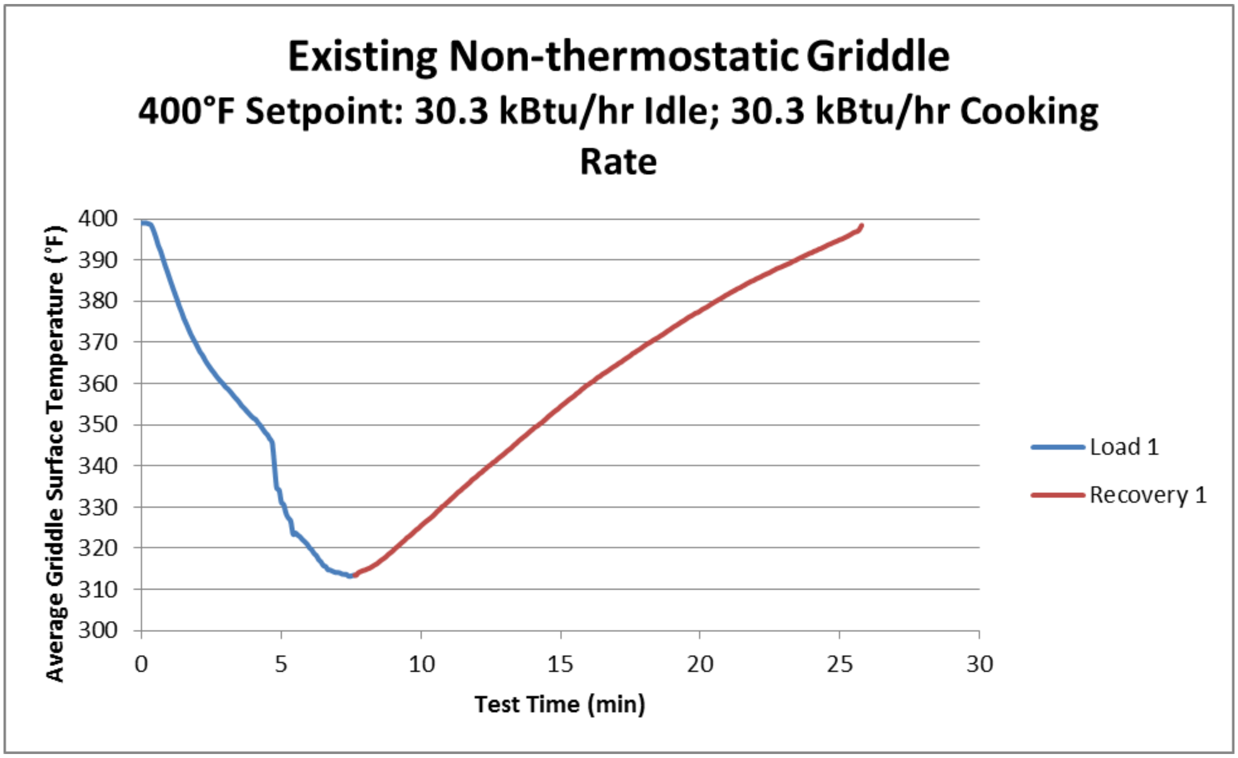


FIGURE 19. DEL TACO'S PRE-EXISTING NON-THERMOSTATIC GRIDDLE: TEMPERATURE PROFILE UNDER HEAVY LOAD AT 400°F

In contrast, the replacement thermostatic griddle was set for an average surface temperature of 375°F—the temperature used when FSTC researchers tested the thermostatic griddle under heavy-load conditions. The non-cooking idle rate while maintaining 375°F was 16.2 kBtu/hr. Using the same temperature setpoint, five loads of 32 frozen ¼-lb burgers were cooked in 50 minutes. It took the thermostatic griddle 1-2 minutes to recover to a minimum temperature of 350°F each time while consuming 61.3 kBtu/hr. The temperature profile shown in Figure 20 illustrates the replacement thermostatic griddle's performance at 375°F.

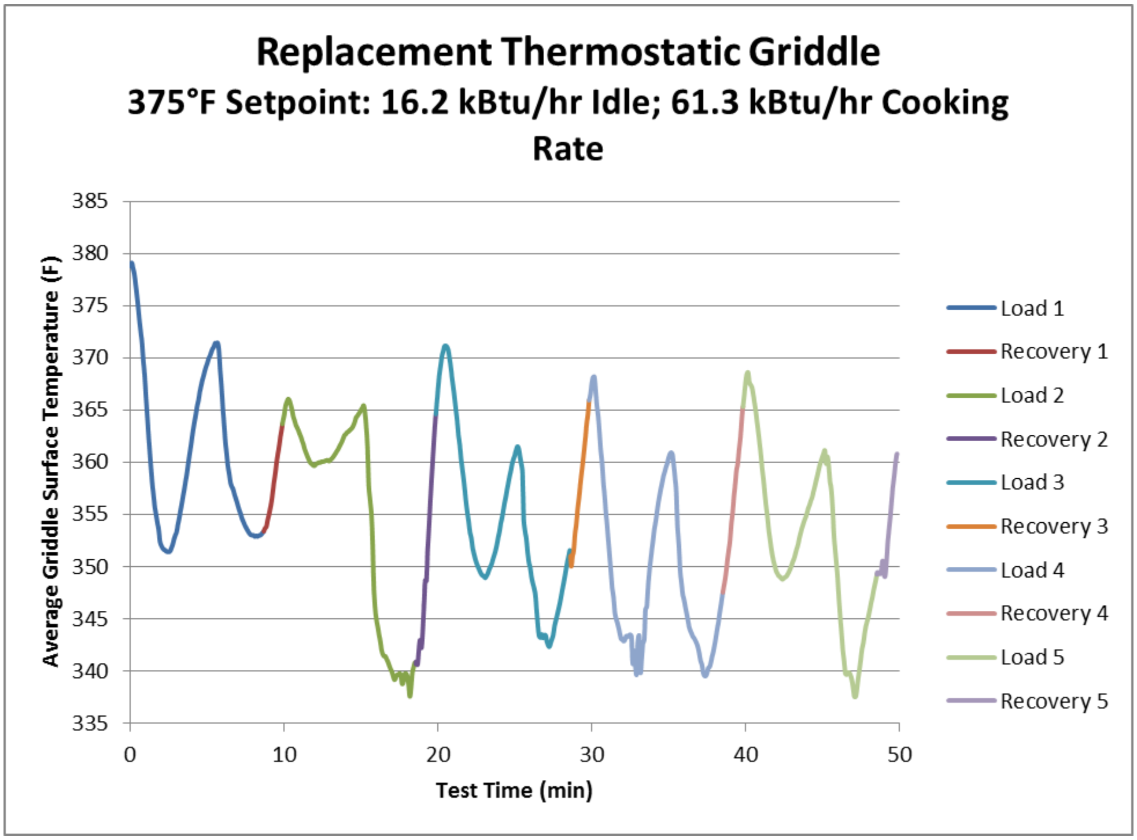


FIGURE 20. DEL TACO'S REPLACEMENT THERMOSTATIC GRIDDLE: TEMPERATURE PROFILE UNDER HEAVY LOAD AT 375°F

Del Taco's pre-existing and replacement griddles are shown in Figure 21.

FIGURE 21. DEL TACO GRIDDLES: PRE-EXISTING (LEFT) AND REPLACEMENT (RIGHT)

Customer Feedback

The operators reported to the FSTC team that they were very happy with the griddle performance.

Conclusions and Recommendations

On a per-square foot basis, with the operating hours normalized, the replacement griddle at Del Taco used 6.5% less energy per square foot per hour. However, when the overall daily energy use between the two griddles was compared, the pre-existing griddle's daily energy use was 14.2% lower than the replacement griddle.

It can be noted that the operator only occasionally adjusted the controls of the manual griddle over the course of the day. The average operating temperature was lower than the assumed 375°F temperature used for the replacement griddle. In this case, it appears that the cooking load on the griddle was fairly light duty and the operator was not unduly inconvenienced by the lower average operating temperatures and longer recovery times associated with using the manual controlled griddle. However, the lower temperatures may affect cooking performance and recovery rates during periods of higher production.

The replacement griddle offered a combination of a larger cooking surface and faster recovery without requiring operator adjustments to the controls during busy periods. When comparing the recovery performance of the thermostatic griddle to the manually-controlled griddle and considering the relative amount of food produced on the griddle, it may have been possible to downsize from a 48-inch wide manual griddle to a 36-inch wide thermostatic griddle. This would have maximized the energy savings potential of the more efficient design and controls that were employed in the replacement griddle. If the entire 48 inches of the griddle is required (e.g. if space is required to cook more than one food item), the temperature controls on the replacement griddle could also be turned down, as long as any increases in food production does not affect productivity as a result of the lower input rates.

The results of this griddle study underscore the need to better understand the production needs of the restaurant needs of the restaurant and account for the faster recovery associated with energy efficient appliances when specifying cooking appliance upgrades.

Lisa V's Hot Dogs (Concord, CA)

Technical Approach

Site Description

Established in 1982, Lisa V's Hot dogs is a 600-square-foot short-order restaurant with a 24-seat dining room and a seven-seat patio located in a multi-unit retail complex. Lisa V's menu specializes in hot dogs, salads, and burritos. Concord is a city located in the East Bay of the San Francisco Bay Area with an approximate population of 122,000.

Lisa V's Hot Dogs was selected as a study site after a design and review consultation conducted by FSTC energy analysts, part of a remodeling project that the restaurant was undertaking.

Site Assessment

The steamer in place was a three-compartment range-top box steamer, with a volume of approximately three cubic feet, which was heated on a three-burner range. Lisa V's also has a steam table across the back wall used for holding hot items (chili, beans, carnitas, etc.).

Site Objectives

The objective for monitoring this site was to compare energy use between the standard-efficiency pre-existing steamer equipment at Lisa V's and an ENERGY STAR®-listed steamer of comparable size and production capacity, which would also qualify for the California Energy Wise rebate program.

FSTC energy analysts determined that the existing steamer box and range top could be replaced by a double-stacked connectionless steamer. The upper compartment of the steamer would be used for cooking at 210°F. The lower compartment of steamer would be used for holding cooked food at 180°F.

The owner of Lisa V's evaluated the replacement steamer at the FSTC lab before installation, and concluded that it would adequately meet the restaurant's production needs.

Monitoring and Evaluation Plan

A gas meter with a resolution of 1/20th of a cubic foot per minute and a data logger were installed to monitor the gas consumption of the pre-existing steamer.

For the replacement steamer a gas meter was installed on each two compartments to monitor gas consumption. Both of these gas meters had a resolution of one cubic foot per minute.

The monitoring period of the pre-existing and replacement steamers was to be a minimum of two weeks for each. It was assumed that the production conditions and operating hours would remain the same between the pre-existing steamer and the replacement steamer.

Because the gas heating value, gas temperature, gas pressure, and barometric pressure could not be measure at the monitoring location, one cubic foot of gas was assumed to contain 1,000 Btu of energy.

Results

Data Collection and Analysis

Steamer operation was determined by using a 15-minute moving average of the one-minute data.

Monitoring on the pre-existing steamer was performed for 40 days. The pre-existing steamer average time on was 11.2 hours/day. The input rate profiles for the pre-existing and replacement steamers are illustrated in Figure 22 below.

Monitoring on both the replacement steamer compartments was performed for 16 days. Both compartments were turned on and off at the same times each day, so daily operating hours were the same. The replacement steamer's top compartment used 61% of the energy during the monitoring period; the replacement steamer's bottom compartment used 39%.

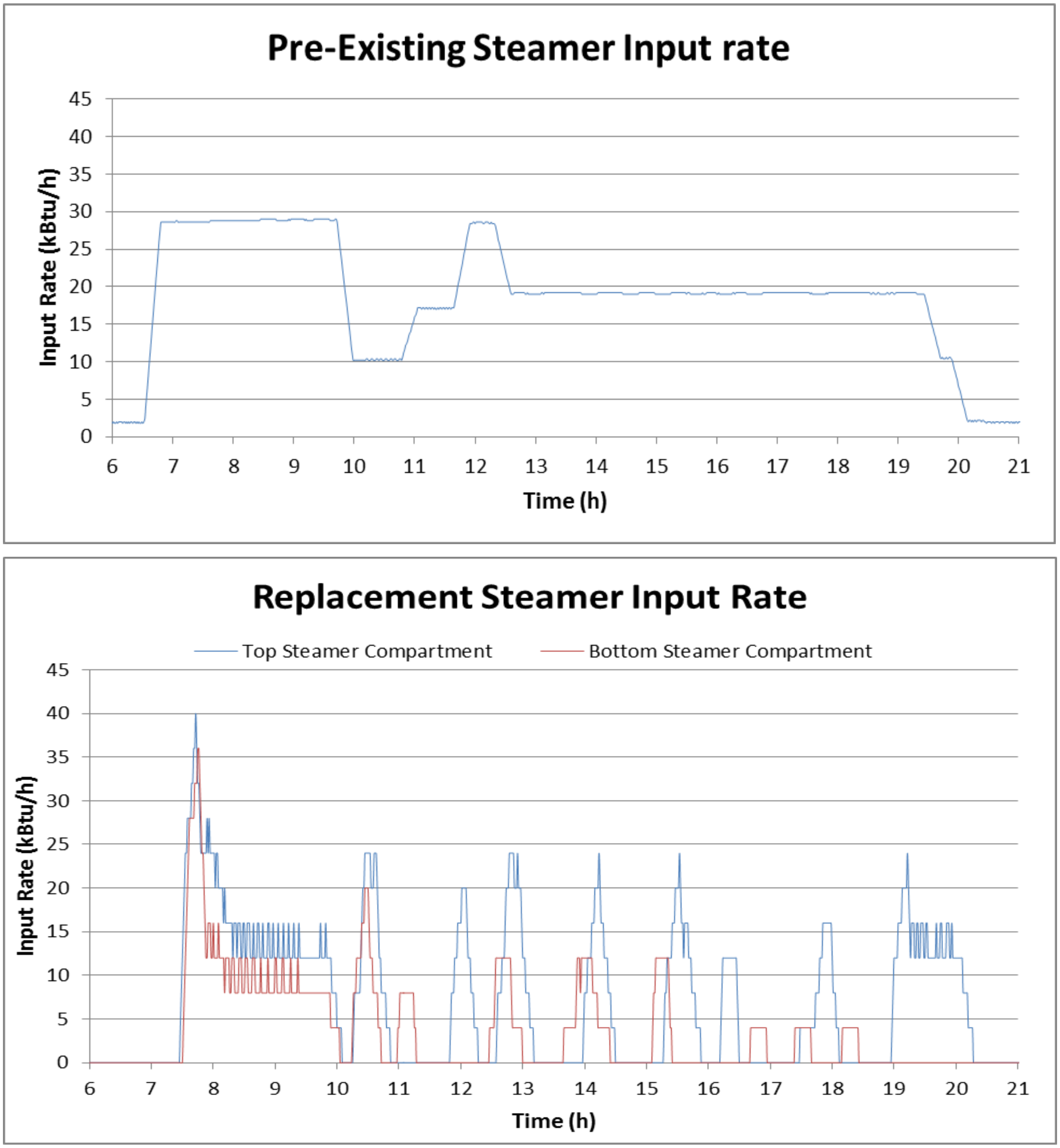


FIGURE 22. LISA V'S HOT DOGS—PRE-EXISTING AND REPLACEMENT STEAMER INPUT RATES

The burners in the replacement steamer's top compartment were energized for 6.5 hours/day, which was set for cooking conditions of 210°F. The top compartment averaged 78,438 Btu per day.

The steamer burners in the replacement steamer's bottom compartment were energized for 5.6 hours/day, which was set for holding conditions of 180°F. The bottom compartment averaged 50,563 Btu per day.

Table 12 documents the measured daily energy, projected annual energy use and associated operating cost of the pre-existing steamer and the replacement steamer. Table 13 documents the annual energy and operating cost savings of the replacement steamer.

TABLE 12. STEAMER ENERGY USE: LISA V'S HOT DOGS

Appliance	Pre-existing Steamer Measured Daily Energy (kBtu)	Replacement Steamer Measured Daily Energy (kBtu)	Pre-existing Steamer Projected Annual Energy (therms)*	Replacement Steamer Projected Annual Energy (therms)*
Steamer	215	129	786	470

**Annual energy use projections assumes 364 days of operation per year*

TABLE 13. PROJECTED STEAMER ENERGY AND OPERATING COST SAVINGS: LISA V'S HOT DOGS

Appliance	Replacement Steamer Annual Energy Savings (therms)	Replacement Steamer Annual Operating Cost Savings ($)*
Steamer	317	210

**Annual operating cost savings based on a natural gas utility rate of $0.85/therm*

Lisa V's Hot Dogs' pre-existing and replacement steamer are shown in Figure 23.

FIGURE 23. LISA V'S HOT DOGS: PRE-EXISTING STEAMER (LEFT) AND REPLACEMENT STEAMER (RIGHT)

CUSTOMER FEEDBACK

After a week of guidance on operating the new equipment from FSTC energy analysts and site monitors, the owner of Lisa V's became very comfortable cooking with the new steamer. The owner was especially impressed with the faster cook times and better product consistency, and is planning to expand the menu based on the new steamer's features that were not available with the pre-existing steamer. Now there is additional room under the hood to add more appliances.

The owner reported that the replacement steamer needed to be refilled four times a day.

RECOMMENDATIONS

The replacement steamer showed a 40% reduction in energy use compared with the pre-existing steamer. However the annual reduction in energy costs is relatively low compared to the capital costs of replacing the steamer.

If Lisa V's has the space in their steam table for holding the cooked food currently held in the replacement steamer's lower unit, then a single steamer unit could possibly meet their needs. If this were feasible, holding food in the existing steam table would require less energy than the installed double-stacked unit.

NORM'S PLACE (DANVILLE, CA)

TECHNICAL APPROACH

SITE DESCRIPTION

Norm's Place is a bar and grill with an 11-seat dining area, an eight-seat bar table, and 12-seat traditional liquor bar. Danville is a city located in the East Bay of the San Francisco Bay Area with an approximate population of 42,000. Norm's Place was selected as a study site after conducting an evaluation of the restaurant's demand control ventilation and a subsequent audit of the cooking equipment by FSTC energy analysts.

SITE ASSESSMENT

After assessing the cooking equipment at Norm's Place, energy analysts identified a 14-inch, 40-lb deep-fat gas fryer as a candidate for replacement. The fryer is one of two fryers on Norm's cook line; both were originally the same model before one was replaced with a more energy-efficient version.

SITE OBJECTIVES

The objective of this study was to demonstrate the energy savings associated with replacing the standard-efficiency fryer at Norm's Place with an ENERGY STAR®-listed fryer of comparable size and production capacity, which would also qualify for the California Energy Wise rebate program.

Monitoring and Evaluation Plan

Gas meters with a resolution of one cubic foot per minute and a data logger recording once per minute were installed to monitor the fry bank gas consumption. Both baseline and replacement monitoring were to take place over a minimum period of two weeks for each.

Because the heating value, gas temperature, gas pressure, and barometric pressure could not be measured at the location, one cubic foot of gas was assumed to contain 1,020 Btu of energy.

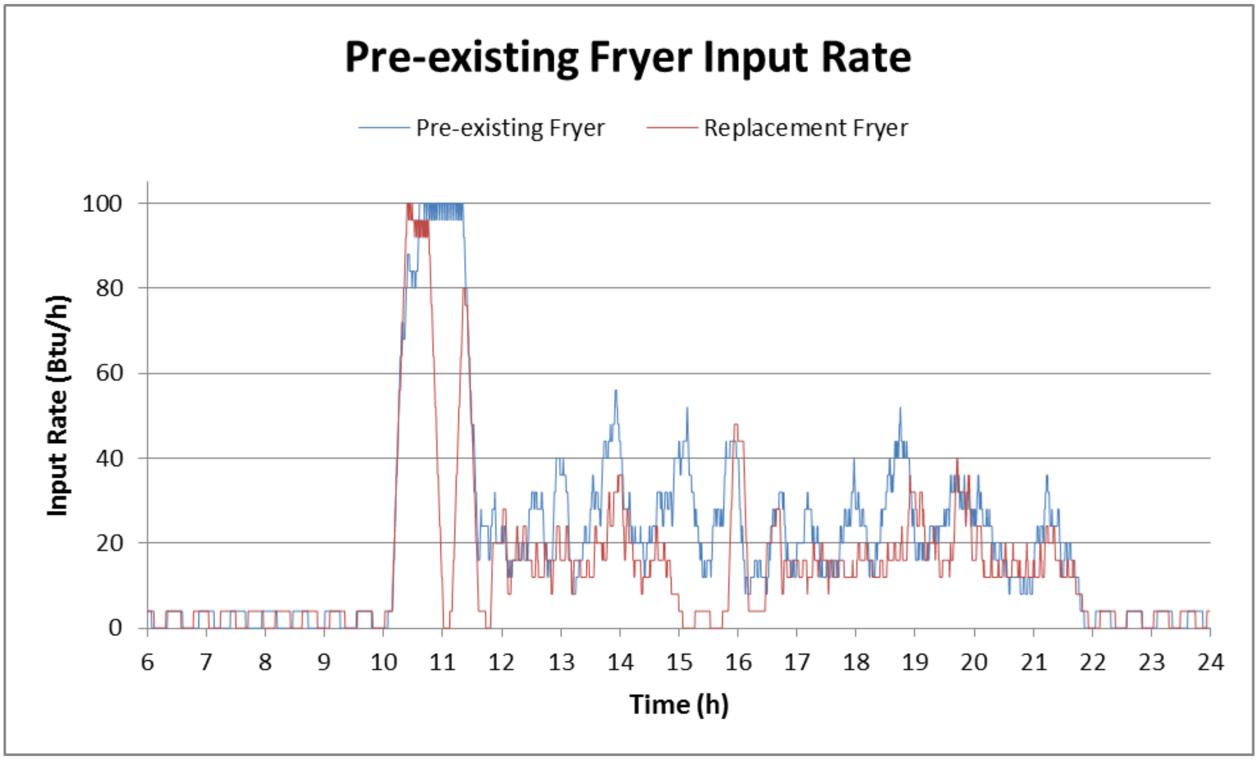
Results

Data Collection and Analysis

Data for the pre-existing and replacement fryer configurations was ultimately collected over a period of three-weeks for each. Because usage changed between the beginning and end of the six-week monitoring period, the first and last week were discarded, and the middle four weeks where the data was relatively consistent were used in the calculations.

Since any changes in efficiency and/or preferential usage of the replacement fryer could affect the amount of time that the control fryer was used for cooking, the gas consumption was normalized based on the differences in the control fryer's energy consumption between the pre-existing and replacement fryer configurations.

The input rate profiles for the pre-existing and replacement fryers at Norm's Place are illustrated in Figure 24 below.



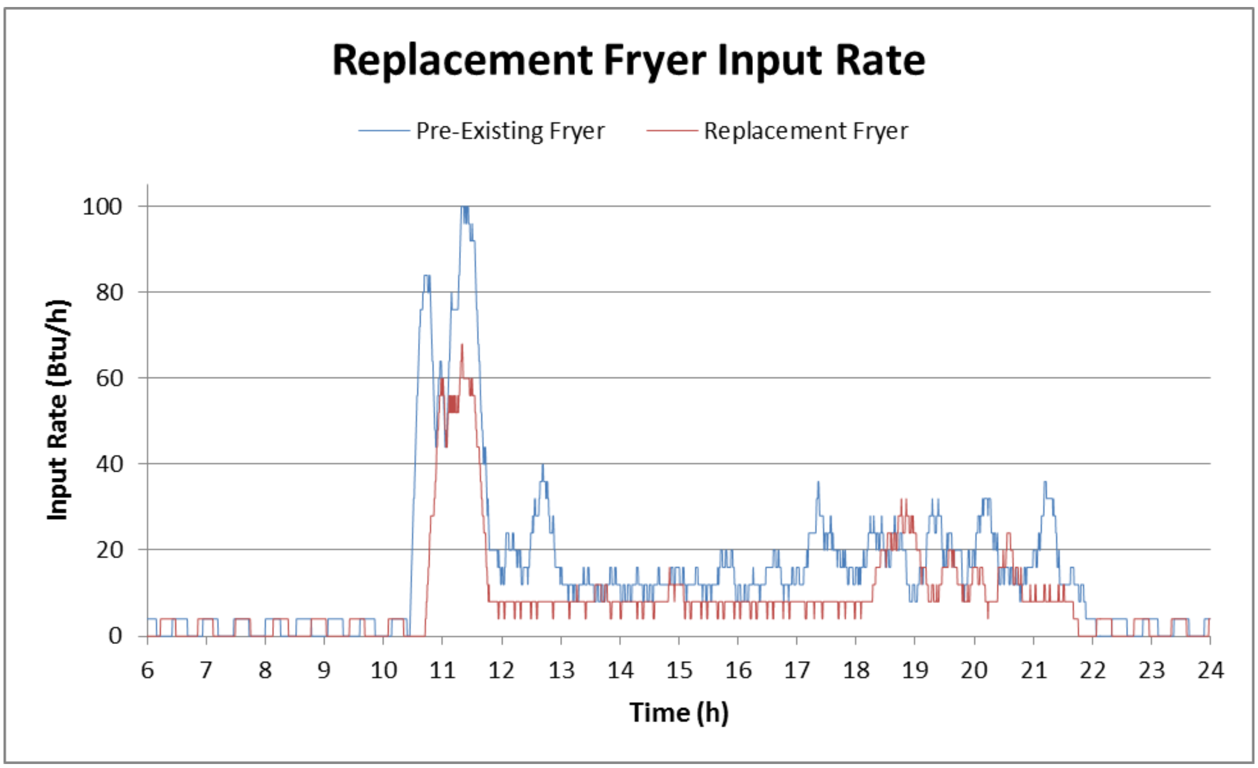


FIGURE 24. NORM'S PLACE—PRE-EXISTING AND REPLACEMENT FRYER INPUT RATES

Table 14 documents the measured daily energy, projected annual energy use and associated operating cost of the pre-existing fryer and replacement fryer. Table 15 documents the annual energy savings associated with the replacement fryer and the annual operating cost savings.

TABLE 14. FRYER ENERGY USE: NORM'S PLACE

Appliance	Pre-existing Fryer Measured Daily Energy (kBtu)	Replacement Fryer Measured Daily Energy (kBtu)	Pre-existing Fryer Projected Annual Energy (therms)*	Replacement Fryer Projected Annual Energy (therms)*
Fryer	245.6	167.1	898	610

**Annual energy use projections assume 365 days of operation per year*

TABLE 15. PROJECTED FRYER ENERGY AND OPERATING COST SAVINGS: NORM'S PLACE

Appliance	Replacement Fryer Annual Energy Savings (therms)	Replacement Fryer Annual Operating Cost Savings ($)*
Fryer	288	244

**Annual operating cost savings based on a natural gas utility rate of $0.85/therm*

Norm's Place's pre-existing and replacement fryers are shown in Figure 25.

FIGURE 25. NORM'S PLACE FRYERS: PRE-EXISTING FRY BANK (LEFT PHOTO) AND FRY BANK WITH REPLACEMENT FRYER (RIGHT PHOTO)

CUSTOMER FEEDBACK

The customer has been very happy with the performance of the replacement fryer and is enthusiastic about the ultimate energy saving potential.

RECOMMENDATIONS

Norm's Place is encouraged to replace the control fryer with a second energy-efficient fryer.

TRUEBURGER (OAKLAND, CA)

TECHNICAL APPROACH

SITE DESCRIPTION

Trueburger is a 1,000-square-foot, fast-casual restaurant located in the central business district of Oakland, a city in the San Francisco Bay Area with an approximate population of 396,000. The restaurant is on a busy thoroughfare and has a 40-seat dining room. Much of the restaurant's business is devoted to take-out orders.

SITE ASSESSMENT

Trueburger was chosen for this ET study following a design and review consultation conducted by FSTC energy analysts, who were involved in the build-out of the restaurant, and reviewed equipment schedules and mechanical drawings to help the owners mitigate energy use through the specification of energy-efficient appliances and equipment. The site was identified as a candidate for an ice machine replacement and load-shifting study. During that time, the fryers at Trueburger were identified as a replacement candidate as well.

The restaurant had two 14-inch, 40-lb fryers of the same make and model. One of these fryers was replaced; the other was left in place, and served as a control fryer for the monitoring interval.

SITE OBJECTIVES

The objective of this study was to demonstrate the energy savings associated with replacing the standard-efficiency fryer at Trueburger with an ENERGY STAR®-listed fryer of comparable size and production capacity, which would also qualify for the California Energy Wise rebate program.

MONITORING AND EVALUATION PLAN

Baseline data for both existing fryers in Trueburger was monitored for a three-week period. Usage was consistent across all three weeks, with a standard deviation of <2% of the total weekly gas consumption for the three-week data set. One of the fryers was then replaced, and both fryers were monitored for another three-week period. Usage was even more consistent across all three weeks during this monitoring period, with a standard deviation of <1% of the total weekly gas consumption.

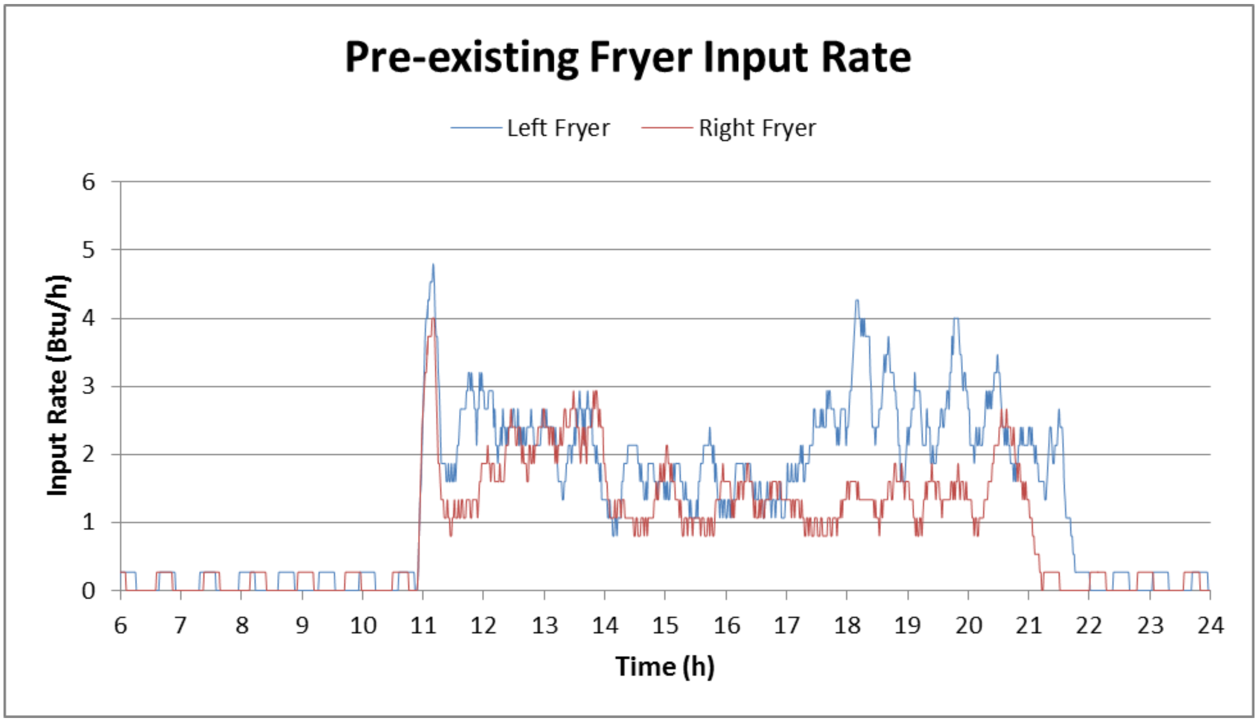
Since any changes in efficiency and/or preferential usage of the replacement fryer could affect the amount of time that the control fryer was used for cooking, the gas consumption was normalized based on the differences in the control fryer's energy consumption between the pre-existing and replacement fryer configurations.

RESULTS

DATA COLLECTION AND ANALYSIS

Figure 26 illustrates the energy input rate differences in Trueburger's production environment when two fryers of the same (pre-existing) model are compared side-by side, and when the replacement fryer is compared side by side with the control fryer (the control fryer is the same model as the pre-existing fryer).

Table 16 documents the measured daily energy use, projected annual energy use and associated operating costs of the pre-existing fryer and replacement fryer. Table 17 documents the annual energy saving associated with the replacement fryer and the annual operating cost savings.



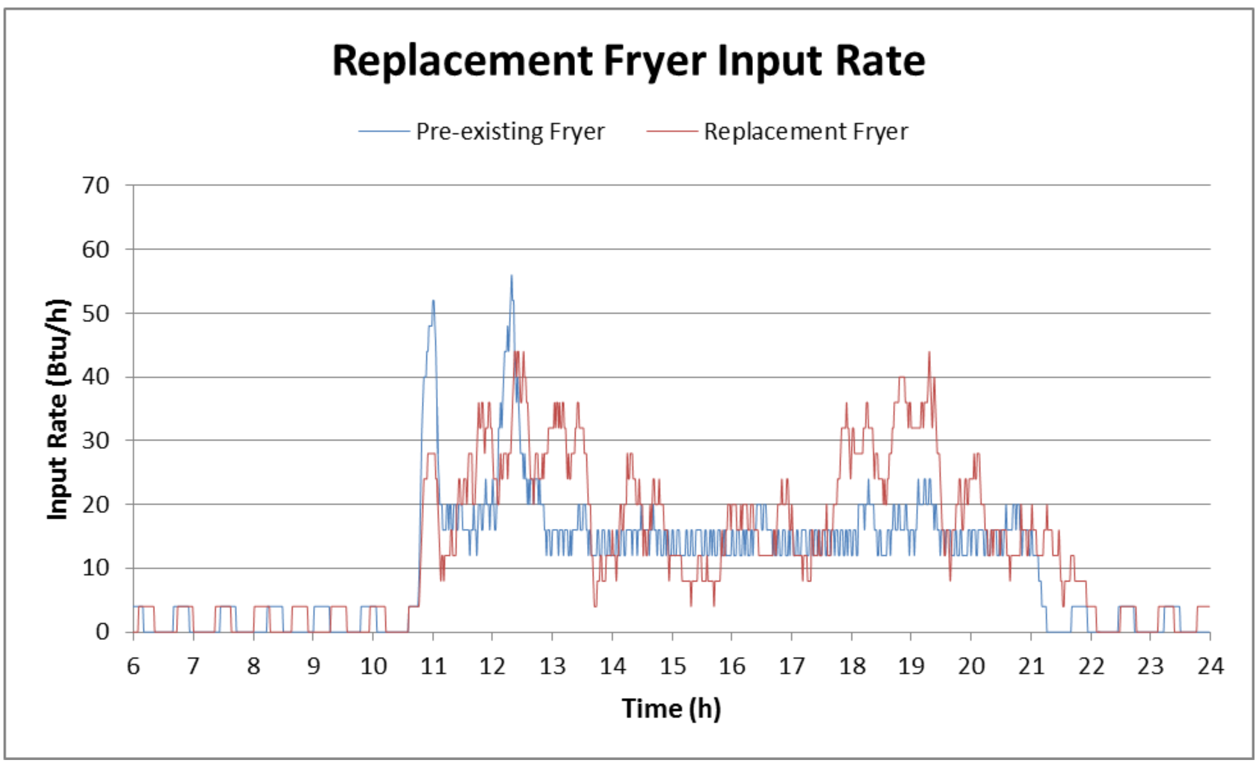


FIGURE 26. TRUEBURGER—PRE-EXISTING AND REPLACEMENT FRYER INPUT RATES

TABLE 16. FRYER ENERGY USE: TRUEBURGER

Appliance	Pre-existing Fryer Measured Daily Energy (kBtu)	Replacement Fryer Measured Daily Energy (kBtu)	Pre-existing Fryer Projected Annual Energy (therms)*	Replacement Fryer Projected Annual Energy (therms)*
Fryer	284	185	1,038	676

**Annual energy use projections assume 365 days of operation per year*

TABLE 17. PROJECTED FRYER ENERGY AND OPERATING COST SAVINGS: TRUEBURGER

Appliance	Fryer Projected Annual Energy Savings (therms)	Replacement Fryer Annual Operating Cost Savings ($)*
Fryer	362	308

**Annual operating cost savings based on a natural gas utility rate of $0.85/therm*

The Trueburger replacement fryer is shown in Figure 27.

FIGURE 27. TRUEBURGER FRYERS: FRY BANK WITH REPLACEMENT FRYER (LEFT SIDE)

CUSTOMER FEEDBACK

The customer has been very happy with the performance of the replacement fryer and is enthusiastic about the ultimate energy saving potential.

SHOWCASE AT US FOODS SHOW (10/16/2012)

The FSTC hosted a 10x10 booth at the US Foods Seminar and show on October 16, 2012. This showcase and seminar presentation promoted the monitoring work from the ice machine project and showcased the latest ice machine technology with a demonstration unit.

US Foods is a leading foodservice distributor in the U.S., with a client base that includes restaurants, healthcare, hospitality facilities, government operations, and educational institutions. Their event is heavily attended by their customers (US Foods busses in their customers from remote locations for this daylong event). While people attend the event to learn about new products, they are also hoping to find answers to questions regarding their appliance needs, food safety, packaging, etc. So rather than trying to get the restaurant operators/owners to carve time out of their day to reach us at the FSTC facility, they came to us more readily at an event they had already planned to attend.

The US Foods Show seminar and showcase event was a huge success. FSTC staff personnel talked to 88 restaurant owners and operators at the showcase, three of whom signed up for an energy audit. Approximately 40 attendees also attended the seminar. Attendees were very receptive to the FSTC's participation in the event, and the movement from digital signs placed at the booth attracted the attention of show attendees to the showcase. 10 – 15 minutes was spent with about half of them to talk about PG&E programs and the FSTC, and to help answer questions and offer suggestions. The US Foods Show proved to be a venue where the message of energy-efficient appliances can effectively reach the small to medium business (SMB) customer.

FIGURE 28. US FOODS SHOWCASE (10/16/2012)

ICE MACHINE FOCUS GROUP (11/8/2012)

As an objective of this project, the Food Service Technology Center hosted an industry focus group meeting on November 8, 2012. The goal was to present the results of replacing existing ice machines with upsized, ENERGY STAR®-qualified ice machines and to engage the industry on a campaign to transform the market in California. Participation at the focus group meeting included representatives from three manufacturers/distributors of ice machines, a local service agency and a major quick-service restaurant chain along with representatives from San Diego Gas & Electric (SDG&E), Southern California Edison (SCE) and Pacific Gas & Electric.

The meeting commenced with introductions, followed by a presentation by the FSTC team that summarized the Center's goals and experiences with respect to decreasing the energy use of ice machines in commercial foodservice facilities and the potential for non-peak operation. Throughout the meeting, the participants identified issues that should be considered while providing recommendations that would accelerate market adoption. Following are some of the several ideas, concerns and suggestions that were discussed.

Implementation

- It was anecdotally reported in the focus group by one of the distributers that there are 10,000 cube-making machines sold annually in the state.
- It was mentioned by the focus group participants that only 2.5% of equipment sold is not included in this directory (due to some manufacturers not participating in AHRI certification, which is a voluntary process).
- The ability of the customer to override a timer or built-in control is important. It should be possible to automate this aspect by using a timer together with bin-level sensing to override time-of-day controls. PG&E emphasized that an override option needs to automatically reset itself for the programed load shift. PG&E expressed a preference to align with the most energy-efficient equipment; they see timers as a bridge while recognizing the need for continuous commissioning.
- SCE would like to see a pilot project for interconnectivity with ice machines (Zigbee/wireless protocol, bin-level sensing, integrated with ice machine control). Control would be initiated from the utility on a critical peak day. SCE has 40,000 standalone restaurants; 500—1,000 sites with standalone meters (a sufficient sample size). FSTC is trying to encourage manufacturers to build in timers, but it is a cost. The suggestion arose to develop a box that responds to signals such as price signals and is manufacturer-neutral.
- An ice machine distributor asked, "What would make energy companies comfortable that customers have load-shifted?" What if manufacturers could prove it through computerized data logs? PG&E Answer: A smart meter solution may be sufficient—more granular data.
- It will be important to make sure that the technology doesn't leave the area that provided the incentives. This issue was factored into PG&E's point-of-sale pilot for commercial foodservice.
- There was a comment from the service agency with respect to best practice: Level the ice machine bin at end of night—otherwise you limit the capacity of the machine.

- The question was posed: How will information get disseminated to end-users? FSTC responded that site audits include ice machine assessments. The website will also be a primary channel to communicate with the industry.
- One manufacturer representative asked if UL/NSF re-filing would be necessary if a timer was added to the equipment. This concern was extended to whether it would violate the listing or warranty, whether some customers might believe there isn't enough ice, and whether running out of ice was just because of the timer. The service agency responded that other equipment has been retrofit without issues with warranty violation (e.g., furnace components).
- One manufacturer representative expressed a concern that if a machine is on a timer and an operator runs out of ice during the period when the ice machine is not generating ice, they would typically call service. However, if the service says that machine is not in warranty, and the customer doesn't pay the bill as a result, the service company will go after the manufacturer—not a good public relations scenario.
- PG&E's vision for demand response: Permanent load shift value: 200 – 600 kW/yr (as an example, PG&E is paying $2,000/kW incentive for ice storage HVAC incentives, and the technology still wasn't cost-effective). Even if a timer is running 95% of the time, it is still more valuable than paying $2,000 kW.
- PG&E mentioned that, for HVAC programs, incentives are passed along upstream to the distributor; it is up to the distributor if they want to share any incentive with the customer. Ice machine incentive programs could be designed the same way.

Replacement Challenges

- Ice machine replacements will be the same as previously—service technicians will have to be educated specifically for new implementations such as integrated programmability or accessory timer switches.
- The utilities need to develop a dealer education *and* service education program.
- Electrical circuit issues: Even though going from a 400-lb/24-h ice machine to a 600-lb/24-h ice machine has a $400-$500 incremental cost, above the 600 lb/24-h is the point where the voltage must increase from 115 V to 208 V. Existing circuit current capacity and replacement machine current requirements and potential upgrade cost must also be considered.
- A question arose on the permitting process: Is a plan check needed to go from 115 V to 208 V? For this reason, it was recommended to use a service channel, rather than the dealer.
- Other upsizing concerns are floor space or footprint limitations, and the potentially excessive added heat load to the space during ice production.
- Installation of remote condensing unit ice machines can be complex and time-consuming and may require permitting. The installation cost can vary widely depending on the building specifics.

Future Focus

- Ice machines represent one of the few pieces of electrical equipment in a restaurant that can be turned off for a period of time within the context of "utility demand response" or "time-of-use" without compromising the foodservice operation. Thanks to the ice storage bin, ice machines have the ability to make ice during periods of the day that are not coincident with the either usage of ice or the utility peak
- There was consensus from the group that our vision for increased energy efficiency and load-shifting and/or demand response was achievable on a "reasonable" time frame. The key is to "walk" before "running and stumbling". The discussion focused on deployment strategies versus presenting reasons why the campaign would not succeed.
- The length of time that a given machine can be turned off is a function of its capacity (both ice making and storage) with respect to the demand for ice within the foodservice operation.
- If an existing ice machine has sufficient production and storage capacity to meet the afternoon ice requirement, complete load shift can be achieved.
- If there is not enough capacity for sustained load-shifting over the entire peak period, then some form of automated demand response may be an option for the critical-peak days.
- Retrofitting existing machines with upsized ENERGY STAR®-qualified ice machines provides a tremendous opportunity to combine energy efficiency with "full-time" demand response or permanent load shift (PLS).
- Educational components have to be brought online. It is critical that restaurant operators don't jump on the "load shift" bandwagon and then get burned by running out of ice. It is in the best interest of all to avoid negative experiences and setbacks.
- The utilities need to connect their restaurant customers with service technicians who can integrate and maintain timers.
- Time-of-use rate structure is going to help push load-shifting along.
- Follow-up to this focus group meeting: The participants were open to attending a follow-up meeting when the FSTC has completed the next phase of a DR/load-shifting study. An ongoing advisory group may evolve as a support to the California utilities.
- In the foreseeable future, it is conceivable that significant portion of the ice making in commercial facilities can be during non-peak periods, and in many cases, during the off-peak hours of the night. This potential can be accelerated if California utilities develop and promote load-shifting or demand response guidelines and programs.

CONCLUSIONS AND RECOMMENDATIONS

This field placement study confirmed the energy-saving and load-shifting capabilities of high-efficiency machines when specified with these goals in mind. Whether in new or existing facilities, the potential to combine peak demand reduction with overall energy saving through the purchase and installation of new, high-efficiency ice machines presents an attractive opportunity. Purchasing a new ice machine with the intention of operating it solely during non-peak periods requires that it and the storage bin be properly sized to provide sufficient ice reserve during busy hours. It is therefore important to for the customer to seek advice from the manufacturers, their representatives, or other consultants to determine the appropriate machine and bin size.

When selecting ice machines, especially when planning to operate them with load-shifting, production and storage capacity must carefully be determined, and the required capacity energy balanced against cost. Operators must be trained to understand load-shifted ice production schedules, and to coordinate ice bin draw schedules (e.g., pulling ice early in the morning to ensure that ice will be produced until noon when the machine is switched off).

Utilities and energy efficiency agencies need to work with ice machine manufacturers to determine whether a customer's ice machine is suitable for load-shifting or whether replacement to a larger capacity machine would be warranted. In many cases this determination will require a low-cost instrumentation package capable of establishing the load profile. The length of time that a given machine can be turned off is a function of its capacity (both ice making and storage) with respect to the demand for ice within the foodservice facility. This available surplus capacity is directly reflected by the duty cycle of the ice machine on a given day, and can vary greatly from one ice machine installation to another. If an ice machine has sufficient production and storage capacity to meet the afternoon ice requirement, complete peak period load-shifting can be achieved. If there is not enough capacity for sustained load-shifting over the entire peak period, then partial-time load-shifting or some form of automated demand response may be an option for the critical-peak days.

Although thus far unaddressed in this report, another beneficial aspect of load-shifting is the reduced energy consumption while operating during periods of lower ambient temperature outside of the afternoon. A FSTC cursory data overview suggests that it might save in the range of 10% of the total ice machine energy as compared to operating through the afternoon with a 30°F temperature swing that is typical in areas of California. Further research is required to quantify this energy reduction contribution of lower ambient temperature combined with load-shifted operation.

In the foreseeable future, it is conceivable that all ice-making in commercial facilities will be during non-peak periods, and in many cases, during the off-peak hours of the night. This potential can be realized within a relatively short period of time if utilities and energy efficiency organizations develop and promote load-shifting or demand response guidelines and programs. The campaign for high-efficiency ice machine purchasing and load-shifting will be accelerated by a targeted incentive program by the California electric utilities. Although the economics of upsizing and load-shifting will inherently drive customers towards this goal, the educational component and financial stimulus of an incentive program will be critical to rapid market adoption.

Like ice machines, this study also confirmed that installing appropriately sized energy-efficient cooking equipment can result in significant energy and cost savings over a relatively short time. The realized savings are further accelerated through the various incentives provided by the California Energy Wise Program. However, knowing the production and capacity needs for the food cooked in a restaurant's operating environment is important when specifying the size and input rates of cooking appliances. Cooking equipment that performs at a higher input rate than necessary can result in energy-efficient cooking appliances ultimately consuming more energy than appliances of lower-rated efficiency. Additionally, equipment with a capacity that is larger than a restaurant's production needs require may save energy; however, its higher initial costs could ultimately result in a longer simple payback period on that energy savings.

APPENDIX 1: APPLIANCE SPECIFICATIONS

BRIDGES REPLACEMENT ICE MACHINE

Manitowoc

QuietQube® i-1470C Remote Ice Cube Machine

Air-Cooled Ice Cube Machine with Patented CVD Technology®

Model

☐ ID-1472C ☐ IY-1474C

ENERGY STAR

ID-1472C Ice Cube Machine - 115V

ICVD Condensing Unit

ID-1472C Ice Machine on a B-970 Bin

Two ID-1472C Ice Machines on a F-1650 Bin

QuietQube Series Remote System consists of a remote condensing unit, interconnecting refrigerant lines, ice machine head section along with an ice storage bin, countertop dispenser, or floor dispenser. All ordered separately. QuietQube ice machine with CVD condensing unit is designed as a Manitowoc system and cannot be used with any other ice machine or remote condenser brand.

- **Space-Saving Design** – Up to to 1,425 lbs. (646 kgs.) daily ice production and only 30" (76.20 cm) wide.
- **Quiet Operation** - eliminates most noise from the refrigeration system. Promotes a relaxing atmosphere.
- **Intelligent Diagnostics** – provide 24 hour preventative maintenance and diagnostic feedback for trouble free operation.
- **Acoustical Ice Sensing Probe** – for reliable operation in challenging water conditions.
- **EasyRead Display** – communicates operating status, cleaning reminders, and asset information through a blue illuminated display.
- **Programmable Ice Production** – by On/Off Time, Ice Volume or Bin Level (with accessory bin level control) further improves energy efficiency and savings.
- **Easy to Clean Foodzone** – Removable water-trough, distribution tube, splash shield, and sensing probes for fast and efficient cleaning. Select components made with AlphaSan® antimicrobial.
- **DuraTech™ Exterior** – provides superior corrosion resistance. Stainless finish with innovative clear-coat resists fingerprints and dirt.
- Available **LuminIce™ Growth Inhibitor** controls the growth of bacteria and yeast within the foodzone.

COMMERCIAL WARRANTY: ICE MAKER 3 YEAR PARTS AND LABOR | EVAPORATOR 5 YEAR | COMPRESSOR 5 YEAR PARTS 3 YEAR LABOR

Ice Shape

Half Dice ⅜" x 1⅛" x ⅞" (.95 x 2.86 x 2.22 cm)

Dice ⅞" x ⅞" x ⅞" (2.22 x 2.22 x 2.22 cm)

NSF · c UL us LISTED · CE · California Low Lead Qualified · AHRI Certified · Quality Management System Certified by DNV ISO 9001:2008

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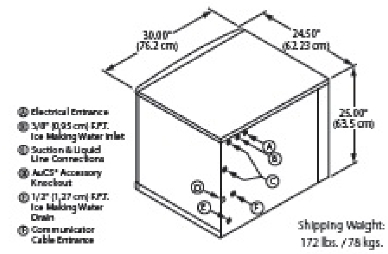
Bridges Replacement Ice Machine, Page 2

Manitowoc

QuietQube® i-1470C Remote Ice Cube Machine

Air-Cooled Ice Cube Machine with Patented CVD Technology®

i-1470C Ice Machine



Specifications

Operating Limits:

- Ambient Temperature Range: 35° to 110°F (1.7° to 43.3°C)
- Water Temperature Range: 35° to 90°F (1.7° to 32.2°C)
- Water Pressure Ice Maker Water In: Min. 20 psi (137.9 kPA) Max. 80 psi (551.1 kPA)

Ice Machine Electric

115/60/1 standard. (230/50/1 also available, consult factory.)

Total Amps: 1.1

Max. fuse size: 15 amps

HACR-type circuit breakers can be used in place of fuses.

Remote Air-cooled Ice Machine

Model	Ice Shape	Ice Production 24 Hours 70°Air/ 50°F Water	Ice Production 24 Hours 90°Air/ 70°F Water*	Power kWh/ 100 lbs @ 90°/70°F*	ENERGY STAR
ID-1472C	dice	1,330 lbs.	1,115 lbs.	4.81	★
		603 kgs.	506 kgs.		
IY-1474C	half-dice	1,425 lbs.	1,180 lbs.	4.62	★
		646 kgs.	535 kgs.		
Water usage/100 lbs./45.4 kgs. of ice					
Potable Water*: 20.1 gallons, 76.1 liters					

AHRI CERTIFIED® *Ratings Certified in Accordance with AHRI Standard 810.

Ice machine for use with ice storage bin or ice dispenser and CVD condensing unit all ordered separately.

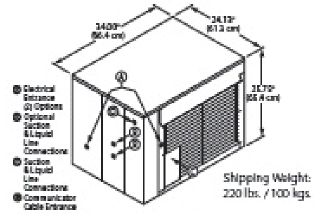
kWh per 100 lbs. is total power of ice machine and condensing unit. Ice machine is 1 ph only. Condensing unit is 1 ph or 3 ph.

Accessories

LuminIce™ Growth Inhibitor reduces yeast and bacteria growth for a cleaner ice machine.

AuCS® Automatic Cleaning System purchased as an option and installed in the field.

iCVD-1495 Remote Condensing Unit



Condensing Unit Electric

208-230/60/1 standard. 208-230/60/3 and 230/50/1 also available. 50 Hz version of this model meets the international standard, IEC60335-1, requirements for "T-tropical rating," the most severe duty rating an ice machine can obtain, (consult factory). HACR-type circuit breakers can be used in place of fuses.

Note: QuietQube ice machine power supply is wired independent of CVD condensing unit.

Min. circuit ampacity 20 *1ph* / 15 *3ph*

Max. fuse size: 20 amps *1ph* / 15 amps *3ph*

HACR-type circuit breakers can be used in place of fuses.

Operating Limits:

- Ambient Temperature Range: -20° to 130°F (-29° to 54°C)

BTU Per Hour: 19,000 (average) 22,000 (peak)

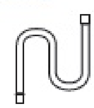
Compressor: Nominal rating: 1.75 HP

Installation Information and Dimensions:

Maximum Line Length
—100' (30.5 m).*

Maximum Vertical Rise*
—35' (10.7 m) above ice machine.

Maximum Vertical Drop
—15' (4.5 m) below ice machine.



**A rise over 20' (6 m) requires S-Trap Kit K-00166 - ordered separately.*

Standard Interconnecting Tubing with Required Communication Wire*

Communication wire comes with each of the following line sets

Model	Line Length ft.	Line Length m.	Weight lbs.	Weight kgs.
RC-25	20	6	14	6
RC-35	30	9	20	9
RC-55	50	15	31	14

**When using a non-Manitowoc line-set, a 18GA 5-conductor communication cable must be installed between the head and condenser sections.*

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TRUEBURGER REPLACEMENT ICE MACHINE

Manitowoc

Indigo™ thinking inside the box

Indigo™ Series 500 Ice Cube Machine

Indigo™ Series 500 Ice Cube Machine

Model: ☐ IR-0500A ☐ ID-0502A ☐ IY-0504A ☐ IR-0501W ☐ ID-0503W ☐ IY-0505W ☐ ID-0592N ☐ IY-0594N

Indigo Series I-500
Ice Machine on B-570 Bin

Designed for operators who know that ice is critical to their business, the Indigo™ Series ice machine's preventative diagnostics continually monitor itself for reliable ice production. Improvements in cleanability and programmability make your ice machine easy to own and less expensive to operate.

- **Space-Saving Design** – Up to 560 lbs. (254 kgs.) daily ice production and only 30" (76.20 cm) wide.
- **Intelligent Diagnostics** – provide 24 hour preventative maintenance and diagnostic feedback for trouble free operation.
- **Acoustical Ice Sensing Probe** – for reliable operation in challenging water conditions.
- **EasyRead Display** – communicates operating status, cleaning reminders, and asset information through a blue illuminated display.
- **Programmable Ice Production** – by On/Off Time, Ice Volume or Bin Level (with accessory bin level control) further improves energy efficiency and savings.
- **Easy to Clean Foodzone** – Hinged front door swings out for easy access. Removable water-trough, distribution tube, curtain, and sensing probes for fast and efficient cleaning. Select components made with AlphaSan® antimicrobial.
- **DuraTech™ Exterior** – provides superior corrosion resistance. Stainless finish with innovative clear-coat resists fingerprints and dirt.
- Available **LuminIce™ Growth Inhibitor** controls the growth of bacteria and yeast within the foodzone.

COMMERCIAL WARRANTY
ICEMAKER 3 YEAR PARTS AND LABOR | EVAPORATOR 5 YEAR | COMPRESSOR 5 YEAR PARTS 3 YEAR LABOR

Specifications

BTU Per Hour:
6,100 (average) 6,900 (peak)

Refrigerant:
R-404A CFC-free

Operating Limits:

- Ambient Temperature Range:
  35° to 110°F (1.7° to 43.3°C)
  Water Temperature Range:
  35° to 90°F (1.7° to 32.2°C)
- Water Pressure Ice Maker Water In:
  Min. 20 psi (137.9 kPA)
  Max. 80 psi (551.1 kPA)

Ice Machine Electric

115/60/1 standard.
(208-230/60/1 and 230/50/1 available in Air and Water-Cooled models only)

Minimum circuit ampacity:

Air cooled:	14.2
Water Cooled:	13.5
Remote:	20.0

Maximum fuse size:

Air Cooled:	20.0
Water Cooled:	20.0
Remote:	25.0

Ice Shape

Half Dice 3/8" x 1 1/8" x 7/8" (.95 x 2.86 x 2.22 cm)

Dice 7/8" x 7/8" x 7/8" (2.22 x 2.22 x 2.22 cm)

Regular 1 1/8" x 1 1/8" x 7/8" (2.86 x 2.86 x 2.22 cm)

CALIFORNIA LOW LEAD QUALIFIED · NSE · c UL us LISTED · CE · QUALITY MANAGEMENT SYSTEM CERTIFIED BY DNV ISO 9001:2008

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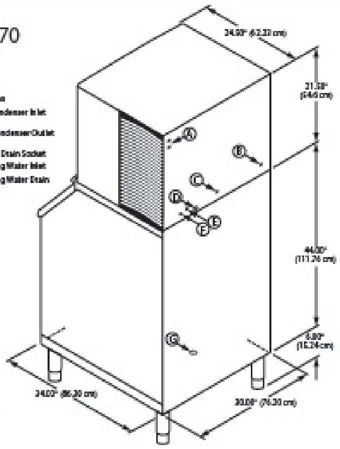
Indigo™ Series 500 Ice Cube Machine

i-500 on B-570 Storage Bin



Installation Note
Minimum installation clearance:
Top/sides: 8" (20.32 cm); Back is 5" (12.7 cm)

Space-Saving Designs

	i-500 B-400	i-500 B-570
Height	59.50" 151.13 cm	71.50" 181.61 cm
Width	30.00" 76.20 cm	30.00" 76.20 cm
Depth	34.00" 86.30 cm	34.00" 86.30 cm
Bin Storage	290 lbs. 131.54 kgs.	430 lbs. 195.04 kgs.

Height includes adjustable bin legs 6.00" to 8.00", (15.24 to 20.32 cm) set at 6.00" (15.24 cm).

Specifications

	Model	Ice Shape	Ice Production 24 Hours 70°Air/50°F Water	Ice Production 24 Hours 90°Air/70°F Water	Power Usage kWh/100 lbs.@90°Air/70°F 1 Ph	Water Usage/100 lbs. 45.4 kgs. of ice Potable Water	ENERGY STAR®
AIR-COOLED	IR-0500A	regular	500 lbs. / 227 kgs.	370 lbs. / 168 kgs.	5.94	19.9 Gal. / 75.3 L	★
AIR-COOLED	ID-0502A	dice	530 lbs. / 240 kgs.	390 lbs. / 177 kgs.	5.79	19.9 Gal. / 75.3 L	★
AIR-COOLED	IY-0504A	half-dice	560 lbs. / 254 kgs.	410 lbs. / 186 kgs.	5.73	19.9 Gal. / 75.3 L	★
WATER-COOLED	IR-0501W	regular	500 lbs. / 227 kgs.	420 lbs. / 191 kgs.	4.58	19.9 Gal. / 75.3 L	NA
WATER-COOLED	ID-0503W	dice	550 lbs. / 249 kgs.	430 lbs. / 195 kgs.	4.58	19.9 Gal. / 75.3 L	NA
WATER-COOLED	IY-0505W	half-dice	550 lbs. / 249 kgs.	440 lbs. / 200 kgs.	4.52	19.9 Gal. / 75.3 L	NA
	*Water-cooled Condenser Water Usage / 100 lbs. /45.4 kgs. of ice: 165 gal/625 L. * Water-cooled models are excluded from ENERGY STAR qualification.						
REMOTE-COOLED	ID-0592N	dice	480 lbs. / 218 kgs.	430 lbs. / 195 kgs.	5.79	19.9 Gal. / 75.3 L	★
REMOTE-COOLED	IY-0594N	half-dice	510 lbs. / 231 kgs.	440 lbs. / 200 kgs.	5.73	19.9 Gal. / 75.3 L	★

Order ice storage bin separately. Ice storage bin and JC-0495 remote condenser must be ordered separately. Consult remote condenser specification sheet for details.

Accessories

LuminIce™ Growth Inhibitor reduces yeast and bacteria growth for a cleaner ice machine.

Bin Level Control Allows ice bin level to be automatically set. Built-in LED light illuminates bin.

Arctic Pure® Water Filters Reduces sediment and chlorine odors for better tasting ice.

AuCS® schedules and performs routine ice machine cleaning automatically.

47698 ©2011 Manitowoc 11/11 Continuing product improvement may necessitate change of specifications without notice

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MEXXI'S REPLACEMENT ICE MACHINE

Manitowoc

Indigo™ thinking inside the box

QuietQube® i-686C Remote Ice Cube Machine

Air-Cooled Ice Cube Machine with Patented CVD Technology®

Model

☐ ID-0686C ☐ IY-0686C

ENERGY STAR

ID-0686C Ice Cube Machine - 115V

CVD Condensing Unit - 230V

ID-0686C Ice Machine on a B-570 Bin

QuietQube Series Remote System consists of a remote condensing unit, interconnecting refrigerant lines, ice machine head section along with an ice storage bin, countertop dispenser, or floor dispenser. All ordered separately. QuietQube ice machine with CVD condensing unit is designed as a Manitowoc system and cannot be used with any other ice machine or remote condenser brand.

- **New Levels of Performance** – showcasing improved ambient ice production along with reductions in energy consumption: 10% Reduction in energy and 5% improvement in production on a weighted average basis for the i-600 series.
- **ENERGY STAR** - the i-600s exceed ENERGY STAR™ standards and targets future energy efficiency standards.
- **Space-Saving Design** – Up to 634 lbs. (288 kgs) daily ice production and only 30" (76.20 cm) wide.
- **Intelligent Diagnostics** – provide 24 hour preventative maintenance and diagnostic feedback for trouble free operation.
- **Acoustical Ice Sensing Probe** – for reliable operation in challenging water conditions.
- **EasyRead Display** – communicates operating status, cleaning reminders, and asset information through a blue illuminated display.
- **Programmable Ice Production** – by On/Off Time, Ice Volume or Bin Level (with accessory bin level control) further improves energy efficiency and savings.
- **Easy to Clean Foodzone** – Removable water-trough, distribution tube, splash shield, and sensing probes for fast and efficient cleaning. Select components made with AlphaSan® antimicrobial.
- **DuraTech™ Exterior** – provides superior corrosion resistance. Stainless finish with innovative clear-coat resists fingerprints and dirt.
- Available **LuminIce™ Growth Inhibitor** controls the growth of bacteria and yeast within the foodzone.

COMMERCIAL WARRANTY

ICE MAKER 3 YEAR | EVAPORATOR 5 YEAR | PARTS AND LABOR | COMPRESSOR 5 YEAR PARTS 3 YEAR LABOR

Ice Shape

Half Dice ⅜" x 1⅛" x ⅞" (.95 x 2.86 x 2.22 cm)

Dice ⅞" x ⅞" x ⅞" (2.22 x 2.22 x 2.22 cm)

CALIFORNIA LOW LEAD QUALIFIED

QUALITY MANAGEMENT SYSTEM CERTIFIED BY DNV ISO 9001:2008

QuietQube® i-686C Remote Ice Cube Machine

Air-Cooled Ice Cube Machine with Patented CVD Technology®

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Mexxi's Replacement Ice Machine, Page 2

OAKLAND MUSEUM CAFETERIA REPLACEMENT ICE MACHINE

Manitowoc

Indigo™ thinking inside the box

Indigo™ Series 606 Ice Cube Machine

Indigo™ Series 606 Ice Cube Machine

Model: ☐ ID-0606A ☐ IY-0606A ☐ ID-0606W ☐ IY-0606W ☐ ID-0696N ☐ IY-0696N

ENERGY STAR

Indigo Series i-606
Ice Machine on B-570 Bin

Designed for operators who know that ice is critical to their business, the Indigo™ Series ice machine's preventative diagnostics continually monitor itself for reliable ice production. Improvements in cleanability and programmability make your ice machine easy to own and less expensive to operate.

- **New Levels of Performance** – showcasing improved ambient ice production along with reductions in energy consumption: 10% Reduction in energy and 5% improvement in production on a weighted average basis for the i-600 series.
- **ENERGY STAR** – the i-600s exceeds ENERGY STAR™ standards and targets future energy efficiency standards.
- **Space-Saving Design** – Up to 635 lbs. (288 kgs) daily ice production and only 30" (76.20 cm) wide.
- **Intelligent Diagnostics** – provide 24 hour preventative maintenance and diagnostic feedback for trouble free operation.
- **Acoustical Ice Sensing Probe** – for reliable operation in challenging water conditions.
- **EasyRead Display** – communicates operating status, cleaning reminders, and asset information through a blue illuminated display.
- **Programmable Ice Production** – by On/Off Time, Ice Volume or Bin Level (with accessory bin level control) further improves energy efficiency and savings.
- **Easy to Clean Foodzone** – Hinged front door swings out for easy access. Removable water-trough, distribution tube, curtain, and sensing probes for fast and efficient cleaning. Select components made with AlphaSan® antimicrobial.
- **DuraTech™ Exterior** – provides superior corrosion resistance. Stainless finish with innovative clear-coat resists fingerprints and dirt.
- Available **LuminIce™ Growth Inhibitor** controls the growth of bacteria and yeast within the foodzone.

WARRANTY
ICE MAKER: 3 YEAR PARTS AND LABOR | EVAPORATOR: 5 YEAR | COMPRESSOR: 5 YEAR PARTS, 3 YEAR LABOR

Ice Machine Electric

208-230/60/1 standard.
(230/50/1 also available)

Minimum circuit ampacity:
Air Cooled: 11.1
Water Cooled: 10.7
Remote: 11.7

Maximum fuse size:
Air Cooled: 15
Water Cooled: 15
Remote: 15

Specifications

BTU Per Hour:
11,800 (average)
13,700 (peak)

Refrigerant:
R-404A CFC-free

Operating Limits:
- Ambient Temperature Range: 35° to 110°F (1.7° to 43.3°C)
  Water Temperature Range: 35° to 90°F (1.7° to 32.2°C)
- Water Pressure Ice Maker Water In:
  Min. 20 psi (137.9 kPA)
  Max. 80 psi (551.1 kPA)

Ice Shape

Half Dice ⅜" x 1⅛" x ⅞" (.95 x 2.86 x 2.22 cm)

Dice ⅞" x ⅞" x ⅞" (2.22 x 2.22 x 2.22 cm)

CALIFORNIA LOW LEAD QUALIFIED · AHRI CERTIFIED · NSF · cULus LISTED · CE · AutoQuotes · QUALITY MANAGEMENT SYSTEM CERTIFIED BY DNV ISO 9001:2008

2110 South 26th Street
PO Box 1720
Manitowoc, WI 54221-1720 USA

Tel: 1.920.682.0161
Fax: 1.920.683.7589

www.manitowocice.com

Manitowoc

Oakland Museum Replacement Ice Machine, Page 2

LISA V'S HOT DOGS REPLACEMENT ICE MACHINE

Manitowoc

Indigo

Indigo™ Series 322 Ice Cube Machine

Model: ☐ ID-0322A ☐ IY-0324A ☐ ID-0323W ☐ IY-0325W

Indigo Series I-322 Ice Machine on B-320 Bin

Designed for operators who know that ice is critical to their business, the Indigo™ Series ice machine's preventative diagnostics continually monitor itself for reliable ice production. Improvements in cleanability and programmability make your ice machine easy to own and less expensive to operate.

- **Space-Saving Design** – Up to 350 lbs. (159 kgs.) daily ice production and only 22" (55.88 cm) wide.
- **Intelligent Diagnostics** – provide 24 hour preventative maintenance and diagnostic feedback for trouble free operation.
- **Acoustical Ice Sensing Probe** – for reliable operation in challenging water conditions.
- **EasyRead Display** – communicates operating status, cleaning reminders, and asset information through a blue illuminated display.
- **Programmable Ice Production** – by On/Off Time, Ice Volume or Bin Level (with accessory bin level control) further improves energy efficiency and savings.
- **Easy to Clean Foodzone** – Hinged front door swings out for easy access. Removable water-trough, distribution tube, curtain, and sensing probes for fast and efficient cleaning. Select components made with AlphaSan® antimicrobial.
- **DuraTech™ Exterior** – provides superior corrosion resistance. Stainless finish with innovative clear-coat resists fingerprints and dirt.
- **Available LuminIce™ Growth Inhibitor** controls the growth of bacteria and yeast within the foodzone.

COMMERCIAL WARRANTY
ICE MAKER 3 YEAR PARTS AND LABOR | EVAPORATOR 5 YEAR | COMPRESSOR 5 YEAR PARTS 3 YEAR LABOR

Ice Machine Electric

115/60/1 standard.
(208-230/60/1 and 230/50/1 also available)

Minimum circuit ampacity:
Air-cooled: 11.5 fph
Water-cooled: 10.7 fph

Maximum fuse size:
Air-cooled: 15 amps
Water-cooled: 15 amps

Specifications

BTU Per Hour:
3,300 (average) 4,500 (peak)

Refrigerant:
R-404A CFC-free

Operating Limits:
- Ambient Temperature Range: 35° to 110°F (1.7° to 43.3°C)
  Water Temperature Range: 35° to 90°F (1.7° to 32.2°C)
- Water Pressure Ice Maker Water In:
  Min. 20 psi (137.9 kPA)
  Max. 80 psi (551.1 kPA)

Ice Shape

Half Dice ⅜" x 1⅛" x ⅞" (.95 x 2.86 x 2.22 cm)

Dice ⅞" x ⅞" x ⅞" (2.22 x 2.22 x 2.22 cm)

CALIFORNIA LOW LEAD QUALIFIED · NSF · c UL US LISTED · CE · COMPANY WITH QUALITY SYSTEM

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Manitowoc

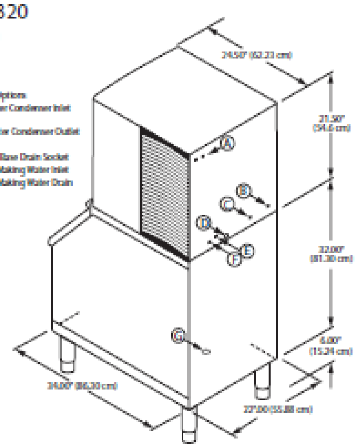
Indigo™ Series 322 Ice Cube Machine

Lisa V's Hot Dogs Replacement Ice Machine, Page 2

Manitowoc

Indigo™ Series 322 Ice Cube Machine

i-322 on B-320 Storage Bin



Ⓐ Electrical Entrance (2) Options
Ⓑ 3/8" (0.95 cm) F.P.T. Water Condenser Inlet (water-cooled units)
Ⓒ 1/2" (1.27 cm) F.P.T. Water Condenser Outlet (water-cooled units)
Ⓓ 1/2" (1.27 cm) Auxiliary Base Drain Socket
Ⓔ 3/8" (0.95 cm) F.P.T. Ice Making Water Inlet
Ⓕ 1/2" (1.27 cm) F.P.T. Ice Making Water Drain
Ⓖ 3/4" (1.91 cm) Bin Drain

Installation Note
Minimum installation clearance:
Top/side: 12" (30.50 cm)
Back is 5" (12.7 cm)

Space-Saving Designs

	i-322 B-320	i-322 B-420
Height	59.50" 151.13 cm	71.50" 181.61 cm
Width	22.00" 55.88 cm	22.00" 55.88 cm
Depth	34.00" 86.30 cm	34.00" 86.30 cm
Bin Storage	210 lbs. 95 kgs.	310 lbs. 141 kgs.

Height includes adjustable bin legs 6.00" to 8.00", (15.24 to 20.32 cm) set at 6.00" (15.24 cm).

Specifications

	Model	Ice Shape	Ice Production 24 Hours		Power Usage kWh/100 lbs. @90°Air/70°F	Water Usage/100 lbs. 45.4 kgs. of Ice	ENERGY STAR®
			70°Air/ 50°F Water	90°Air/ 70°F Water		Potable Water	
AIR-COOLED	ID-0322A	dice	335 lbs. / 152 kgs.	225 lbs. / 102 kgs.	7.49	23.9 Gal. / 90.5 L	
AIR-COOLED	IY-0324A	half-dice	350 lbs. / 159 kgs.	230 lbs. / 104 kgs.	7.32	23.9 Gal. / 90.5 L	
WATER-COOLED	ID-0323W	dice	330 lbs. / 150 kgs.	270 lbs. / 122 kgs.	6.19	23.9 Gal. / 90.5 L	NA
WATER-COOLED	IY-0325W	half-dice	350 lbs. / 159 kgs.	290 lbs. / 132 kgs.	5.94	23.9 Gal. / 90.5 L	NA

* Water-cooled Condenser Water Usage / 100 lbs. /45.4 kgs. Of Ice: 193 gal/731 L.
* Water-cooled models are excluded from ENERGY STAR qualification.

Order ice storage bin separately.

Accessories

LuminIce™ Growth Inhibitor reduces yeast and bacteria growth for a cleaner ice machine.

Bin Level Control Allows ice bin level to be automatically set. Built-in LED light illuminates bin.

Arctic Pure® Water Filters Reduces sediment and chlorine odors for better tasting ice.

AuCS® schedules and performs routine ice machine cleaning automatically.

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PO Box 1720
Manitowoc, WI 54221-1720 USA

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www.manitowocice.com

Manitowoc

LISA V'S HOT DOGS REPLACEMENT STEAMER

AccuTemp

WORLD'S BEST EVOLUTION™ BOILERLESS STEAMER

N6 DBL Connectionless Evolution

2 Double Stacked. Stand-Mounted 6 Pan, Natural Gas Boilerless Convection Steamers

Project: ____________ Location: ____________ Item #: ____________ Quantity: ________

Standard Features

- Fast cook times with patent-pending Steam Vector Technology, which utilizes no moving parts
- Cook mode and Variable Temperature Hold mode
- Steamer powered by a Heavy Duty Stainless Steel Blue Flame Power Burner rated at 60,000 btu/hr
- Easy-to-use digital controls, with digital temperature display
- Independent digital electronic timer with programmable preset
- Simple water and drain connections
- No water filtration or treatment required
- No warranty exclusions for water quality
- Uses less than 1 gallon of water per hour
- Front-mounted drain valve
- Specify Altitude if over 2,000 ft above sea level
- Internal gas regulator
- No scheduled de-liming or maintenance
- Heavy-duty, field-reversible door
- Door can be opened at any time during cooking cycle
- Steamer cavity constructed of reinforced 14 ga. 304 stainless steel
- Easy-to-clean control panel
- Automatic altitude compensation
- Dishwasher-safe one-piece wire pan racks
- Dishwasher-safe SVT steam collector and distributor panels
- Front-mounted condensate tray
- English and Spanish operating instructions on door
- Simplified service access panel
- Low water, high water and overtemp indicator lights
- (2) 5' power cords and plugs included, separate receptacle needed for each unit
- One year parts and labor warranty
- Lifetime Service & Support Guarantee
- UL LISTED Safety Certification (ANSI Z 83.11)
- UL EPH Sanitation Certification (NSF 4)

Optional Features

- Stainless steel support stand available with casters, bullet feet or flanged feet
- Perforated cooking shelf
- Propane

Environmental Approvals & Programs

ENERGY STAR

Other Approvals

UL US LISTED

ANSI 4

Pan Capacities - per cavity

Pan Size	Qty.
#200 full size (12x20x2.5")	6
#400 full size (12x20x4")	4

Short Spec

Evolution steamer is AccuTemp Products' connected, boilerless steam cooker that utilizes AccuTemp's Patent Pending Steam Vector Technology for faster cook times, improved energy efficiency, better pan to pan uniformity, and less water consumption. Steam Vector Technology requires no moving parts inside the cooking chamber. Steam to be produced inside the cooking cavity with no heating components exposed to water. Unit to be powered by a Heavy Duty Stainless Steel Blue Flame Power burner, Easily connects to water, drain & gas lines. Uses less than 1 gallon of water per hour. Unit to include low water, high water, overtemp warning lights and auto shut off feature. Evolution to include heavy duty, field reversible door. Standard digital controls with independent timer. No water quality exclusions to warranty and no water filtration or treatment required. Units to be mounted on a stainless steel support stand. Unit to be UL Safety and Sanitation Certified, and Energy Star qualified. Built in USA.

N6 Evolution Models shown with optional drain pan and stand with casters

MM4231-1003

AccuTemp Products, Inc.
8415 North Clinton Park • Fort Wayne, IN 46825 • 800-210-5907 • 260-493-0415 • Fax 260-493-0318 • accutemp.net

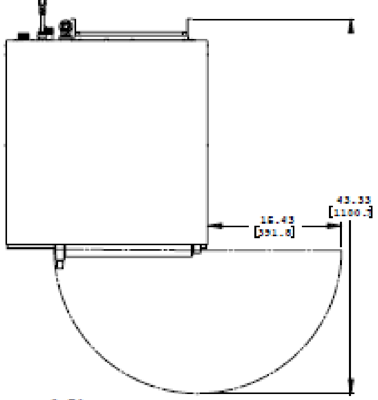
Lisa V's Hot Dogs Replacement Steamer, Page 2

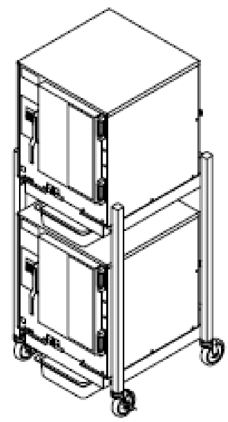
N6 DBL CONNECTIONLESS EVOLUTION
2 Double Stacked. Stand-Mounted 6 Pan, Natural Gas Boilerless Convection Steamers

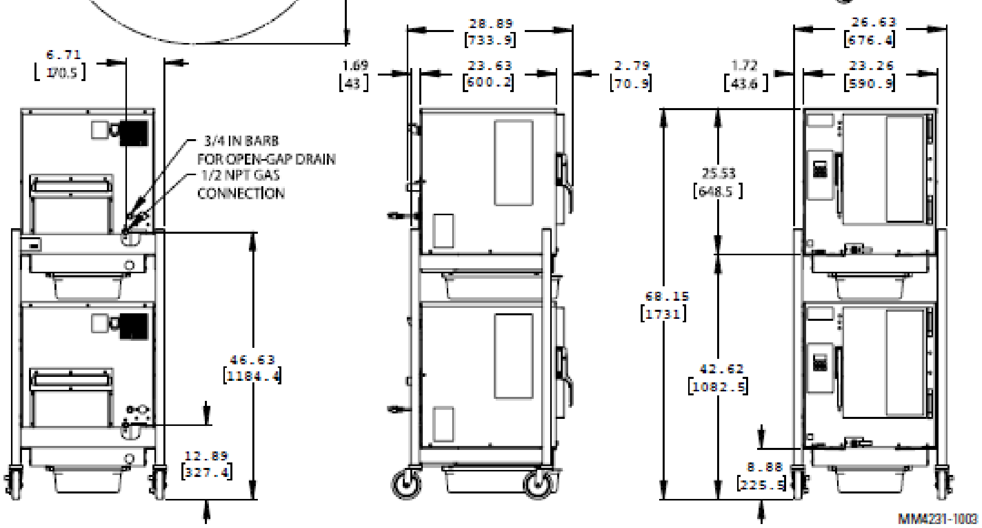
Gas Steamer Model Specifications per cavity DBL – TWO CAVITIES		
Model #	N61201D DBL	P61201D DBL
Gas Supply	Natural Gas	Propane
Recommended Gas Feed Rate	5" wc min 14" wc max	12" wc min 14" wc max
Gas operating Pressure	5.0" wc	10.0" wc
Maximum input BTU's/hr	60,000	60,000
Electrical Powered	120v, Single Phase, 60hz, 1 AMP	
NEMA Plug	5-15 three prong plug	

Notes:

1. Allow 3" between fryer, ranges, and other hot surfaces.
2. Each unit equipped with 5' power cord with NEMA 5-15 three prong plug, 120v, single phase, 60hz, 1 AMP.
3. For use on individual branch circuits only.
3. Each unit equipped with 1/2" NPT Threaded Natural Gas Connection.
4. Dimensions outside brackets are inches, in brackets are millimeters.
5. This appliance not intented for household use.
6. Units equipped with internal Gas Regulator.







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ARTISAN BISTRO, NORM'S PLACE, TRUEBURGER REPLACEMENT FRYER

PITCO

Project____________________

Item No.____________________

Quantity____________________

Model VF35
Tube Fired Gas Fryer

STANDARD SPECIFICATIONS

CONSTRUCTION

- Welded tank with an extra smooth peened finish ensures easy cleaning.
- Long lasting, high temperature alloy stainless steel heat baffles are mounted in the heat exchanger tubes to provide maximum heating and combustion.
- Standing pilot light design provides a ready flame when heat is required.
- Stainless steel front, door, sides and splash back.

CONTROLS

- Solstice burner/baffle design.
  - -Increases cooking production
  - -Lowers flue temperature
  - -Improves working environment
  - -Generates more production per BTU
- Thermostat maintains selected temperature automatically between 200°F (93°C) and 400°F (190°C).
- Integrated gas control valve acts as a manual and pilot valve, automatic pilot valve, gas filter, pressure regulator, and automatic main valve.
- Gas control valve prevents gas flow to the main burner until pilot is established and shuts off all gas flow automatically if the pilot flame goes out.
- Temperature limit switch safely shuts off all gas flow if the fryer temperature exceeds the upper limit.

OPERATIONS

- Front 1-1/4" NPT drain valve, for quick draining

Model VF35 Tube Fired Gas Fryer

STANDARD ACCESSORIES

- Tank-stainless steel
- Cabinet - stainless front, door and sides
- One tube rack
- One built-in flue deflector
- Two twin size baskets
- One drain extension
- One drain line clean-out rod
- Removable basket hanger for easy cleaning
- 9"(22.9cm) adjustable legs, easier access to clean

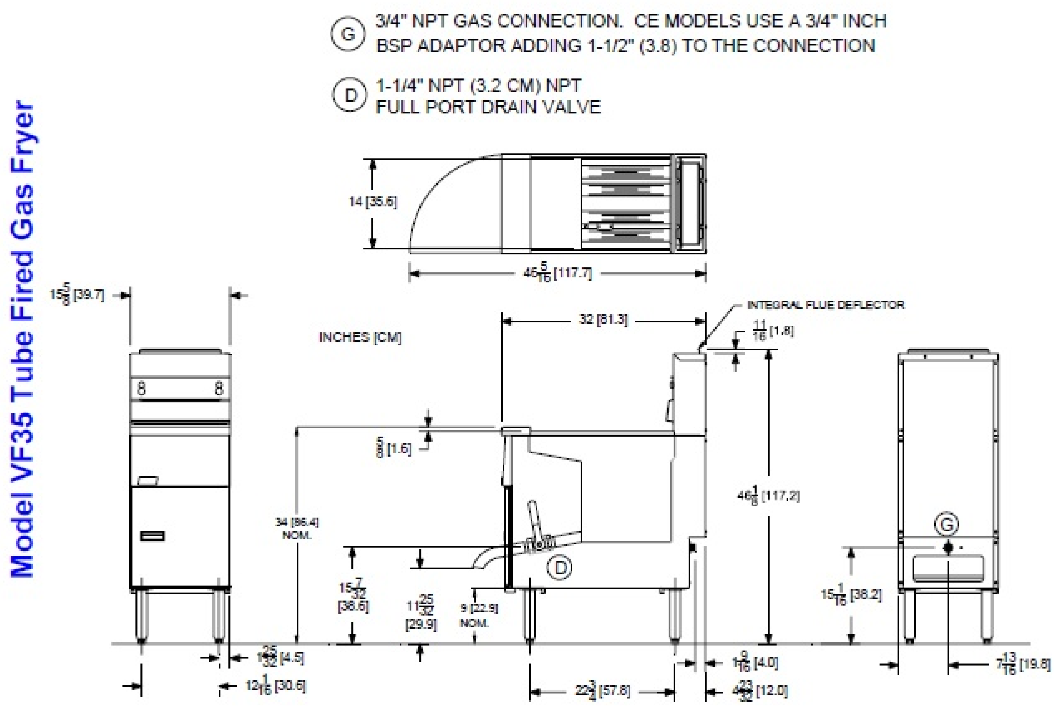
AVAILABLE OPTIONS & ACCESSORIES

- ❑ Tank Cover
- ❑ 9"(22.9cm) Casters

Pitco Frialator, Inc • P.O. Box 501, Concord, NH 03302-0501 • 509 Route 3A, Bow, NH 03304
603-225-6684 • FAX: 603-225-8497 • www.pitco.com
L10-347 Rev 2 06/10 Printed in the USA

Artisan Bistro, Norm's Place, Trueburger Replacement Fryer, Page 2

Model VF35 Tube Fired Gas Fryer



ELECTRICAL	OIL CAPACITY
No Electrical options available	35 lbs (15.9 kg)
SHIPPING INFORMATION (H x W x L)	**SHIPPING INFORMATION (Approximate)**
36 x 19 x 46 in (116.8 x 48.3 x 91.4 cm)	181 lbs (82.1 kg) 18.2 ft3 (0.5 m3)
GAS CONSUMPTION	**PERFORMANCE CHARACTERISTICS**
70,000 BTU's/Hour (20.5kW) (74MJ/hr)	Cooks 55-59 lbs. (24.9-26.7kg) of fries per hour. Frying area is 14" x 13-5/8" x 4" (35.6 x 34.6 x 10.2 cm)
SHORT FORM SPECIFICATION	
Provide Pitco VF35 tube-fired gas fryer. Fryer shall have an atmospheric burner system combined with three stainless steel tubes utilizing high temperature alloy stainless steel baffles. Fryer shall have a deep cool zone; minimum 13% of total oil capacity. Fryer cooking area shall be 14" x 13-5/8" (35.6 x 34.6 cm) with a cooking depth of 4" (10.2 cm). Heat transfer area shall be a minimum of 431 square inches (2780 sq cm).	
TYPICAL APPLICATION	
Frying a wide variety of foods in a limited amount of space. Frying that requires a medium volume production rate.	

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603-225-6684 • FAX: 603-225-8497 • www.pitco.com L10-347 Rev 2 06/10 Printed in the USA
We reserve the right to change specifications without notice and without incurring any obligation for equipment previously or subsequently sold.

DEL TACO REPLACEMENT GRIDDLE

Electrolux

EM Series
Smooth Gas Griddle Top 48"

ITEM # ______

MODEL # ______

PROJECT NAME # ______

SIS # ______

AIA# ______

EM Series

Smooth Gas Griddle Top 48"

169015 (ARG48FL)	Smooth Gas Griddle Top 48" (1220 mm)

Short Form Specification

Item No. ______

Unit to be Electrolux Smooth Gas Griddle Top with four high efficiency 26,000 BTU (7.6 kW) burners. Suitable for natural gas or propane gas. Thick 1" (25 mm) mild steel griddle plate maintains selected temperatures and assures quick recovery. 3.2" (81.5 mm) wide drainage channel running on full length of cooking surface. Two large grease drainage holes diameter 2.4" (60mm). Two half gal. (2 l) grease collector drawer with hole to indicate when full, capture all excess grease and oil and can be extracted for easy dumping and cleaning. Worktop in AISI 304 stainless steel. 3mm stainless steel splashback. Front and side panels in stainless steel with Scotch Brite finish. All major components can be accessed from front of the appliance for ease of maintenance. Special heavy duty chrome plated knobs for durability and easy cleaning. The configuration of bezels and knobs provides high level of protection against water infiltrations. Right-angled side edges to allow flush fitting joints between units. Supplied with 4" (102mm) height adjustable, removable legs. Unit may be installed on refrigerated base or open cupboard.

Intertek Intertek

Main Features

- Four high efficiency 26,000 BTU (7.6 kW) burners.
- Thick 1" (25 mm) mild steel griddle plate maintains selected temperatures and assures quick recovery.
- Suitable for natural gas or propane gas.
- Flame failure device to protect against accidental extinguishing of the flame.
- 3.2" (81,5 mm) wide drainage channel running on full length of cooking surface.
- Two large grease drainage holes diameter 2.4" (60mm).
- Two half gal. (2 l) grease collector drawers with hole to indicate when full, capture all excess grease and oil and can be extracted for easy dumping and cleaning.
- Worktop in AISI 304 stainless steel.
- 3mm stainless steel splashback.
- Front and side panels in stainless steel with Scotch Brite finish.
- All major components can be accessed from the front for ease of maintenance.
- Special heavy duty chrome plated knobs for durability and easy cleaning.
- The configuration of bezels and knobs provides high level of protection against water infiltrations.
- Right-angled side edges to allow flush fitting between units.
- Provided with kit for side-by-side connection between units for minimizing gaps and possible dirt traps.
- Supplied with 4" (102mm) height adjustable, removable legs.
- Unit may be installed on refrigerated base by removing the legs and inserting the special pins (optional accessory model # 169048).
- Unit may be installed on open cupboard by removing the legs and inserting the srews provided as standard with the open cupboards.
- Included accessories: propane converter kit, pressure regulator and main shut off valve.

Optional Accessories

- KIT 4 PINS TO FIX TOP EQUIP.TO REF.BASE PNC 169048

Approval: ______

Electrolux Professional
www.electroluxusa.com/professional
electroluxprofessional@electroluxusa.com

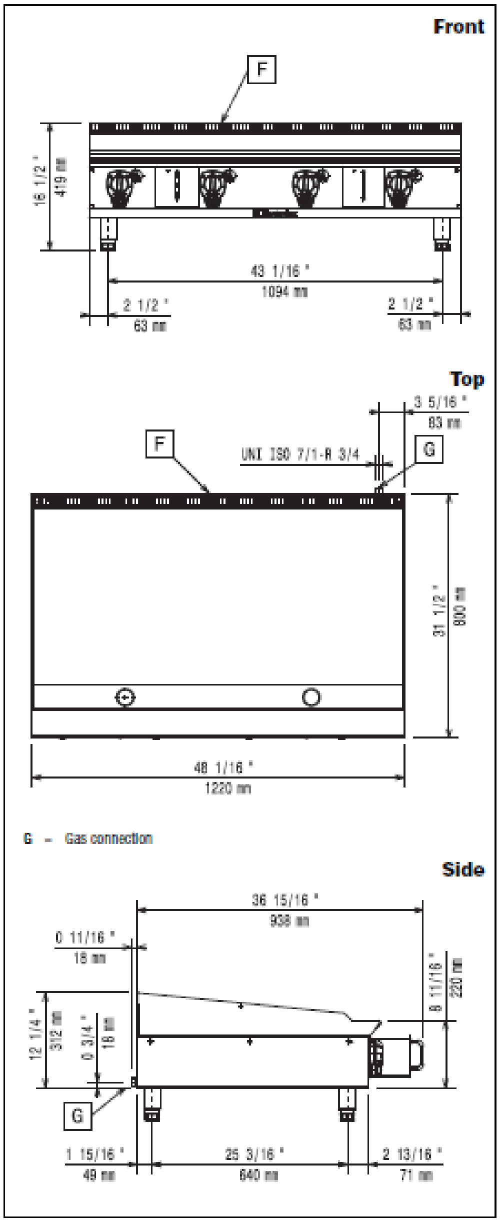
Electrolux

EM Series
Smooth Gas Griddle Top 48"

Del Taco Replacement Griddle, Page 2

Electrolux

EM Series
Smooth Gas Griddle Top 48"



Gas

Gas power:	104000 Btu/hr (30.4 kW)
Gas inlet:	3/4" NPT
Natural gas pressure:	4"w.c. (10 mbar)
Propane gas pressure:	7"w.c. (18 mbar)

Key Information

Cooking surface width:	47 13/16" (1214 mm)
Cooking surface depth:	22 5/8" (575 mm)
Working temperature MIN:	194 °F (90 °C)
Working temperature MAX:	500 °F (260 °C)
External dimensions, width	48 1/32" (1220 mm)
External dimensions, depth	31 1/2" (800 mm)
External dimensions, height	16 1/2" (419 mm)
Net weight:	313 lbs (142 kg)
Shipping width:	35 7/16" (900 mm)
Shipping depth:	50 " (1270 kg)
Shipping height:	25 1/2" (648 mm)
Shipping weight:	348 lbs (158 kg)
Shipping volume:	26.15 ft³ (0.74 m³)

* The rear and side clearances shown on the diagram indicate the minimum distances recommended from the appliance to combustible surfaces.

EM Series
Smooth Gas Griddle Top 48"

The company reserves the right to make modifications to the products without prior notice. All information correct at time of printing.

5-11-10

APPENDIX 2: CASE STUDY FACT SHEETS

BRIDGES

ENERGY SUCCESS STORY

ENGINEERING CASE STUDY
BRIDGES RESTAURANT
DANVILLE, CA

PG&E Food Service Technology Center
Audit & Action demonstration project

Bridges Restaurant's ice machine was replaced with an ENERGY STAR® qualified ice machine, that consumes less energy and uses it during non-utility-peak hours when energy costs and demand charges are lower. The new ice machine reduced annual operating costs by $812. Along with the annual savings of the new ice machine, Bridges capitalized on a $200 PG&E California Energy Wise Rebate to offset the initial purchase cost, giving them an incremental payback of 30 months.

Ice Machine – Calculated Energy Use

	Original Machine	Replacement Machine with Integrated Timer
Ice Harvest Rate (lbs/24hr)	772	1,180
Energy Consumption Rate (kWh/100lb)	6.4	4.62
Duty Cycle (%)	81.5	51.9
Annual Energy Use Savings (kWh)	–	4,270
Demand Reduction (kW)	–	2.0
Hours Shifted to Non-Peak	0	6
Annual Operating Cost Savings ($)[1]	–	629

[1] [illegible]

Bridge's original ice machine.

ENERGY STAR replacement ice machine.

How do you get a free site energy audit?
fishnick.com
800.398.3782

Food Service Technology Center
fishnick.com

TRUEBURGER

ENERGY SUCCESS STORY

ENGINEERING CASE STUDY
TRUEBURGER
OAKLAND, CA

PG&E Food Service Technology Center
Audit & Action demonstration project

Trueburger's ice machine was replaced with an ENERGY STAR® qualified ice machine that consumes less energy and was programed to produce ice during non-utility-peak periods when energy costs and demand charges are lower. The new ice machine reduced annual operating costs by $289. Along with the annual savings of the new machine, Trueburger capitalized on a $200 PG&E California Energy Wise Rebate to offset the initial purchase cost.

Ice Machine – Calculated Energy Use

	Original Machine	Replacement Machine with Integrated Timer
Ice Harvest Rate (lb/24hr)	147	410
Energy Consumption Rate (kWh/100lb)	10.3	5.73
Duty Cycle (%)	96.1	31.9
Annual Energy Use Savings (kWh)	4,390	2,740
Demand Reduction (kW)	–	0.52
Hours Shifted to Non-Peak	0	6
Annual Operating Cost Savings ($)[1]	–	289

[1] Electric utility costs based on PG&E A-1 TOU (Time of Use) rate schedule.

Trueburger's original ice machine.

ENERGY STAR replacement ice machine.

How do you get a free site energy audit?
fishnick.com
800.398.3782
This program is funded by California utility customers and is administered by Pacific Gas and Electric Company under the auspices of the California Public Utility Commission.

Food Service Technology Center
fishnick.com

MEXXI'S

PG&E Food Service Technology Center *Audit & Action* demonstration project

Mexxi's Taqueria replaced its ice machine with an ENERGY STAR® qualified ice machine that consumes less energy and was programed to produce ice during non-utility-peak periods when energy costs and demand charges are lower. The new ice machine reduced annual operating costs by an impressive $626. Mexxi's Taqueria capitalized on a $200 PG&E California Energy Wise Rebate to offset the initial purchase cost adding to the savings of the new ice machine.

Ice Machine – Calculated Energy Use

	Original Machine	Replacement Machine with Integrated Timer
Ice Harvest Rate (lb/24hr)	365	530
Energy Consumption Rate (kWh/100lb)	11.7	5.54
Duty Cycle (%)	64.8	26.9
Annual Energy Use Savings (kWh)	6,430	2,890
Demand Reduction (kW)	–	1.13
Hours Shifted to Non-Peak	0	6
Annual Operating Cost Savings ($)[1]	–	626

[1] Electric utility costs based on PG&E A-1 TOU (Time of Use) rate schedule.

Mexxi's Taqueria original ice machine.

ENERGY STAR replacement ice machine.

OAKLAND MUSEUM

PG&E Food Service Technology Center
Audit & Action demonstration project

The Oakland Museum of California's ice machine was replaced with an ENERGY STAR® qualified ice machine that consumes less energy and was programed to produce ice during non-utility-peak periods when energy costs and demand charges are lower. Along with a reduced annual operating costs of $238 for the new machine, the Oakland Museum capitalized on a $200 PG&E California Energy Wise Rebate to offset the initial purchase cost.

Ice Machine – Calculated Energy Use

	Original Machine	Replacement Machine with Integrated Timer
Ice Harvest Rate (lb/24hr)	220	555
Energy Consumption Rate (kWh/100lb)	7.90	5.29
Duty Cycle (%)	58.9	20.8
Annual Energy Use Savings (kWh)	2,900	1,860
Demand Reduction (kW)	–	0.56
Hours Shifted to Non-Peak	0	6
Annual Operating Cost Savings ($)[1]	–	238

[1] Electric utility costs based on PG&E E-19 rate schedule.

Oakland Museum's original ice machine.

ENERGY STAR replacement ice machine.

COMAL

PG&E Food Service Technology Center Design Support Showcase Program

Once a completely gutted commercial space in the heart of downtown Berkeley, Comal is a shining example of what can be accomplished when a passion for sustainability, energy efficiency, long-term profitability and engineering knowhow collide. Comal's Principals John Paluska and Andrew Hoffman along with Abueg Morris Architects and kitchen designer Alec Bauer of Kitchen Restaurant + Bar Specialists, have created a unique and exciting restaurant that incorporates total sustainable design and best practice. Supporting the energy-efficient design from the earliest stages were PG&E Customer Relationship Manager Santino Bernazzani and Sr. Energy Analyst Todd Bell of the utility's Food Service Technology Center (FSTC).

Comal's Andrew Hoffman and Todd Bell (FSTC) use the PG&E My Energy website to review Comal's energy use history.

From the first design consultation to reviewing subsequent equipment schedules and mechanical drawings for Comal, Bell and the FSTC team ensured that the energy and water-using systems were efficient and where applicable, eligible for PG&E California Energy Wise rebates. Bauer selected an Accutemp boilerless steamer and Blodgett convection oven for Comal's steaming and baking needs. These ENERGY STAR® and rebate qualified appliances will annually save 15,000 kWh and 210 therms. The Accutemp steamer's boilerless steaming technology will save Comal 18,000 gallons of water per year versus a boiler-based type steamer.

"I highly recommend (FSTC) to everyone I know who wants to open a restaurant, I tell them its a great resource."

Bell identified and replaced a low-efficiency gas fryer on the hotline with an ENERGY STAR fryer under the PG&E Emerging Technologies (ET) appliance demonstration project to promote energy-efficient cooking appliances. Pre and post energy monitoring of the original and replacement fryers showed an 825 therm reduction that will save Comal $700 per year in operating costs.

California Energy Wise rebate qualified gas convection oven.

The appliances on the hotline operate in perfect harmony with the hoods above, whose exhaust fans are controlled by Captive Aire's demand ventilation energy management system. This temperature sensing fan control technology modulates fan speeds to match the cooking load of the appliances under the hood. This delivers significant savings, especially during periods when the appliances are idle or lightly used.

On the refrigeration side, the new walk-in cooler is equipped with all the features prescribed in the CA Title 20 Appliance Energy Efficiency Standard – electronically commutated evaporator fan motors, a plastic strip curtain and auto-door closer. Nugget ice production comes from a Manitowoc top tier ENERGY STAR ice machine and the True reach-in refrigerators are best in class as well. A high-efficiency, A.O. Smith condensing water heater supplies hot water to the low flow pre-rinse sprayer and ENERGY STAR dishmachine. This energy efficient water heater will save Comal $1,000 annually in water heating cost when compared to a non-condensing, standard-efficiency water heater common in today's restaurants..

LED lamps are featured in the dining room and kitchen including the exhaust hoods, the modular cans over the dining counter, bar task lighting and in the strip lighting along the dining room walls. These fixtures illuminate work and dining surfaces at a fraction of the cost of traditional incandescent or halogen lamps and have a 100-fold longer lifespan.

The use of energy and water efficient technologies is transparent to staff and customers, which shows that restaurant operators like Paluska and Hoffman can confidently specify efficient equipment and best practices without sacrificing performance.

California Energy Wise rebate qualified gas fryer.

Savings by Managing Energy

Sponsored by the PG&E Emerging Technologies (ET) Program

California Energy Wise Rebate Qualified Appliances
Total Rebates[1]: $4,599

- Accutemp steamer – $1,250
- Blodgett convection oven – $500
- Pitco fryer – $749
- Manitowoc ice machine – $100
- True reach-in refrigerators ($50/unit) – $200
- Captive Aire demand ventilation energy management system ($300/HP) – $1,800

Energy Efficient Technologies

- A.O. Smith high efficiency condensing water heater
- T&S Brass low flow pre-rinse spray valve
- LED lamps in exhaust hood fixtures
- Recessed modular LED fixtures
- Electronically commutated walk-in cooler evaporator fan motors

Best Practice Measures

- Dishmachine exhaust hood fan interlocked with dishmachine
- Ice machines operate on time clocks to shut them off during the peak utility rate period
- Coffee machine turned off during hours of close
- Dinning room light fixtures turned off during non-service day time hours due to daylight harvesting
- Walk-in cooler door equipped with plastic strip curtain and auto door closer
- Hot water recirculation line operates on a time clock to shut it off during hours of close

[1] fishnick.com/saveenergy/rebates/

How do you get a free site energy audit?
fishnick.com
800.398.3782

This program is funded by California utility customers and is administered by Pacific Gas and Electric Company under the auspices of the California Public Utility Commission.

APPENDIX 3: SHOWCASE LIST OF ATTENDEES AND VENDORS

BRIDGES LIST OF ATTENDEES

First Name	Last Name	Company / Organization
Pete	Baria	Alameda County Probation
Matthew	Belasco	Pittsburg Unified School District
Waltraud	Charles	Autobahn Cafe
Brian	Chen	Wokkee Chinese Restaurant
Jeffrey	Collins	Antioch Unified School District
Gary	Cooper	Dickeys Barbecue Pit
Javonito	De La Cruz de Morfulleda	OB's Cafe
Maribel	Delgado	Mi Oficina Computer Cafe
Ernie	Guerrero	La Tapatia Mexican Restaurants
Frieda	Hoffman	Local 123
Eric	Janssen	Amber Bistro
Bradly	Kaderabek	Round Hill Country Club
Lawrence	Kong	Minerva's Restaurant
Sherrylyn	Larkins	Jodie's Restaurant
Travis	Law	TriMark Economy Restaurant Fixtures
Eric	Lim	Dragon Terrace
Judy	Macaluso	PG&E
Steven	Myli	East Bay Regional Park District
Sheena	Nagpal	KGSM Inc.
Richard	Nidever	Everex Communications
Aryan	Omar	Aryana Afghan Cuisine
Reyes	Ramos	Agave
Jodie	Royston	Jodie's Restaurant
Michael	Stott	Bear Claw Bakery & Cafe
Martin	Thang	Manns Chinese Cuisine
Quang	Tran	Mrs. FieldsCookies Great Mall
Jeff	Yao	Westin St Francis
Joe	Buhowsky	
Robby	Skog	Maria Maria
Kevin	Michel	ICF/PGE
Bryan	Harder	ICF/PGE
Lee	Huang	Eneron
Tam	Phung	GreenStar Hub
John	Kim	NAMA Restaurant
Jose	Hernandez	Amici's Pizzeria
Payal	Shal	Rising Loafer

Bridges List of Vendors

First Name	Last Name	Company / Organization
Martin	Sum	Contra Costa Environmental Health
Stewart	Bambino	San Ramon Chamber of Commerce
Michael	Panza	Biagio Artisan Meats
Henry	Ichinose	ABS Seafood
Claudia	Pingatore	Green Business Program
Paris	Greenlee	Green Business Program
Stacey	Roth	TriValley CVB
Pete	Palm	Western Pacific Distributors
Charles	Bohlig	EBMUD
Rolando	Gonzalez	EBMUD
Mike	Palm	Western Pacific Distributors
Loretta	Broniak	Energy Retrofit Co.
Deborah	Casagrande	Energy Retrofit Co.

US Foods Show Guests

First Name	Last Name	Company / Organization
Jose	Aguilar	Lone Tree Golf Course
Carol	Aladin	Buckhorn Grill San Francisco
Robin	Aldridge	Kaiser Santa Clara
Tom	Anderson	San Damiano Retreat
Silverio	Arteaga	Buckhorn Grill Napa
Marlen	Benitez	San Damiano Retreat
Gina	Berry	Healdsburg District Hospital
Bob	Boehm	Bobby's Place
Grace	Boehm	Bobby's Place
Pat	Cavanaugh	Carp Harmon
Henry	Chan	The Prolific Oven Bakery
Michael	Clark	Michael's on Main
Robbie	Clearie	Redding Tents & Events Inc.
Dani	Cline	Sabert
Kyle	Coffey	Pacific Connection Catering
Sam	Daniels	American Legion Post 31
Steve	De Parsia	De Parsia's

First Name	Last Name	Company/Organization
Jarrod	DeSoto	Bobby's Place
Robert	Donohoe	St. Mary's Medical Center
Rhiannon	Eddy	The Purple Orchid
Greg	Ellery	Radisson Hotel
Rommel	Esteybar	Pebble Beach Co.
Chris	Faurot	County of Sonoma Probation
Oscar	Flores	Buckhorn Grill San Francisco
Antonio	Gomez	Severinos Sea Cliff Inn
Rod	Goodman	Jenness Park
Shelly	Goodman	Jenness Park Christian Camp
Danny	Guadagnolo	D'bonis Pizza
Chris	Hampton	Handles Gastropub
Marisol	Hernandez	Pacifica Senior Living
Russ	Hollett	Cattlemens
Thomas	Horton	Buckhorn Grill
Brian	Isaeff	US Foods
Chris	Jackson	Jackson Catering & Events
Jose	Jaquez	Faultline Brewing Co
Rocio	Keiser	Buckhorn Grill Embarcadero
Sharbari	Khanna	Kaiser Santa Clara
Jack	Lair	Woody
Karen	Lair	HVFM
Scott	Litteral	Il Forno Classico
Jesse	Lockwood	BW Yosemite Gateway
Debbie	Logan	Kaweah Delta West Campus
Celeste	Lusher	Crusco's Ristorante
Lorelie	Magalong	Veterans Home of CA
Eleni	Magoulas	Pete's Henny Pennys
Nikos	Maheras	Mezes
David	Maria	Buckhorn Grill
Corina	Matsuo	Five Ten Bistro
Rpbert	Matsuo	Bistro Bar Inc.
Ben	Mattman	JW Marriot San Francisco
Matthew	McKnight	The National Hotel
Tom	McLaughlin	Buckhorn Grill
Ian	Melnilsak	Danny's Roadside Kitchen
Steven	Miller	Buckhorn Grill Pleasanton
Aulely	Miranda	Barones Restaurant
Carlos	Orozco	Casa Orozco

First Name	Last Name	Company/Organization
Jesus	Orozco	Casa Orozco
Todd	Parent	Extreme Pizza
Randy	Peters	Randy Peters Catering
Lisa	Peters	Randy Peters Catering
Roger	Praph	La Gare
Paul	Punsalang	Buckhorn Grill Walnut Creek
Mark	Purnell	Afterfive Bar
Juan	R.	500 Club
Stan	Ramirez	Stannie's Place
David	Reich	Outpost
Christine	Reid	Berkeley Bowl Produce, Inc
Thomas	Rimpel	The Westin St. Fracncis
Branden	Rodgers	Jackson Fine Dining
Bill	Rogers	State of CA
Stratis	Rozakeas	Mills-Peninsula Health Services
Juan	Ruiz	Buckhorn Emeryville
Ignacio	Ruiz	Cattlemens
Shaina	Sartor	Nexus
Eric	Schaetz	Chicago Fire
Jefferson	Seay	Chef's Pride
Cynthia	Sidrian	Little Manuel's
Gary	Stidham	Sun City Roseville Community Assoc. Inc.
Nancy	Storm	US Foods
Kathy	Sweet	Pebble Beach Co.
Snehal	Tambe	Plum Tree Care Center
William	Wagner	
Curtis	West	Buckhorn Grill Roseville
Jeff	Yao	The Westin St. Francis
Nazanin	Yasavolian	Amber Systems Technologies

Comal Guests

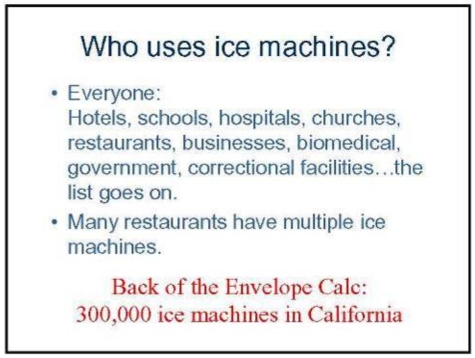
First Name	Last Name	Company / Organization
Araceli	Barriguete	Taqueria Los Cerros
Arlene	Giordano	Le Bateau Ivre
Billi	Romain	City of Berkeley
Craig	Jones	Uncle Willie's BBQ & Fish
David	Lee	Cybelles
Eric	Lim	Dragon Terrace
Ernie	Guerrero	La Tapatia Mexican Restaurants
Javonito	De La Cruz de Morfulleda	OB's Cafe
Jon	Lee	Stuffed Inn
Jon	Guhl	Little Star Pizza
Josh	Levine	Pepples Donuts Inc.
Karen	Bevels	SAML, Inc.
Marsha	Mcbride	Cafe Rouge
Nancy	Deming	Oakland Unified School District
Norman	Riffe	Jed Riffe Catering
Patty	Bonfilio	Pixar Animation Studios
Perry	Harmon	Loards
Pete	Baria	Alameda County Probation
Rebecca	Stevens	Pepples Donuts Inc.
Robert	Law	Oakland School District
Robert	Sill	Arden Wood Inc.
Shirley	Fudge-Mueller	Pacific Gas & Electric Company
Susannah	Blumenstock	Little Star Pizza
Thanu	Chaichana	Tuk Tuk Thai cafe
Tina	Ferguson-Riffe	Smoke Berkeley
Travis	Law	TriMark Economy Restaurant Fixtures
Judy	Chess	UC Berkeley
Monica	Rocchino	The Local Butcher Shop
Rick	Robinson	Gotts Roadside
Ken	Priest	Gotts Roadside
Kit	Dean	Mary's Place

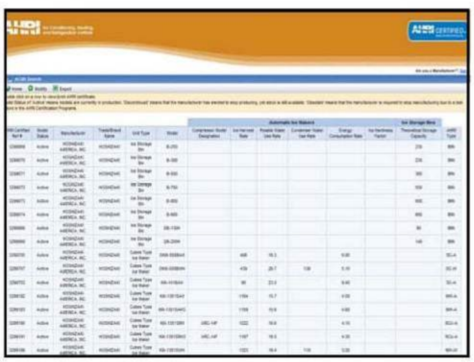
First Name	Last Name	Company / Organization
Faranak	Shariati	Cyprus Restaurant
Don	Nguyen	Saigon Express
Simone	Arpaio	Almare Gelato
Alberto	Malvestio	Almare Gelato
Eric	LaPlante	Hotel Shattuck Plaza
Jake	Shrath	Hotel Shattuck Plaza
David	Lau	Asha Tea House
Jeanne	Boulet	PG&E
Mike	Benzen	Diablo Unified School District
Brian	Fritz	Diablo Unified School District
Quang	Tran	Mrs. Fields Cookies
Charles	Stevenson	UC Berkeley
Amy	Breshears	Comal
Omar	Huerta	Comal

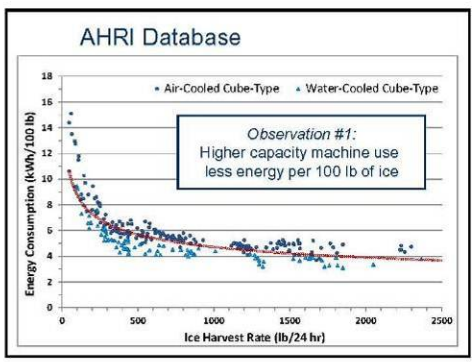
Comal Vendors

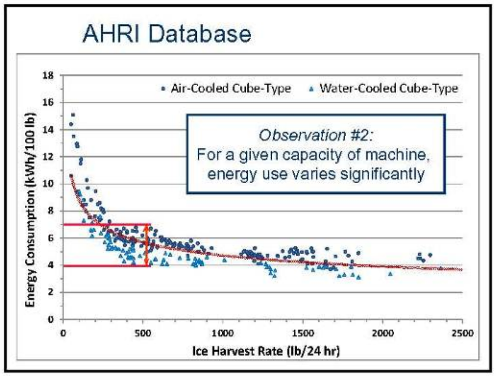
First Name	Last Name	Company / Organization
Leila	Khatapoush	Green Business Program
Nadia	Borisova	EBMUD
Doug	Sampson	PG&E
Joel	Everett	PG&E
Santino	Bernazzani	PG&E
Don	Logsdon	Energy Retrofit Co.
Lori	Broniak	Energy Retrofit Co.
Michelle	Jeffrey	Stopwaste.org
Cassie	Bartholomew	Stopwaste.org
Ruben	Ramirez	PG&E (TVP)
Jennifer	Cogley	City of Berkeley
Rolando	Gonzalez	EBMUD
Charles	Bohlig	EBMUD
Andy	Downing	Greenleaf
Shelly	Haygood	Spindrift
Bradley	Mart	Fog Busters
Rosemary	Logsdon	Energy Retrofit Co.
Mike	Palm	WPD
Pete	Palm	WPD

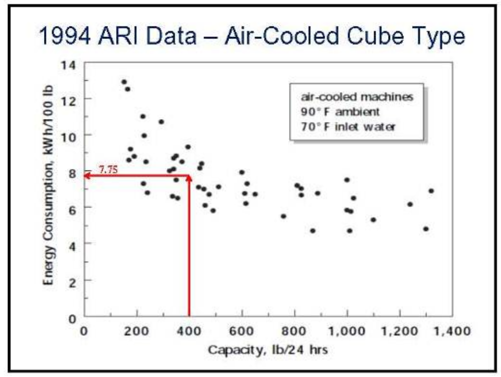
APPENDIX 4: FSTC ICE MACHINE SEMINAR PRESENTATION

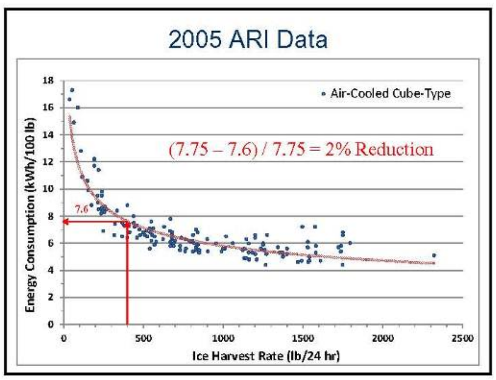


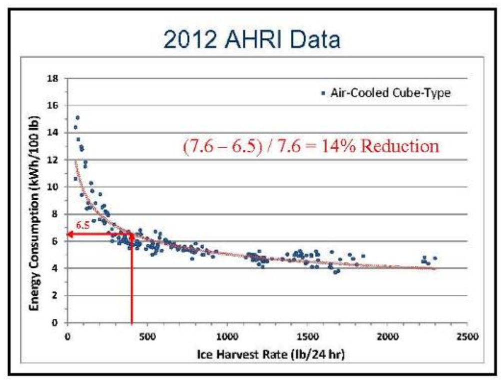


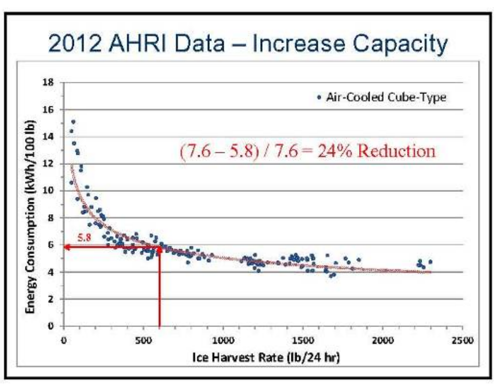


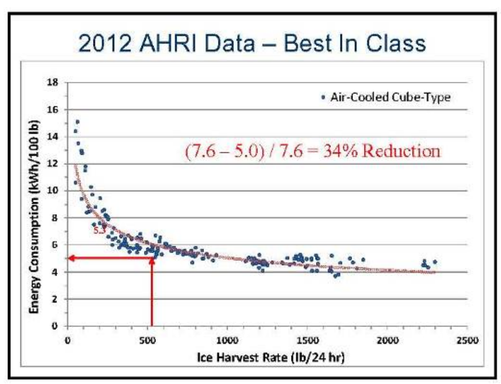

AHRI Database
Air-Cooled Cube-Type
Water-Cooled Cube-Type
Observation #2:
For a given capacity of machine, energy use varies significantly
Energy Consumption (kWh/100 lb)
Ice Harvest Rate (lb/24 hr)


1994 ARI Data – Air-Cooled Cube Type
air-cooled machines
90° F ambient
70° F inlet water
7.75
Energy Consumption, kWh/100 lb
Capacity, lb/24 hrs


2005 ARI Data
Air-Cooled Cube-Type
(7.75 – 7.6) / 7.75 = 2% Reduction
7.6
Energy Consumption (kWh/100 lb)
Ice Harvest Rate (lb/24 hr)


2012 AHRI Data
Air-Cooled Cube-Type
(7.6 – 6.5) / 7.6 = 14% Reduction
6.5
Energy Consumption (kWh/100 lb)
Ice Harvest Rate (lb/24 hr)


2012 AHRI Data – Increase Capacity
Air-Cooled Cube-Type
(7.6 – 5.8) / 7.6 = 24% Reduction
5.8
Energy Consumption (kWh/100 lb)
Ice Harvest Rate (lb/24 hr)


2012 AHRI Data – Best In Class
Air-Cooled Cube-Type
(7.6 – 5.0) / 7.6 = 34% Reduction
Energy Consumption (kWh/100 lb)
Ice Harvest Rate (lb/24 hr)

Ice Machines in Commercial Food Service

- Restaurants will have a minimum of one ice machine, typically between 500-1800 lb/day of ice production.
- Used for food prep, food display and drinks.
- Normal use by staff during business hours results in ice production during the middle of the day, coinciding with peak demand periods.
- Can an ice machine operation be shifted to utility off-peak periods?

What is Load Shifting an Ice Machine?

- Running an ice machine off the utility-peak period, and through the night to produce ice for the next day.
- Ice is stored in the bin and the staff pulls ice during the next day as usual, but no ice is produced to replace what is taken out during the afternoon.
- The ice machine turns back on during non-peak periods (evening and night), filling the bin back up when the energy rates and demand charges are at their lowest.
- A simple timer switch (or built in control) could be used to turn the machine off for the duration of the peak period.
- A more sophisticated Utility demand response program is another option.

What are the benefits of Load Shifting?

- Producing ice off peak could mean a cost saving for the restaurant operator.
- Utilities could shift a significant electrical load off peak, thus reducing their on-peak demand (and generation requirements).

Ice Machine Field Study

- How does the ARI database relate to the real world?
- How much water (and energy) do they really use?
- How much ice do machines typically produce in different types of operations (duty cycle)?
- What do typical load profiles look like?


FISHER NICKEL

A Field Study to Characterize Water and Energy Use of Commercial Ice-Cube Machines and Quantify Saving Potential

Food Service Technology Center

Prepared by

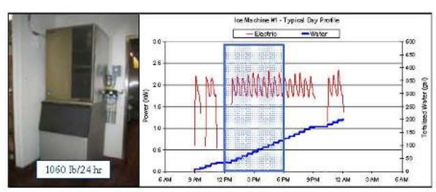
Prepared for

and

and

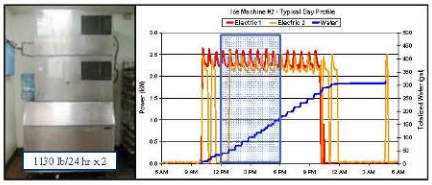
http://www.fishnick.com/publications/appliancereports/special/Ice-cube_machine_field_study.pdf

Ice Machine Field Study



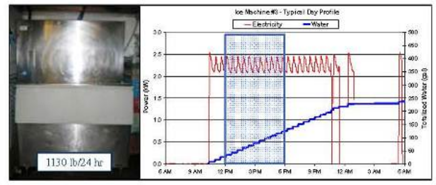
Avg. Duty Cycle = 48%
Max. Duty Cycle = 61%
Load Shift: YES

Ice Machine Field Study



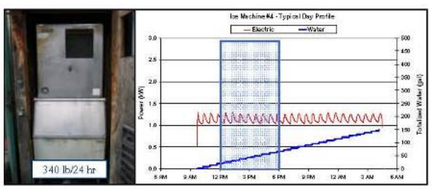
Avg. Duty Cycle = 50%
Max. Duty Cycle = 65%
Load Shift: YES

Ice Machine Field Study



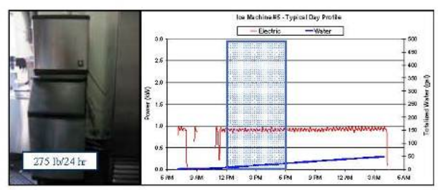
Avg. Duty Cycle = 60%
Max. Duty Cycle = 91%
Load Shift: Maybe

Ice Machine Field Study



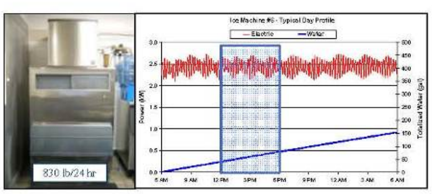
Avg. Duty Cycle = 59%
Max. Duty Cycle = 85%
Load Shift: Maybe

Ice Machine Field Study



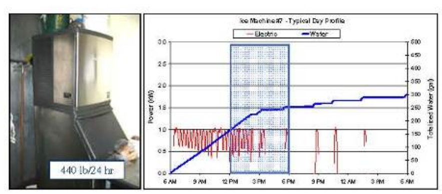
Avg. Duty Cycle = 83%
Max. Duty Cycle = 100%
Load Shift: No

Ice Machine Field Study



Avg. Duty Cycle = 87%
Max. Duty Cycle = 100%
Load Shift: No

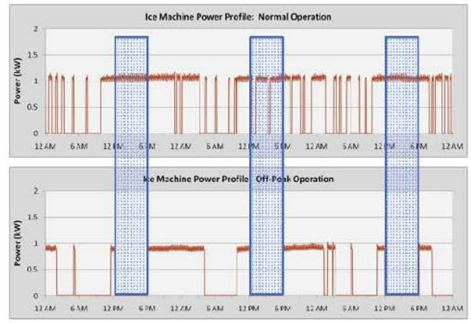
Ice Machine Field Study



Avg. Duty Cycle = 35%
Max. Duty Cycle = 48%
Load Shift: YES

Table 1. Machine Upgrade Results Summary.

	QY0454A Ice Machine	IY0504A Ice Machine
Rated Production Capacity (lb/24 hr)[1]	380	410
Rated Bin Capacity (lb)[1]	310	430
Average Cycle Power (kW)	1.05	0.89
Average Duty Cycle (%)	64	37
Average Cycle Time (min)	15.7	13.5
Average Cycle Harvest Weight (lb)	4.25	4.65
Average Cycle Water Use (gal)	1.19	1.12
Estimated In-Site Production Capacity (lb/24 hr)[2]	390	497
Energy Consumption Rate (kWh/100 lb)[2]	6.54	4.34
Potable Water Use Rate (gal/100 lb)[3]	28.0	24.0
Projected Annual Energy Use (kWh)[4]	4,710	3,130
Projected Annual Water Use (gal)[4]	20,130	17,290
Annual Energy Cost[5]	$847	$563
Annual Water Cost[6]	$135	$116



The Bottom Line

Average Cycle Power Reduction (kW)	–	0.16
Energy Saving (kWh/100 lb)	–	2.20
Energy Percentage Saving	–	33.6%
Annual Energy Saving (kWh)	–	1,580
Annual Energy Cost Saving	–	$284
Water Saving (gal/100 lb)	–	4.0
Water Percentage Saving	–	13.8%
Annual Water Saving (gal)	–	2,840
Annual Water Cost Saving	–	$19
Annual Energy and Water Cost Saving	–	$303
Peak Demand Reduction (kW)[8]	–	1.05

If the facility in this study were on a time-of-use rate (which will take effect in 2013) the total cost saving of installing the more efficient ice machine combined with load shifting would be approximately $500 per year.

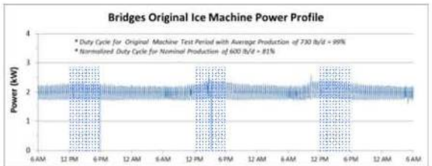
From the utilities perspective, there would be a 1,580 kWh/yr energy saving with an avoided peak demand of 1.05 kW.

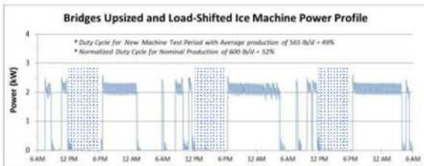
Energy Efficient Ice Machines Demonstration Showcase

Identified four restaurants to install energy efficient ice machines with integrated programmable controls set to turn unit off during peak utility rate period

Bridges Restaurant, Danville CA

Ice Machine Energy Use		
	Original Machine	New Machine
Rated Production (lb/24 hr)	772	1,180
Rated Energy Use (kWh/100 lb)	6.4	4.62
Normalized Duty Cycle (%)	82	52
Annual Energy Savings (kWh)	-	4,270
Peak Demand Reduction (kW)	-	2.0



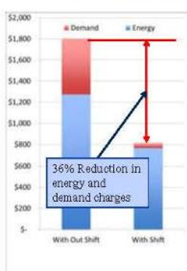


Ice Level at 12:00 PM

Ice Level at 3:00 PM

Ice Level at 6:00 PM

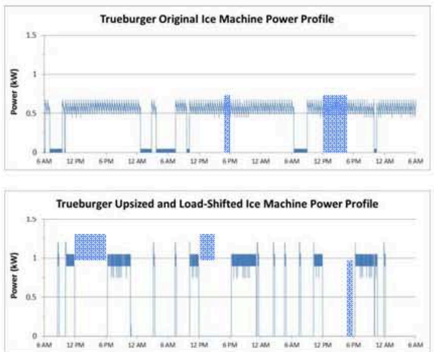
Cost Savings: Bridges



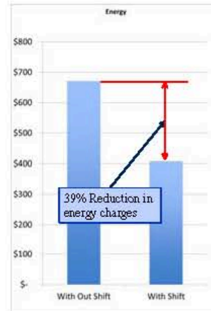
- Installing a higher efficiency ice machine and programming the machine to be off for the duration of the utility peak period resulted in annual energy charge reduction of $548.
- The demand charge reduction was an additional $117.
- The total annual electricity cost reduction for this restaurant was $665.

Trueburger, Oakland

Ice Machine Energy Use		
	Original Machine	New Machine
Rated Production (lb/24 hr)	147	410
Rated Energy Use (kWh/100 lb)	10.27	5.73
Normalized Duty Cycle (%)	89	29
Annual Energy Savings (kWh)	-	1,520
Peak Demand Reduction (kW)	-	.52



Trueburger Cost Savings: $271



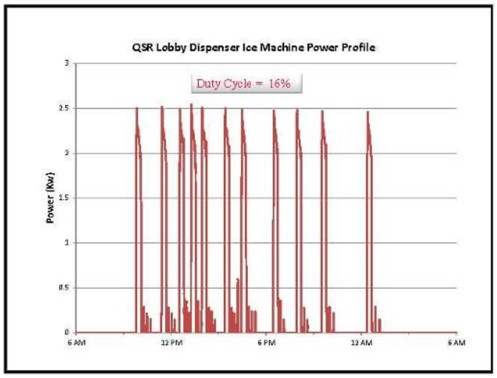
How do you know if your ice machine is a candidate?

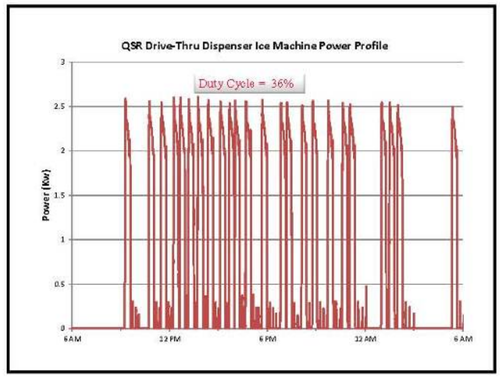
You may need to monitor its operation.

Peak Duty Cycle of 51%

14-Apr	3:19:48	3.32	13.82%
15-Apr	5:49:23	5.82	24.24%
16-Apr	5:01:22	5.02	20.90%
17-Apr	4:12:14	4.20	17.50%
18-Apr	5:43:21	5.72	23.82%
19-Apr	7:02:48	7.03	[illegible]
20-Apr	12:20:35	12.33	51.39%
21-Apr	11:03:27	11.05	[illegible]
22-Apr	6:58:49	6.97	29.03%
23-Apr	7:48:29	7.80	32.50%
24-Apr	3:59:56	3.98	16.60%
25-Apr	8:59:29	8.98	37.43%
26-Apr	10:10:25	10.17	42.36%
27-Apr	3:53:46	3.88	16.18%
28-Apr	6:36:31	6.60	27.50%
29-Apr	3:59:18	3.98	16.60%
30-Apr	5:26:14	5.43	22.64%

What about soda machines?





The Potential…

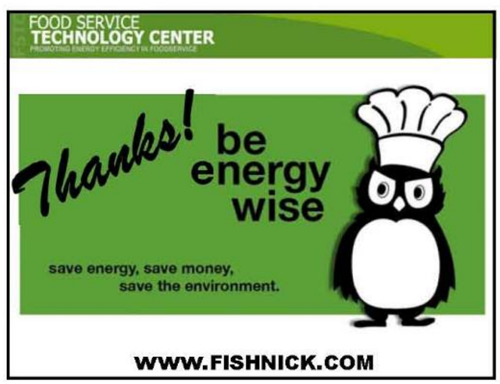
- Ice machines represent one of the few pieces of electrical equipment in a restaurant that can be turned off for a period of time within the context of "utility demand response" or "time-of-use" without compromising the foodservice operation.
- Thanks to the ice storage bin, ice machines have the ability to make ice during periods of the day that are not coincident with the either usage of ice or the utility peak.

A California Utility Perspective!

- In California – potentially 75,000 existing ice machines in commercial food service (out of 150,000) could be moved off peak – immediately!
- Estimated 1.0 kW probable Peak demand reduction per machine.
- 75 Megawatt on-peak power avoided!
- Huge benefit to electric utilities (California's solar goal is 20 MW by 2020)

The Future

In the foreseeable future, it is conceivable that ice making in all restaurants will be during non–peak utility periods, and in many cases, during the off-peak, cooler hours of the night.



APPENDIX 5: FOCUS GROUP AGENDA

Food Service Technology Center
Celebrating 25 Years of Energy Efficiency in Commercial Foodservice

FSTC Industry Focus Group Meeting Agenda
Ice Machine Energy Efficiency and Load Shifting Potential

Thursday, November 8, 2012
2:00 pm to 5:00 pm

Welcome to the PG&E Food Service Technology Center	Charlene Spoor
Introductions and background of participants	All
Objectives and scope of the ice machine initiative	Don Fisher
Results of field monitoring, equipment upgrades and load-shifting experiences to date	Todd Bell/ Angelo Karas
Demand response focus in Southern California	Carlos Haiad, SCE
Discussion of issues and hurdles to market adoption	Participants
Outline the strategy/next steps to realize potential for energy efficiency and load-shifting and/or demand response in the commercial foodservice sector	Participants
Adjourn	

Please contact Don Fisher at 925-866-5770 or dfisher@fishnick.com to confirm participation or to discuss scope the agenda.

12949 Alcosta Boulevard, Suite 101, San Ramon, CA 94583 1.800.398.3782 Direct Line 925.866.2844

APPENDIX 6: FOCUS GROUP LIST OF ATTENDEES

First Name	Last Name	Company/Organization
Ashley	Devine	Norm's Refrigeration
Pete	McLaughlin	Norm's Refrigeration
Dennis	Hunt	Contra Costa Climate Control
James	Alnutt	Contra Costa Climate Control
Andre	Saldivar	SCE
Carlos	Haiad	SCE
Martin Vu	SCE (Phone)	
Janis	Heppel	SDGE (Phone)
Greg	Gummere	Manitowoc
Pete	Palm	WPD
David	Harpring	YUM
Charlene	Spoor	PGE
Tom	Wright	Hoshizaki
Steve	Bragg	Hoshizaki
Albert	Chiu	PGE
Jonathan	Burrows	PGE
Don	Fisher	FNi/FSTC
Adam	Cornelius	FSTC
Todd	Bell	FSTC
Angelo	Karas	FSTC

APPENDIX 7: RATE SCHEDULES

Rate Schedule	Customer Charge	Season	Time-of-Use Period	Demand Charge (per kW)			Time-of-Use Period	Total Energy Charge (per kWh)			PDP[1] Charges	PDP[2] Credits DEMAND (per kW)			PDP[2] Credits ENERGY (per kWh)			"Average" Total Rate[3] (per kWh)
A-1	Single Phase Service per meter/day =$0.32854 Polyphase Service per meter/day =$0.65708	Summer		-				$0.20495			-	-			-			$0.18531
		Winter		-				$0.14344			-	-			-			
A-1 TOU	Single Phase Service per meter/day =$0.32854 Polyphase Service per meter/day =$0.65708	Summer		-			On peak	$0.22006			$0.60	-			($0.00991)			
							Part Peak	$0.21324							($0.00991)			
							Off Peak	$0.19250							($0.00991)			
		Winter		-			Part Peak	$0.15102				-			-			
							Off Peak	$0.13642										
A-6 TOU	Single phase service per meter/day =$0.32854; Polyphase service per meter/day =$0.65708. Plus Meter charge =$0.20107per day for A6 or A6X; =$0.05914 per day for A6W[5]	Summer		-			On peak	$0.44432			$1.20	-			($0.09283)			$0.17650
							Part Peak	$0.22500							($0.01857)			
							Off Peak	$0.13661							-			
		Winter		-			Part Peak	$0.15166				-			-			
							Off Peak	$0.12661										
				Secondary	Primary	Transmission		Secondary	Primary	Transmission		Secondary	Primary	Transmission	Secondary	Primary	Transmission	
A-10 (Table A)	$4.59959 per meter per day	Summer		$12.12	$11.35	$7.43		$0.13741	$0.12857	$0.10452	-	-	-	-	-	-	-	$0.15876
		Winter		$5.63	$5.84	$4.13		$0.10257	$0.09835	$0.08604								
A-10 TOU (Table B)	$4.59959 per meter per day	Summer		$12.12	$11.35	$7.43	Peak	$0.15023	$0.13927	$0.11425	$0.90	($2.11)	($1.99)	($2.23)	($0.00875)	($0.00899)	($0.00648)	Secondary $0.15885
							Part-Peak	$0.14442	$0.13513	$0.11047					($0.00875)	($0.00899)	($0.00648)	Primary $0.14765
							Off-Peak	$0.12677	$0.11931	$0.09610					($0.00875)	($0.00899)	($0.00648)	Transmission $0.12142
		Winter		$5.63	$5.84	$4.13	Part-Peak	$0.11034	$0.10469	$0.09189		-	-	-	-	-	-	
							Off-Peak	$0.09520	$0.09231	$0.08049								
E-19 TOU	Meter charge: =$4.77700/day for E19 V or X; =$4.63507/day for E19W[4]; =$19.71253/day for E19S mandatory; =$32.85421/day for E19P mandatory; =$59.13758/day for E19T mandatory	Summer	Max. Peak	$14.59	$14.37	$12.24	Peak	$0.13357	$0.12324	$0.08177	$1.20	($6.35)	($6.09)	($5.54)	$0.00000	$0.00000	$0.00000	Secondary $0.13878
			Part Peak	$3.41	$3.13	$2.71	Part Peak	$0.09502	$0.08980	$0.07843		($1.37)	($1.18)	($1.23)	$0.00000	$0.00000	$0.00000	Primary $0.13156
			Maximum	$11.85	$9.23	$5.35	Off Peak	$0.06978	$0.06988	$0.06678		-	-	-	-	-	-	Transmission $0.11466
		Winter	Part Peak	$0.21	$0.40	$0.00	Part Peak	$0.08991	$0.08603	$0.07725		-	-	-	-	-	-	
			Maximum	$11.85	$9.23	$5.35	Off Peak	$0.07267	$0.07227	$0.06801								

[1] Peak Day Pricing (PDP) (Consecutive Day and Four-Hour Event Option). All Usage During PDP Event. See specific tariff for further details.

[2] Peak Day Pricing (PDP) (Consecutive Day and Four-Hour Event Option). See specific tariff for further details.

[3] Average rates based on estimated forecast. Average rates provided only for general reference, and individual customer's average rate will depend on its applicable kW, kWh, and TOU data.

[4] Effective May 1, 2006, the voluntary TOU one time reprogramming charge of $87 if there is a TOU meter already present, and one time $443 meter installation charge if there is no TOU meter, were eliminated.

[5] The lower daily TOU meter charge continues to apply to customers who were on Rate W as of May 1, 2006. Rate X applies to all other customers.

This table provided for comparative purposes only. See current tariffs for full information regarding rates, application, eligibility, average rate limiter and additional options.

APPENDIX 8: TIME-OF-USE PERIODS

A-1, A-10 and E-19 Time-of-Use Periods		
Summer Period A (May-October)		
Peak:	12:00 noon to 6:00 pm	Monday through Friday (except holidays)
Partial-Peak:	8:30 am to 12:00 noon	Monday through Friday (except holidays)
	6:00 pm to 9:30 pm	Monday through Friday (except holidays)
Off-Peak:	9:30 pm to 8:30 am	Monday through Friday (except holidays)
	All Day	Saturday, Sunday, and Holidays
Winter Period B (November-April)		
Partial-Peak:	8:30 am to 9:30 pm	Monday through Friday (except holidays)
Off-Peak:	9:30 pm to 8:30 am	Monday through Friday (except holidays)
	All Day	Saturday, Sunday, and Holidays

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[1] Karas, Angelo and Don Fisher. 2007. A Field Study to Characterize Water and Energy Use of Commercial Ice-Cube Machines and Quantify Saving Potential. San Ramon, CA: PG&E Food Service Technology Center. *http://www.fishnick.com/publications/fieldstudies/Ice_Machine_Field_Study.pdf*

[2] Karas, Angelo, David Cowen and Don Fisher. 2011. Ice Machine Field Study: Energy and Water Saving with Ice Machine Upgrade and Load Shifting. San Ramon, CA: PG&E Food Service Technology Center. *http://www.fishnick.com/publications/fieldstudies/Ice_Machine_Upgrade_Load Shifting_Field_Study.pdf*.

[3] Air-Conditioning, Heating, and Refrigeration Institute. 2012. AHRI Directory of Certified Automatic Commercial Ice-Makers and Ice Storage Bins. (http://www.ahridirectory.org/ahriDirectory/pages/home.aspx)

[4] ENERGY STAR®. 2012. *Program Requirements, Product Specification for Automatic Commercial Ice Makers*. http://www.energystar.gov/

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[8] Zabrowski, D. and L. Mills. 2010. *Characterizing the energy efficiency potential of gas-fired commercial foodservice equipment.* Final Report. California Energy Commission: Contract No.: 500-06-028. San Ramon (CA): Prepared for the California Energy Commission, Public Interest Energy Research (PIER) Program.

[9] Itron, Inc. 2006. *California Commercial End-use Survey.*Consultant Report. California Energy Commission: Contract No.: 300-00-002. San Ramon (CA): Prepared for the California Energy Commission, Public Interest Energy Research (PIER) Program.