Restaurants—Opportunities for Energy Efficiency

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Nationally, as reported by the National Restaurant Association, restaurants use an average of 590,000 Btu per square foot annually, twice as much per square foot as the next largest commercial user.

Forty-six restaurants were audited as part of a needs assessment prior to implementing an energy efficiency education program for the restaurant industry in the state of Florida. The audits were extensive walk-thru energy audits. The restaurants examined included over 234,940 square feet and over $1.6 million in utility bills. A cross section of restaurant types and ownership structures were examined. Eighty-four different data points were gathered for each restaurant. Each restaurateur was given an audit report and the data were accumulated in an overall assessment of energy efficiency opportunities.

The year prior to the audits, the average annual energy cost (gas and electric) for these facilities was $35,458 with a high of $86,700. Electric use averaged 415,973 kWh annually and gas use averaged 13,427 therms annually. The restaurants in our study averaged 512,568 Btu per square foot annually compared to the national figure of 590,000 Btu per square foot annually.

As quantified in these audits, opportunities for energy efficiency in restaurants are significant. Efforts such as proper maintenance and no cost or low cost implementations could realize energy savings up to 20%. With retrofits, employee training, and serious energy management, much greater savings could be achieved; up to 40% in some of the restaurants audited.

Introduction

The energy issues facing the food service industry are complex. The answers are not always clear. As a part of the implementation of an energy efficiency program for the Florida restaurant industry, the University of Florida, Energy Extension Service conducted a needs analysis to determine major educational opportunities.

Restaurants are intense energy users (Claar, Mazzucchi, and Heidell 1985). Nationally, restaurants use an average of 590,000 Btu per square foot annually. The next largest user, hospitals, use 180,000 Btu (Frey, Oatman, and Claar 1989).

The storing and preparing of food, sanitation, and long hours of operation all contribute to energy use. Florida restaurants have high cooling and dehumidification requirements from the internal loads as well as high fresh air requirements. In an energy end-use monitoring, project Claar, et al., reported over one-third of energy consumed in restaurants was for food preparation equipment, slightly less than one-third for HVAC; and the remainder was used for sanitation, lighting, and refrigeration.

According to the National Restaurant Association, food service sales totaled $200 billion in 1988. Utility costs were almost $9 billion or 4 1/2% of total sales. In fact, utility costs can nearly equal profits in many operations. Restaurateurs do not often acknowledge energy efficiency as an opportunity to enhance profits. Unlike labor and supplies, energy is a cost that can be reduced without risking the loss of sales or employee and customer comfort.

The food service industry has traditionally focused more attention on food and employee costs rather than energy. Energy became a cost of doing business. Making energy efficiency a positive factor in today's profit picture is a part of good restaurant management. According to Friend (1991), energy costs in a restaurant typically represent

38% of pre-tax profits. The impact of a 20% decrease in energy consumption is equal to a 7.6% increase in pre-tax profits.

Restaurants offer numerous efficiency opportunities and are an important end use target. As reported by Claar, et al., low cost issues such as maintenance, turning off equipment when not in use, and lighting changes can provide significant efficiency improvement. This is not always the case in other end use segments. By comparison, the residential segment has smaller energy loads. A residence uses about 1000 kWh per month and a restaurant can easily use 1000 kWh per day. Within the residential segment, more decision makers must be convinced to adopt new efficiency technologies or practices. In the restaurant industry, there often are relatively few people responsible for making energy implementation decisions. Energy efficiency improvement decisions effect multiple units and those decisions can have significant impact.

The restaurant industry is a growth industry. Mike Hurst (1991), as immediate past-president of the National Restaurant Association, reported national predictions for 200,000 new food service units in the decade of the '90s with a 30% increase in new jobs. Most of the growth in this segment will be in the area of fast food. This is the fastest growing business in the country (Hurst 1991).

This industry has high public visibility. The realization of this visibility has made the industry very conscious of being a "green neighbor" (Feldman 1991). Energy efforts can bring public recognition. Currently, many energy alternatives are hidden from the public eye. This industry can bring visibility to technology.

Needs Analysis Approach

A series of extensive walk-thru energy audits formed the basis of the University of Florida, Energy Extension Service's needs analysis. The audits were conducted within the Tampa Bay area of Florida to define the educational opportunities for a restaurant energy efficiency education program.

Hillsborough county, as part of the largest metropolitan market in the state was chosen for the site of this project. In the year of the audits, Hillsborough county had 2,037 food service licenses and 1,269 restaurants. Of these, 800 were considered targets for the needs analysis. A target restaurant was defined as being open year round, over 30 seats and excluded employee cafeterias, ice cream and donut stores, and sport concessions.

The restaurant efficiency opportunities examined in the walk-thru were based on work done by the utility industry (Carl 1992 and Swensen 1985), the Model Electric Restaurant Project (Frey et al. 1989), the project on Restaurant Energy Performance (Claar et al. 1985) and the prior experience of the auditor. Specific areas of opportunity examined, based on the findings of Claar et al., included: maintenance of all equipment, human use of equipment, turning off equipment when not in use, staggering start-up, dishwashing/hot water temperatures, tightness of refrigeration equipment, storage of food items in refrigeration equipment for air circulation, efficient lighting, reduction of air infiltration, thermostat calibration, among other opportunities.

Audits

Forty-six restaurants were examined. The sample was self-selected, obtained from response to a randomly selected mail survey. All restaurants indicating interest in participating in the needs analysis were included. The restaurants represented over 234,940 square feet and over $1.6 million in utility bills. Combined, these establishments used over 120 billion Btu annually (Table 1).

Table 1. Profile of the Restaurants Surveyed

Number of Restaurants Completed	46
Number of Square Feet Evaluated	234,940
Total Annual Energy Dollars	1.6 million
Annual Number of Btu Consumed	120 billion

A cross section of restaurant types were visited. The vast majority were full service (Table 2). A variety of types of ownership were represented, individual, franchise, and corporate.

Table 2. Types of Restaurants Surveyed

Type	Number in sample
Full Service	26
Quick Serve	4
Pizza	4
Pub	4
Primarily Catering	2
Country Club	2

Eighty-four data points were collected or calculated for each restaurant (Table 3). An audit report was given to each restaurateur and the data were accumulated to form the basis of the needs analysis. While the audit report was delivered with an extensive one-on-one explanation of findings, no attempt was made to follow-up with behavior change strategies. The purpose of this project was limited to defining needs for educational programming.

Information was collected on the status of the restaurants at the time of the walk-thru. The time of day and the time of year affect status readings. The majority of audits were performed in the late winter or early spring. The time of the audit was selected by the restaurant manager-in the morning, before lunch preparations began, or in the afternoon before dinner preparation. This hampered getting status readings when the restaurant was at peak usage.

Energy Use in the Restaurants

At the time of the walk-thru, the size of the restaurant was measured. These facilities ranged from a 700 square foot take-out pizza establishment to a 19,900 square foot yacht club (Table 4).

The prior year's average annual energy cost (gas and electric) for these facilities was $35,458 with a high of $86,700 and a low of $4,900. Electric use averaged 415,973 kWh annually with the high of 1,049,280 kWh and the low of 36,080 kWh. The gas usage averaged 13,427 therms with a high of 38,089 therms and low of O. The high user in all categories was a large, high volume, lunch-dinner chain (one of the poorest maintained of any restaurant audited). The low cost was the 700 square foot take-out pizza establishment using a very efficient radiant conveyor oven, little air-conditioning, fluorescent lighting, and limited refrigeration equipment.

Annual Btu use per square foot was calculated. This ranged from 1,126,881 Btu to 135,700 Btu. The most intense energy user by this index was an operation that suffered from poor building construction and poor maintenance.

Comfort Factors

Information related to guest comfort was recorded (Table 5). Data were collected on the temperature and humidity of the space, calibration of the thermostat, and watts of lighting.

The temperature in the restaurants, at time of audit, averaged 74 degrees. Most were using the air-conditioning even if it was well before the first customer was expected. The low temperature recorded was 64 degrees and the high was 82 degrees. The thermostat calibration was off by an average of 9% higher than our thermometer readings of ambient temperature.

Humidity is a significant factor in guest comfort. The target humidity for guest comfort in Florida is 50% to 55%. The average relative humidity was 59%. Only seven of the restaurants had humidity readings below 50%.

Lighting is an integral part of the way a restaurant chooses to do business. Light levels for dining are related to atmosphere and ambience issues. Lighting levels in some of the kitchens were a concern. Only two kitchens had lighting levels above 50 foot candles. For tasks such as cutting, either by machine or knife, 90 to 100 foot candles are recommended.

For lighting the entire space (kitchen and dining areas), the restaurants used an average of 7,931 watts of light or 7.9 kW for an average of 16 hours run time. Therefore, at the 8 cents per kWh, average for Florida, it cost a restaurant over $10.00 a day to operate the lights. That is more than $3,600 per year. The largest lighting load was in a high volume, lunch-dinner facility that used more than two hundred bulbs for decoration. The annual lighting cost for that facility was over $8,200.

On a watt per square foot basis, the restaurants averaged 1.55 watts per square foot. The range was from .44 watts per square foot to 4.40 watts per square foot. One facility used compact fluorescent bulbs in the dining area.

In Florida restaurants, the availability of air-conditioning is highly essential to business. Lost efficiency in air-conditioning was examined. The sources of lost efficiency were related to building infiltration and equipment inefficiency. The inefficiency estimates were based on insulation in the building, window glass area, condition of door seals and caulking, and status of air-conditioning maintenance (Table 6).

Audit Suggestions

The audit gave detailed information for six categories of savings through no cost improvements (Table 7). These savings included actions as simple as a positive action switching program which was defined as turning off what wasn't needed. Heat strips and dining room lights were often on, long before guests arrived and when no need was apparent. Refrigeration shelves were seldom organized so stock could be easily located, and items were seldom arranged with space between items for cold air circulation. Savings from hot water leaks and hot water drips are quantified under "reduce hot water temperature to health department minimums." A number of drips at

Table 3. Data Collected and Provided for Each Restaurant Through the SBDC Audit Report Format

- Number of Square Feet
- Total cost of Energy
- Total BTU usage
- Equivalent Barrels of oil used
- Electrical usage in Dollars
- Electrical usage in KWH
- Electrical usage in BTU
- Gas usage in Dollars
- Gas usage in Therms
- Gas usage in BTU
- Toxic emission equivalent
- Total estimated Dollar savings possible
- Total estimated BTU savings possible
- Total estimated Barrel of oil savings possible
- Monthly Bill savings
- Emissions reduction
- Operating hours
- Reduction possible-long term
- Controlled zones
- Optimum system size - no load
- Optimum cost operation - no load for ac & heat
- Window surface (in sq. feet)
- Missing building caulk and door seals
- Ventilation readings (in cfm)
- Additional AC load from building factors
- AC cost of operation with building load
- Estimated AC lost efficiency in Dollars/year
- Estimated AC lost efficiency in Dollars/month
- Estimated AC lost efficiency in BTU
- Thermostat Calibration - % off
- Ambient temperature
- Humidity
- Total watts in use
- KWH used per year in lighting
- BTU used per year in lighting
- Estimated dollar saving/yr. with lighting placement and switching
- Estimated dollar saving/mo. with lighting placement and switching
- Estimated BTU saving with lighting placement and switching
- Estimated lost efficiency in electric appliance load in dollars/yr.
- Estimated lost efficiency in electric appliance load in dollars/mo.
- Estimated lost efficiency in electric appliance load in BTU/yr.
- Estimated lost efficiency in gas appliance load in dollars/yr.
- Voltage fluctuation
  % over +10 volts
  % over +25 volts
- Estimated Reduction from Passive Shading of AC Unit and Windows in BTU/yr.
- Estimated Reduction from Positive Action Switching Program in BTU/yr.
- Estimated Reduction from Reduce Hot Water to 110 Deg. in BTU/yr.
- Estimated Reduction from Adjust and Balance Ventilation in BTU/yr.
- Estimated Reduction from Stock Refrigeration Units Properly in BTU/yr.
- Estimated Reduction from clean and Adjust All Gas Equipment in BTU/yr.
- Estimated Yearly Reduction in BTU from items suggested in no cost program
- Estimated Monthly Reduction from items suggested in no cost program in dollars
- Estimated Monthly Reduction from items suggested in no cost program in KWH
- Estimated Reduction from Tinting & Added Insulation on Inside Window in dollars/yr.
- Estimated Reduction from Cleaning & Repairing Vent Systems in dollars/yr.
- Estimated Reduction from Repair Buildings Caulking & Seals, Windows/Doors/Ceilings etc. in dollars/yr.
- Estimated Reduction from Repair or Install Hot Water Pipe Insulation & Refrigeration Seals in dollars/yr.
- Estimated Reduction from Energy Saver Light Bulbs in dollars/yr.
- Estimated Yearly Reduction in BTU from items suggested in low cost program
- Estimated Monthly Utility Bill Reduction from items suggested in low cost program in dollars
- Estimated Yearly Utility Bill Reduction from items suggested in low cost program in KWH
- Estimated Reduction from Air Curtains in dollars/yr.
- Estimated Reduction from Thermal Windows in dollars/yr.
- Estimated Reduction from Energy Efficient Ballast
- Estimated Reduction from Energy Efficient Appliances and Motors in dollars/yr.
- Estimated Yearly Reduction in BTU from items suggested in long term program
- Estimated Monthly Reduction from items suggested in long term program in dollars
- Estimated Monthly Reduction in KWH from items suggested in long term program

Table 4. Annual Energy Use in Audited Restaurants

Audit Items	Average	Range	
		Low	High
Size of Restaurant (sq. ft)	5,107	700	19,900
Electric Usage in kWh	415,973	36,080	1,049,280
Gas Usage in therms	13,427	none	38,089
Total Cost of Energy	$35,458	$4,900	$86,700
Total Btu used	2,617,886,609	123,104,960	7,389,053,360
Btu per sq.ft.	512,568	135,700	1,126,881

Table 5. Status Information (observed conditions) Related to Comfort

Comfort Item	Average	Range	
		Low	High
Temperature	74	64	82
Humidity Range	59%	39%	77%
Watts of Light	7,931	1,055	17,855
Watts per sq. ft.	1.55	.44	4.40

Table 6. Estimated Air Conditioning Lost Efficiency and Factors for the Lost Efficiency

Efficiency Lost and Associated Factors	Average Per Restaurant	Range	
		Low	High
Air Conditioning - Estimated lost efficiency in dollars (due to infiltration and equipment inefficiencies)	$5,313	$1,700	$23,000
Sources of infiltration losses included:			
Window Area (sq. ft)	481	15	2,736
Missing Caulking (lin. ft.)	306	75	1,600

Table 7. Potential Annual Btu Savings Estimated - Through No Cost Energy Improvements

No Cost Improvements	Potential Saving Estimates: Average Per Restaurant	Range: Low	Range: High
Passive Shading	3,400,000	200,000	8,800,000
Positive Action Switching	1,600,000	100,000	5,800,000
Reduce Hot Water to Health Department Minimums	3,000,000	200,000	13,700,000
Balance Ventilation System	4,500,000	1,900	18,600,000
Stocking Refrigeration Properly	1,700,000	100,000	5,600,000

sink taps were found as well as hot water leaks in other areas. Gas cooking equipment needed adjustment. Orange flames were predominate.

The audit gave detailed information for five categories of savings through low cost improvements (Table 8). Some of the restaurants had window treatments or tinting and only a few had thermal pane windows.

The maintenance condition of the refrigeration equipment was poor. Door seals did not seal properly. Some seals were so deteriorated they were hanging down and dragging on the floor. Savings for adding hot water pipe insulation and fixing the seals and gaskets and other leaks within refrigeration equipment were significant. The estimation of savings was determined by combining the measure of three elements: the length of uninsulated hot water pipe, the inches of defective refrigeration seals, and square inches of infiltration in refrigeration walls (holes cut in walls, defective insulation and gaskets and plugs missing in walk-in panels).

Within the savings projected under "repair building caulking seals, windows, doors, and ceiling," was the issue of ceiling tiles and infiltration around the cracks in the edges of those tiles.

Employee Habits

Employee habits and practices were observed during the audits. The types of inefficient practices found included:

- Gas cooking equipment was on for long periods with no apparent food preparation.
- Lids weren't used with pots and water boiled so rapidly it splashed out.

Table 8. Potential Annual Btu Savings Estimated - Through Low Cost Energy Improvements

Low Cost Improvements	Estimated Saving: Average Per Restaurant	Range: Low	Range: High
Window Tinting or Interior Insulation	3,100,000	400,000	11,600,000
Clean and Repair Ventilation System	900,000	100,000	3,700,000
Repair building, caulking, seals, windows, doors, and ceilings	74,600,000	15,700,000	52,500,000
Repair or install refrigeration seals and hot water pipe insulation	341,000,000	129,700,000	163,000
Install energy saver light bulbs	49,400,000	2,300,000	116,900,000

- Hot water taps were left running.
- Outside doors and walk-in doors were propped open for 20 minutes or more at a time during deliveries.
- A walk-in refrigeration unit was apparently used by employees to cool off. Within a 20 minute period, 5 trips were made in and out of the walk-in with no one carrying anything in or bringing anything out.
- Walk-in doors weren't closed. One remained ajar the entire time it took to do the audit. In one kitchen, 6 refrigeration units had doors ajar.
- While some restaurants had vestibules, the doors were often propped open.
- The back doors of restaurants were open for ventilation while air-conditioning was in operation.

Discussion

Annual Btu use per square foot was employed to compare this sample to the national situation. Frey et al. 1989, reported the annual Btu per square foot nationwide is 590,000 Btu. The 46 restaurants in this study averaged 512,568 Btu per square foot.

Claar et al. 1985, made a series of general observations in respect to energy conservation opportunities in their extensive end-use monitoring project of restaurants. Their observations included: the need for regular maintenance of restaurant equipment, the establishment of operational guidelines, proper sizing, and turning off equipment when there is no need for it. This needs analysis confirmed each of these observations.

Conclusions

Restaurants are challenging work environments. Individual unit managers are focused on customers, food, and employee issues with the attitude that energy is the cost of doing business.

This survey reaffirmed that the opportunity for energy efficiency in restaurants is significant. Efforts such as proper maintenance and no cost or low cost implementations can realize energy savings up to 20%. With retrofits, employee training, and serious energy management, much greater savings could be achieved. Within the restaurants audited, many had savings opportunities that could reach up to 40% of energy costs.

This needs analysis has focused the work of the Florida Energy Extension Service Restaurant Program. In the two years since the completion of this needs analysis, three extensive projects have been implemented. A project was recently completed that examined photovoltaic parking lot lighting for the restaurant industry (Miller 1994). A project addressing the use of a solar/electric desiccant air-conditioning system for the reduction of humidity in restaurants has been undertaken and a mid-point report issued (West and Iyer 1994). A third project, in partnership with electric utilities, Wendy's International and several manufacturers, is examining the impact of ten energy efficiency measures that have been designed into a new restaurant. The energy use is being compared to a standard design store, three miles away. The innovative store was opened May, 1993 with an expected monitoring/report completion date of December, 1994.

Endnotes

1. The Small Business Development Center (SBDC) at the University of South Florida and the Energy Extension Service (EES) of the University of Florida, pursued a joint venture in the audit of the target restaurants and the compilation of data collected. The SBDC Auditor was completely responsible for the content and validity of the data. The EES Agent was primarily responsible for obtaining restaurants to audit, observation of employee habits, follow-up education with the development of implementation strategies, and the compilation and reporting of the data. Both the Small Business Development audit program and the Energy Extension Service are supported through finding from the Florida Energy Office, Department of Community Affairs.

2. All Btu calculations are site use (i.e. 1 kWh = 3412 Btu, 1 therm = 100,000 Btu).

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