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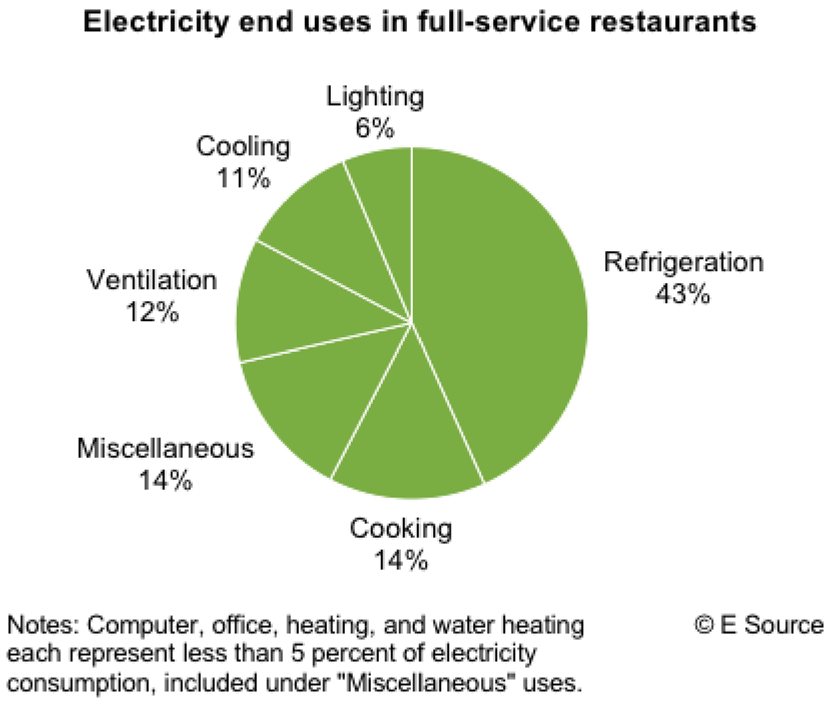
Managing Energy Costs in Restaurants

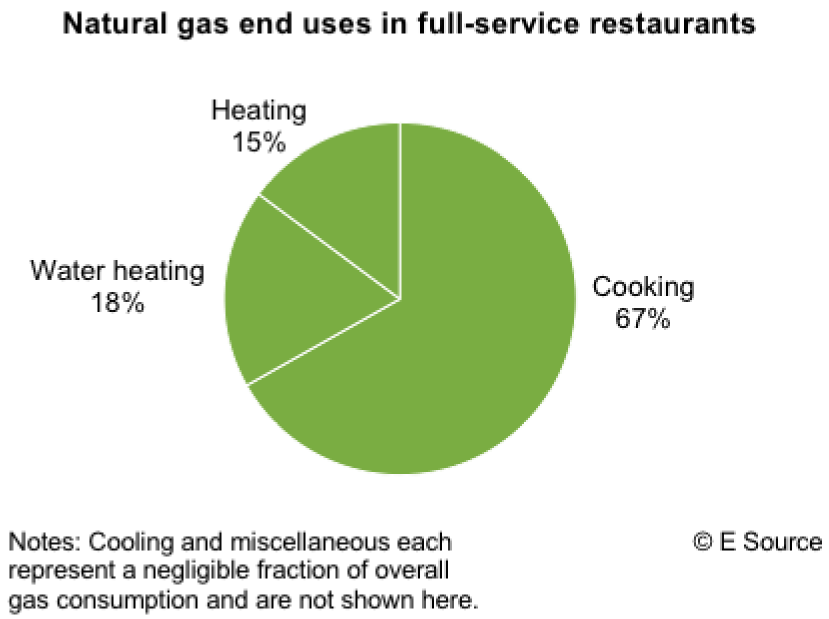
Restaurants in the U.S. have one of the greatest energy intensities of any type of commercial building—an average of 38 kilowatt-hours (kWh) of electricity and 111 cubic feet of natural gas annually per square foot (ft^2). A number of opportunities for saving energy can often be found in the end-use areas that consume the most energy. In a typical restaurant, cooking, water heating, refrigeration, and space heating represent almost 80 percent of total use (**Figure 1**), making those systems the best targets for energy savings.

Average energy use data

Figure 1: Energy consumption by end use

In restaurants, refrigeration and cooking are the two main uses of electricity. Though cooking makes up roughly two-thrids of natural gas usage, the remaining third is split fairly evenly between water heating and space heating.



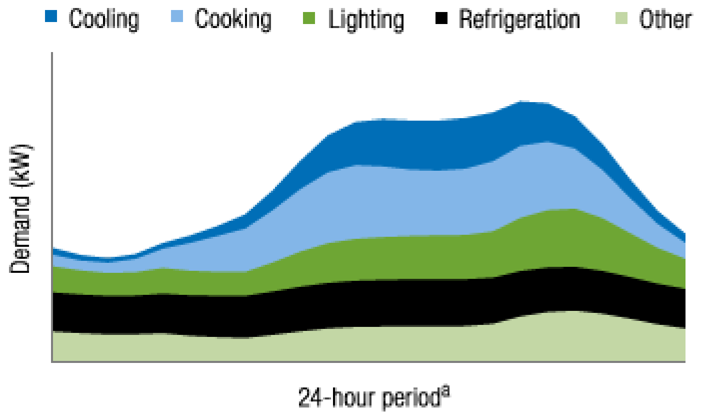


Top technology uses

- Cooking
- Refrigeration
- Water Heating

In order to better manage your building's energy costs, it helps to understand how you are charged for those costs. Most utilities charge commercial buildings for their natural gas based on the amount of energy delivered. Electricity, on the other hand, can be charged based on two measures—consumption and demand (**Figure 2**). The consumption component of the bill is based on the amount of electricity, in kWh, that the building consumes during a month. The demand component is the peak demand, in kilowatts (kW), occurring within the month or, for some utilities, during the previous 12 months. Demand charges can range from a few dollars per kilowatt-month to upwards of $20 per kilowatt-month. Because it can be a considerable percentage of your bill, you should take care to reduce peak demand whenever possible. As you read the following energy cost-management recommendations, keep in mind how each one will affect both your consumption and demand.

Figure 2: Diagram of a hypothetical daily load shape



Notes: kW = kilowatt.
a. 24-hour period = midnight to midnight.

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QUICK FIXES

this section

Restaurants tend to operate with narrow profit margins. Achieving just a 20 percent reduction in energy costs will translate directly into an additional 1 percent in profit. The following low- or no-cost steps can have a real impact on your restaurant's bottom line.

Turning things off

In storage areas. There are a variety of ways to turn off lights and equipment in storage areas (such as walk-in coolers)—some simple, some sophisticated. Among the simplest methods is to encourage your staff to be conscious of energy use and to turn lights or equipment off in vacant rooms. A more sophisticated approach might employ occupancy sensors or timers to turn lights and equipment off during unoccupied hours.

In the kitchen. Encourage your staff to use good operating habits and turn kitchen equipment off when not in use. For example, fryers sit idle more than 75 percent of the time, even in busy quick-service restaurants. You can save a lot of energy and money by turning off your backup fryer when you don’t need it. Eliminating just four hours per day of idle fryer time could save up to $150 per year. Likewise, if you turn off an idle broiler for just one hour per day you can save up to $400 per year in energy costs. One way to ensure unused equipment is turned off is to develop simple energy-management procedures—with checklists—and to assign responsibility between shifts and at the end of the day for turning off cooking equipment, exhaust fans, lights, computers, and other restaurant equipment.

Dishwashing equipment. Turning off high-temperature dishwashers at night so that built-in burners or heating elements will not consume energy can save about $500 per year (at an electricity rate of $0.13/kWh). Turning the dish machine exhaust hood off can save another $250 per year. Make sure that the booster heater is shut off at night for a savings of $60 per year—even if you turn off the dishwasher itself, the booster heater might have a separate manual switch.

Turning things down

Equipment. For equipment that you choose not to turn off entirely, such as the refrigeration system or air conditioner, set controls to minimum levels during operating hours and turn down equipment just before closing each night. You may also consider using programmable thermostats , which can adjust your HVAC system settings automatically. For dishwashers, check that the rinse pressure is set to 15 to 25 pounds per square inch (100 to 172 kilopascals) to avoid excess water use, set the wash-tank temperature to 160° Fahrenheit (F; 71° Celsius [C]), and set the booster heater setpoint to 180°F (83°C).

Lights. In spaces where natural lighting is available, dim lights in proportion to the availability of sunlight. Daylighting controls are available that can perform this function for you automatically.

Repair and maintenance

Keep lights clean. Clean lighting fixtures and bulbs to ensure they continue to perform as designed (especially if you use dimmers).

Inspect refrigerator, freezer, and hot-food holding cabinet doors. Poorly maintained refrigerator doors can leak cool air, which means the condenser runs unnecessarily to maintain the proper temperature. The same is true for the heating element in a poorly maintained hot-food holding cabinet. Replace worn gaskets and make sure doors are aligned properly. In the case of refrigerators and freezers, also check that automatic door closers are functioning and strip curtains are not damaged. Strip curtains on walk-in refrigerators and freezers can cut outside air infiltration by as much as 75 percent and can have a payback of less than one year. One study found that adding strip curtains to the doors of a 240-ft^2 walk-in refrigerator reduced energy consumption by 3,730 kWh per year—about 9 percent of total energy consumption.

Most commercial reach-in refrigerators with glass doors have heaters (sometimes called defoggers) that eliminate condensation on the inside surface of the door. In many dry climates or in non-merchandising applications, these heaters can be simply turned off, thereby saving energy with no loss of functionality. Door heaters don't draw a tremendous amount of power, but because they're on 24/7/365, they can chew up about $75 of electricity per year, and it costs nothing to throw the switch. The heater switch can usually be found right on the front of the refrigerator.

Repair controls. Thermostats and control systems can drift out of calibration or even fail outright. Take the time to periodically check thermostats and other controls. If necessary, contact qualified technicians to recalibrate or replace controls. Also, repair or replace broken control panels on ovens, steamers, and other appliances that feature control systems, and replace missing knobs on manually controlled appliances like ranges, griddles, and broilers. These measures will improve cooking performance, safety, and kitchen appearance, and they'll also reduce energy use.

Inspect the water heater. There are a number of steps you can take to make your existing water heater as efficient as it can be. First, make sure it's set to a temperature no higher than 140°F. Next, insulate the first several feet of the hot water pipe coming off the heater with inexpensive tube insulation available at most hardware stores. Older water heaters (manufactured in or before 2000) can often benefit from an insulating blanket wrapped around the entire tank, also available in most hardware stores. Third, if your gas water heater has a vent damper, make sure the damper motor's switch is in the "on" position, and that it closes when the burners are off. Finally, some systems utilize a recirculation pump to ensure that hot water is quickly available at taps far from the heater. If your system uses a recirculation pump, put it on a timer so that it only functions when your kitchen is operating.

Inspect conveyor washer curtains. Ensure that the strip curtains on conveyor-type washers are intact and long enough to prevent heat from escaping the wash chamber.

Repair water leaks. A cold water leak that loses 0.2 gallons per minute will waste more than 100,000 gallons over the course of a year and cost a restaurant $700 in water alone. If a restaurant has a similar-sized hot water leak, the cost can be as much as $1,700 for wasted water and energy every year.

Restaurant operators will get some of their biggest payoffs from maintenance and repairs of HVAC systems. Some simple checks can indicate problems, but regularly scheduled preventive maintenance should help to avoid costly fixes while also keeping your energy bills down. Preventive maintenance should include the following measures:

Check the economizer. Many air-conditioning systems use a dampered vent called an economizer to draw in cool outside air when it is available to reduce the need for mechanically cooled air. If not regularly checked, the linkage on the damper can seize up or break. An economizer stuck in the fully opened position can add as much as 50 percent to a building's annual energy bill by allowing hot air in during the air-conditioning season and cold air in during the heating season. Have a licensed technician check, clean, and lubricate your economizer's linkage about once a year and make repairs if necessary.

Check air-conditioning temperatures. With a thermometer, check the temperature of the return air going to your air conditioner and then check the temperature of the air coming out of the register nearest the air-conditioning unit. If the temperature difference is less than 14°F or more than 22°F, have a licensed technician inspect your air-conditioning unit.

Change filters. Filters should be changed monthly; they should be changed more often if you are located next to a highway or construction site where the air is much dirtier.

Check cabinet panels. On a quarterly basis, make sure the panels to your rooftop air-conditioning unit are fully attached with all screws in place, and check that gaskets are intact so no air leaks out of the cabinet. If chilled air leaks out, it can cost $100 per rooftop unit per year in wasted energy.

Clean condenser coils. Check condenser coils quarterly for trash or natural debris that can collect there.

Check for airflow. Hold your hand up to air registers to ensure that there is adequate airflow. If there is little airflow, or if dirt and dust are coming out of the register, have a technician inspect your unit and ducts.

LONGER-TERM SOLUTIONS

this section

Although the actions covered in this section require more extensive implementation, they can dramatically increase the efficiency, comfort, and safety of your restaurant. Ask your local utility's representative for more information about initiating such projects.

Commissioning

Commissioning is a process in which engineers observe a building's energy systems and perform a tune-up to ensure that they are operating appropriately and efficiently. Doing so can lead to reductions of 10 to 15 percent in annual energy bills. When this process is applied to an existing building that has not been commissioned before, it is called *retrocommissioning* . When it is applied to a building that has been commissioned before, it is called *recommissioning*. Recommissioning is recommended every three to five years to maintain top levels of building performance. In restaurants, commissioning also allows you to evaluate airflows between cooking and dining areas and to use that information for implementing air-pressure balancing measures. Commissioning usually costs between 5 and 40 cents/ft2.

Kitchen measures

High-efficiency kitchen equipment. Cooking equipment, coolers, and dishwashers are energy hogs in a restaurant—high-efficiency cooking equipment can be 15 to 30 percent more energy-efficient than standard equipment. The benefits of purchasing an energy-efficient model go beyond energy savings, as well: The same measures that make the units more efficient can also lead to better performance. For a list of Energy Star–qualified products and an online calculator that can help you determine savings for your particular upgrade, visit the commercial food service section of the Energy Star web site .

Smart vent hoods. Commercial kitchen exhaust hoods remove a lot of indoor air, forcing the ventilation system to draw outside air into the kitchen to make up for those high airflows. In climates where the kitchen makeup air is conditioned, that conditioning can account for up to one quarter of the entire energy use of a food service establishment. Intelligent, variable-speed hood controller systems can significantly reduce energy costs in your kitchens. A photoelectric smoke or heat detector determines when and how much ventilation is needed and activates the exhaust fan at the proper speed, compared to the continuous operation of the fan in a traditional vent hood. In appropriate applications, this technology yields a one- to two-year simple payback.

In 2004, researchers from California’s Food Service Technology Center (FSTC) monitored energy use and demand before and after the installation of this technology in a 30-foot canopy hood at the Inter-Continental Mark Hopkins Hotel in San Francisco, California. The researchers found that it reduced electrical demand from 14.0 kW to 5.3 kW, for a savings of 8.7 kW. Projected annual electrical cost savings for the fans came to $9,910 (based on $0.13/kWh). Reduction in makeup airflow reduced the annual cost of natural gas for heating by $9,460 (based on $0.80 per therm). The total savings of $19,370 resulted in a payback period of less than one year. An additional benefit to kitchen staff is the noise reduction that frequently accompanies installation of a variable-speed hood controller.

Induction cooking. Cooking energy consumption can be reduced 10 to 20 percent by using an induction cooktop rather than a conventional cooktop. That’s because induction cooking transfers 85 to 90 percent of the energy directly into the cooking pan, compared to gas cooking or electric cooking which are only about 55 or 70 percent efficient respectively. Because they’re more efficient, induction cooktops generate less ambient heat, which can reduce cooling bills, create a more comfortable kitchen environment, and eliminate safety issues associated with open-gas flames or hot electric surfaces. Induction cooking also heats food more quickly than gas, provides very stable cooking temperatures, and the cooking surfaces are easier to clean than those for conventional stoves.

Connectionless steamers. Replacing inefficient steam cookers represents one of the most substantial opportunities for energy savings in a commercial kitchen. There are an estimated 205,000 compartment steamers in food service operations nationwide. Of these, most are traditional units that rely on a boiler to vaporize a constant inflow of water. The FSTC estimates that 60 percent of the current compartment steamers in use—or 123,000 units—waste enough water and energy to warrant replacement. Self-contained, or “connectionless,” steamers provide the most efficient alternative to conventional units, and they offer combined annual water and energy savings of up to $6,000 per machine.

Connectionless steamers are not attached to water lines. Instead, they rely on a manually filled reservoir that sits in the bottom of the steamer. Unlike traditional steamers, connectionless units recirculate the steam rather than continuously venting. The result of this closed system is a substantial savings in both energy and water. In all, connectionless steamers use about 2 gallons of water per hour—compare that to an average of 40 gallons for traditional models. Over the course of a year, the water savings achieved by replacing inefficient steam cookers with an equivalent-sized connectionless model can exceed 150,000 gallons. If all the inefficient boiler-based models were replaced nationwide, the annual water savings would be about 20 billion gallons—enough to supply roughly 210,000 households. The energy savings are also striking. A highly efficient connectionless steamer could save up to 11,000 kWh over a conventional model. If the entire food service industry replaced conventional steam cookers with highly efficient machines, the energy savings would reach 1.25 billion kWh—equal to the electricity consumption of about 115,000 households.

Ice makers. The energy efficiency of new ice makers has improved considerably over the past decade, and there are now many efficient models to choose from, some of which provide substantial energy savings with little or no incremental cost over less-efficient models—a win-win situation. With new state and federal standards coming into effect, the number and diversity of energy-efficient ice makers will continue to increase.

In some cases, high-efficiency ice makers have little or no incremental cost versus less-efficient models. For example, a search for air-cooled ice makers with approximately 1,200 pounds of capacity showed that a model meeting the Consortium for Energy Efficiency (CEE) Tier 1 standards was more expensive than its less-efficient counterparts at $120 (2 percent) more than a baseline model; models meeting the Tier 2 and Tier 3 standards cost $250 (3 percent) and $350 (5 percent) less than the baseline model, respectively.

When you're shopping around for a new ice maker, be sure to pick a machine with the right capacity. Oversizing an ice maker can increase energy consumption due to excessive standby losses. On the other hand, larger ice makers generally consume less energy per unit of ice than smaller ones. It is important to pick a unit that most closely matches your quantity requirements. Ice machines are designated by the amount of ice that they can produce in a 24-hour period, under reference conditions of 70°F (21°C) ambient temperature and 50°F (10°C) inlet water temperature. Typical sizes are 250, 400, 500, 650, 800, 1,000, 1,200, and 1,400 pounds per 24 hours, but machines are available that make several tons of ice per day. Actual capacity varies with both ambient temperature and water temperature. Manufacturers usually recommend using the capacity listed at the test conditions used by the Air-Conditioning and Refrigeration Institute (ARI): 90°F (32°C) ambient air and 70°F (21°C) water. Selecting equipment based on the capacity at those conditions will ensure that adequate ice can be produced under most conditions encountered in operation.

New U.S. federal and state standards will continue to push ice-maker efficiency upward.

Federal energy-efficiency requirements taking effect in 2010 will be the same as the current (voluntary) CEE Tier 1 standards. California’s 2008 energy-efficiency standards for commercial ice makers are also the same as the current CEE Tier 1 standards.

Refrigeration measures

Evaporator fan controllers in coolers. Nearly all walk-in coolers have forced-circulation evaporators that contain motorized propeller fans. These fans run continuously, despite the fact that full airflow is only necessary 50 percent of the time. Inexpensive walk-in cooler controllers are now available that slow these fans when full cooling capabilities are not necessary.

Demand-defrost kits. On average, timer-based defrosters (used to defrost the ice that accumulates on the evaporator coils during operation) account for about 20 percent of the total energy consumption of walk-in freezers. Demand-defrost systems, which initiate defrosts only when they are needed, can save significant amounts of energy by reducing the number of defrost cycles. Independent tests show that the more advanced demand-defrost controllers can reduce defrost cycles by as much as 40 percent compared to defrosters with timers—saving from $150 to $3,000 annually on energy costs depending on the size of the freezer. In addition, these controllers can help maintain the quality of products kept in the freezer because fewer defrost cycles translates into a more constant temperature in the freezer. One study found that for a 1-ton walk-in freezer, which typically consumes 4 megawatt-hours annually to run the electric defroster with a timer, a demand-defrost controller will save approximately $150 annually in energy costs. Given that these systems typically cost about $400 to $600, the demand-defrost controller will yield a payback of about two to four years.

Lighting measures

Switch to compact fluorescent lamps. Replacing incandescent bulbs with compact fluorescent lamps (CFLs) not only saves energy, but the bulbs also last much longer, so they save on maintenance. One restaurant owner replaced 20 100-watt bulbs with CFLs that used less energy, helping the restaurant to save more than $400 per year. CFLs are now available in 2,700-kelvin models that produce a warm color tone similar to that of incandescent lamps. You can also adjust their light intensity by installing dimmable ballasts. Just be sure to use CFLs in appropriate ballasts, especially if dimmers are in the circuit.

Install T8 lamps and electronic ballasts. If your facility uses T12 fluorescent lamps , relamping with the latest T8 lamps and electronic ballasts can cut 35 percent off your lighting bill. Adding specular reflectors, new lenses, and occupancy sensors or timers can double the savings. Paybacks of one to three years are common.

Use daylighting controls. Daylighting control systems use sensors and either switches or dimmers to adjust electric lighting levels in response to available daylight. These systems offer the potential to cut energy use, reduce peak demand, and create a more desirable indoor environment in your restaurant, but in many cases they fail to live up to that potential. The keys to optimizing these systems are combining good design with commissioning, effectively coordinating the efforts of many building disciplines, and training staff on how to use the systems. In addition, new technologies for daylighting control are being developed to make daylighting systems easier to install and calibrate.

Illuminate with LEDs. Replace incandescent exit signs , exterior signs, colored accent lights, downlights, and menu boards with ones lit by light-emitting diodes (LEDs). LEDs direct light very effectively and come in many colors, which make them a good candidate for restaurant applications. Although initial costs for LEDs are high, the lamps can last 5 to 10 years, so you’ll also save on maintenance costs.

- *Exit signs.* These signs must be lit both day and night, which can take a bite out of a restaurant’s budget. A single LED exit sign saves on the order of $45 per year and will shine brightly for 5 to 10 years, which can significantly reduce material and labor costs as compared with standard incandescent models.
- *Downlights.* In the dining room, recessed downlighting fixtures equipped with white LEDs can save considerable energy compared with an incandescent light source. LED

downlights are also fully dimmable and, according to many, provide superior light quality. Just make sure you purchase a trusted LED downlight, because this is a relatively young niche industry that has been the subject of occasional inflated vendor claims.

- *Open signs.* LEDs are the best choice for replacing neon "open" signs—they use 80 percent less energy than neon but have about the same initial cost. The majority of LED models run from $99 to $150 for a plain sign; the majority of neon models fall into the $50 to $150 price range. Over a 10-year period, however, total life cycle costs for an neon sign could run about $480, whereas a comparable LED unit with a 10-year life would incur overall costs of about $170 (**Figure 3**).

Figure 3: Energy use of an LED open sign compared with a neon open sign

An LED open sign will save $455 in energy and replacement costs over its lifetime compared with a comparable neon open sign.

Variable	LED	Neon
Watts	10	50
Hours of daily use	10	10
Annual kWh consumed	36.50	182.50
Annual energy cost	$3.65	$18.25
Lifetime (years)	13.0	3.3
Number of signs purchased over 13 years	1	4
Cost per sign	$135.00	$100.00
Total spent on new signs over 13 years	$135.00	$400.00
Total costs over lifetime of LED sign	**$182.00**	**$637.00**

Notes: kWh = kilowatt-hour;
LED = light-emitting diode.

Use smart lighting design in parking lots. Many restaurants set their peak demand when they turn on lights in parking lots. And parking lots are often designed with far more lighting than most lighting experts recommend. Parking lot light levels may depend on local ordinances, but can generally be fairly low. The guidelines laid out by the Illuminating Engineering Society of North America (IESNA) suggest 0.5 to 5.0 foot-candles, depending on the level of activity and the potential hazards. Typically, an average of 1 foot-candle (or less) is sufficient. Not only is overlighting costly, it can be dangerous to drivers if their eyes cannot adjust fast enough in the transition from highly lit to dark areas.

When designing lighting for a new parking lot, consider low-wattage metal halide lamps in fixtures that direct the light downward, rather than high-pressure sodium lamps. Even with a lower wattage, you can safely use fewer lamps if this choice is made. Metal halide is less efficient than high-pressure sodium in conventional terms, but it puts out more light in the blue part of the spectrum, which turns out to be easier for our eyes to see under low-light conditions. LED lighting has emerged as an even more efficient parking-lot option than high-intensity lighting, however, since their high initial costs result in long payback periods, be sure to conduct a thorough analysis before you commit to LED lighting for your parking lot.

Install security lights. Security lights around the perimeter of many restaurants can consume prodigious amounts of electricity. By installing an inexpensive motion sensor, a restaurant can save about $130 per year on every 300-watt double-fixture floodlight on the property. Additionally, security lights integrated with a motion sensor can actually deter crime better than flood lights that are left on all night.

Water heater measures

High-efficiency water heaters. When replacement time comes around, upgrade your tank water heater—whether gas-fired or electric-powered —to a high-efficiency model. Though high-efficiency models often cost a little more up-front, they'll save $400 per year in fuel expenses for a small establishment and substantially more in a large restaurant.

Tankless water heaters. High-efficiency tankless water heaters , also known as instantaneous or on-demand water heaters, heat water only when it's needed and can save significant amounts of money and take up less space than traditional models. Tankless water heaters also have very long lifetimes—20 years compared to traditional water heaters' 6 to 10 years. Their reduced maintenance and replacement costs go a long way toward offsetting the higher purchase price of a tankless heater, which can run from $1,000 to about $2,000, depending upon output capacity. Tankless water heaters do have one drawback: They provide hot water more slowly than conventional tank water heaters. This can slow the performance of equipment that are flow-dependent. This disadvantage can be overcome by plumbing multiple tankless units in parallel to provide the desired flow rate. In other applications, the lower flow rates available from tankless heaters are often adequate for the job.

Dishwashing measures

Water-efficient dishwashers. High-efficiency dishwashers are distinguished by their low water consumption per rack for conveyer or door-type dishwashers (this may not apply to under-counter units). Purchasing or renting a dishwasher that's certified by NSF to have a water consumption rating of less than 1 gallon per rack (this rating is available on the NSF web site) reduces the amount of water heating necessary. Low-temperature dishwashers use less energy than high-temperature units, but operating costs are about the same because of the cost of the sanitization chemicals required for low-temperature units. If you choose a high-temperature dishwasher, consider installing a gas booster heater instead of an electric one—depending on local energy prices, energy cost savings often more than make up for increased capital and installation cost.

Low-flow pre-rinse spray valves. Water heating in commercial kitchens accounts for nearly 10 percent of restaurants' total energy use. Installing low-flow sprayers is the easiest and most cost-effective method of saving hot water in a commercial kitchen; it can reduce the amount of hot water required to wash dishes by 50 percent or more without compromising cleanliness or slowing down the dishwashing process. Low-flow spray valves, which discharge hot water at a rate no greater than 1.6 gallons per minute (gpm) at a water pressure of 60 pounds per square inch, are used to remove food scraps from utensils, pots, dishes, and pans before placing them in a dishwasher. Since January 1, 2006, all new prerinse valves sold have been low-flow, as required by the U.S. Energy Policy Act of 2005 (EPAct 2005). However, for facilities using older spray valves that are less efficient—with typical flow rates of 4 to 6 gpm—considerable savings are possible from switching to low-flow spray valves. According to the FSTC, substituting a low-flow spray valve for a valve flowing at 3 gpm for 2 hours per day will save over 43,000 gallons of water and $600 to $700 annually. The FSTC offers a free online tool that can help calculate cost savings from installing a low-flow valve on its web site .

Ventilation measures

Optimize makeup air. Kitchen ventilation systems represent one of the largest uses of energy in a commercial food service facility, accounting for up to 75 percent of the HVAC load. A new design guide, available on the FSTC web site , “Improving Commercial Kitchen Ventilation System Performance: Optimizing Makeup Air,” presents strategies for minimizing the impact that the introduction of makeup air will have on hood performance and energy consumption. A commercial kitchen ventilation system that is designed using the guide is not only likely to improve safety and comfort, it will also save a good deal of energy. One case study conducted in a typical restaurant found that applying the design guide’s recommendations reduced makeup air supply by 2,000 cubic feet per minute and annual commercial kitchen ventilation system energy cost (including makeup air fan energy, conditioning, and exhaust) by $4,000.
