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Commercial Kitchens
Cooking Up Green Opportunities

by Brent Ehrlich

FIFTEEN YEARS AGO I MANAGED the kitchen of a busy lodge high in the Colorado Rockies, where we prepared more than 500 restaurant meals a day on aging equipment.

At 6:00 every morning, the first one into the kitchen flipped on all the lights and ventilation hoods, then turned on most of the ovens, stoves, griddles, broilers, dishwashers, and other equipment—which often sat unused for hours while the vent hoods worked needlessly to exhaust conditioned air from the kitchen and restaurant. Every Monday, stock was left to simmer overnight with one vent hood running full-blast. And when walk-in refrigerator space was limited, frozen foods, such as shrimp, were placed under open faucets to thaw, cold water trickling over the food and down the drain. Great food, enormous waste: similar scenes play out every day in restaurants across North America.

According to the Pacific Gas & Electric (PG&E) Food Service Technology Center (FSTC), commercial food service equipment consumes over $10 billion of energy per year in the U.S., with as much as 80% of that energy wasted—transformed into heat and noise by inefficient equipment. Considering that most kitchens run energy-intensive equipment for over fourteen hours a day, it's not surprising that these spaces have about 2.5 times the energy intensity of other types of commercial building space—around 250,000 Btu/ft^2, according to the Consortium for Energy Efficiency (CEE). The challenges of reining in this waste are enormous, yet attainable.

Photo: Food Service Design Group/San Diego Restaurant Supply

Commercial kitchens must balance energy and water efficiency with functional design. This kitchen was customized to fit the needs of a luxury hotel in downtown San Diego.

This article provides an overview of the equipment and other factors that affect energy and water use in commercial kitchens. I've left out some large categories, such as lighting, that are common to all buildings, while recognizing that these are also essential to saving energy in the commercial kitchen.

Background

The food service industry has lagged behind many others where energy and water efficiency are concerned. Old,

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Quote of the month:

"This approach pretty much confirms that passive solar is the Rodney Dangerfield of energy solutions."

– Stephen Thwaites, Thermotech Fiberglass Fenestration
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From the Editors

BuildingGreen: Independent Again

BuildingGreen and Taunton Press have mutually agreed to unwind the equity partnership that was set up two years ago (see *EBN* Mar. 2008). The companies had come together primarily to create the home building website *GreenBuildingAdvisor.com*. The weak economy and struggling building industry forced the companies to reexamine the business model and the partnership.

Taunton Press, which is based in Connecticut, will become the sole owner of *GreenBuildingAdvisor.com*, and BuildingGreen, based in Vermont, will retain ownership of all other publications and websites, including *Environmental Building News*, the *GreenSpec Directory*, *BuildingGreen.com*, and *LEEDuser*. BuildingGreen will once again be owned solely by its original owners (primarily Alex Wilson, Jerelyn Wilson, and Nadav Malin). The two companies will maintain a strong working relationship and continue to collaborate on *GreenBuildingAdvisor.com*.

mail@BuildingGreen

Ontario Feed-in Tariff Deserves Attention

I really appreciate the quality of your articles and generally read them cover to cover. I also appreciate your inclusion of items with Canadian information and news. However, in your recent feature article, "Making Your Own Electricity" (see *EBN* Nov. 2009), I was very surprised and disappointed that you made no mention of Ontario's recently enacted Green Energy Act, which includes a very progressive feed-in tariff (FIT) for renewable energy sources. I believe that it is the most progressive in North America, offers comparable rates to those in Germany, and is likely to have a very significant effect on the economic viability of renewables in the Province.

Charles Simon
Charles Simon Architect + Planner
Eden Mills, Ontario

Editors' Response:

Thanks for pointing that out. Ontario's feed-in tariff is indeed a standout in North America—and the world. Enacted in October 2009, the program offers options for small-scale renewable energy installations (less than 10 kW) under its "MicroFIT" program, with a separate "FIT" program for larger-scale projects. The tariff applies not only to photovoltaic (PV) panels but also to biogas, biomass, landfill gas, hydropower, and wind. Participants in the FIT and MicroFIT programs enter into a 20-year contract (40 years in the case of hydropower) to receive a fixed rate for the power they generate—up to $0.80 (CDN)/kWh for solar, with rates in the $0.10–$0.19/kWh range for other sources. Considering Ontario's commitment to closing all its coal-fired power plants by 2014, the province is surely banking heavily on these generous rates to bring about a permanent shift away from carbon-intensive electric generation. Germany's rates, among the world's highest, have been falling, as planned, by about 8% annually. The U.S., on the other hand,

is now playing catch-up. A handful of states have proposed programs, but only three are in place: California pays a non-incentivized rate for installations of 1.5 MW or less, capped at 500 MW; Hawaii's program is so new that rates have not yet been set; Vermont's FIT was capped at 50 MW with only 12.5 MW allocated for PV—all of which were spoken for on the program's inaugural day.

What's Happening

Industry Agrees to Phase Out DecaBDE Flame Retardant

Following negotiations with the U.S. Environmental Protection Agency (EPA), the two U.S. producers and primary exporter to the U.S. of decabromodiphenyl ether (decaBDE) agreed in December 2009 to a three-year phaseout of the chemical.

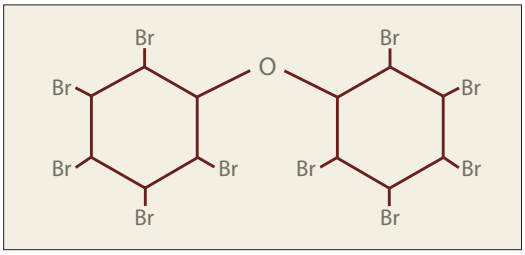
DecaBDE is a brominated flame retardant that, along with other polybrominated diphenyl ethers (PBDEs), has long been targeted by environmental and health advocates (see "Flame Retardants Under Fire" in *EBN* June 2004).

Two chemicals in the PBDE family, the penta- and octa- forms, were eliminated earlier in the decade, but decaBDE has remained in widespread use, especially in hard (durable) plastics for consumer electronics and office equipment, upholstery textiles, drapery backings, and plastic pallets. Annual North American consumption was about 50 million pounds (23 million kg) in 2001, according to industry sources, though usage has dropped as much as 50% since then.

"Though decaBDE has been used as a flame retardant for years," said Steve Owens, the EPA assistant administrator for the Office of Prevention, Pesticides and Toxic Substances, "the U.S. Environmental Protection Agency has long been concerned about its impact on human health and the environment." There is further concern that decaBDE can degrade into the more hazardous forms pentaBDE and octaBDE.

The phaseout was announced on December 17, 2009, by EPA, along with the Louisiana company Albemarle, the Connecticut company Chemtura (previously Great Lakes Chemical Company), and the Israeli company ICL Industrial Products and its subsidiary Dead Sea Bromine Company. According to Dave Clary, vice president and chief sustainability officer for Albemarle, the manufacturers came to EPA proposing the voluntary phaseout. "It was an industry initiative," he said. While Albemarle and the other manufacturers continue to argue that decaBDE (also called "decabrom") is safe, "we decided to spend our efforts in more positive ways developing new products, rather than spend them defending decabrom," Clary told *EBN*.

Both Albemarle and ICL will phase out decaBDE sales for most electrical and electronic equipment by December 31, 2010, and for all uses (except some transportation and military applications) by the end of 2012, with the latter uses being eliminated by the end of 2013. Chemtura (which is currently in Chapter 11 reorganization) has pledged to eliminate all uses except certain transportation and military applications by the end of 2012 but does not refer to a 2010 date. All three companies retained the right to sell remaining inventory for six months after the December 2012 phaseout date, while promising not to stockpile the chemical prior to the phaseout date.



Decabromodiphenyl ether consists of two carbon rings, an oxygen atom, and ten bromine atoms.

"This agreement is great news for our health," said Arlene Blum, Ph.D., a visiting scholar in chemistry at the University of California, Berkeley and executive director of the Green Science Policy Institute. She cautioned, though, that the agreement does not ensure that flame retardant producers will move to safer products. One of the substitutes being considered is decabrominated diphenylethane (DBDPE), but according to Blum, DBDPE "is similar in structure and may be even more persistent and bioaccumulative."

When problems arose in the past with brominated flame retardants, such as with polybrominated biphenyl ethers in the 1970s, the industry switched to slightly different chemical formulations. Environmental and health advocates say it's time to change that approach. "The chemical producers should stop moving from one toxic flame retardant to the next and develop new green products that are not based on bromine or chlorine," argues Blum.

The same day the voluntary industry phaseout of decaBDE was announced, U.S. Representative Chellie Pingree of Maine introduced federal legislation to ban products containing the chemical. The Deca-bromine Elimination and Control Act (H.R. 4394) would phase out the chemical by 2013. "I am encouraged by the eleventh-hour agreement," said Pingree in a press release (referring to the decaBDE phaseout), "and if it is followed, it will achieve my primary goal with this legislation—getting deca out of the environment." Pingree has vowed to push ahead with her legislation, how-

ever. "The chemical industry hasn't always lived up to voluntary agreements," she said. "This bill will make sure that they do."

Maine House Speaker Hannah Pingree (Rep. Pingree's daughter) sponsored successful legislation in 2006 to ban decaBDE in the state of Maine, making that state the first to ban the chemical. Washington state also bans the use of decaBDE, and several other states have been moving toward such restrictions.

In a move toward decaBDE alternatives, Albemarle Corporation announced in early December 2009 a new, more environmentally friendly flame retardant, GreenArmor, that will be available in the second half of 2010 for a wide range of applications. This will be the first chemical to be rolled out through the company's "Earthwise" brand. According to Clary, GreenArmor is a brominated flame retardant, but it is a *polymeric* compound based on a polystyrene that the company makes. "Because it's a polymer, it can't be absorbed by living organisms," Clary told *EBN*. "It's just too big." Green Armor's flame-retardant properties are also retained more effectively when a product it is used in is recycled than is the common non-brominated flame retardant resorcinol diphenyl phosphate (RDP), according to Albemarle. *EBN* has not verified the claim that the brominated chemical in GreenArmor is indeed safe or that it won't degrade into smaller compounds that might be hazardous. We were disappointed that Albemarle's replacement flame retardant is not halogen-free.

–Alex Wilson

For more information:

U.S. Environmental Protection Agency
Office of Pollution Prevention and Toxics
www.epa.gov/oppt

Albemarle Corporation
Baton Rouge, Louisiana
225-388-8011
www.albemarle.com

New Tax Credit Limits Window Choices

The good news is that there's a new 30% tax credit for residential window replacements (part of the American Recovery and Reinvestment Act of 2009). The bad news is that along with establishing a maximum U-factor of 0.30, it also sets a maximum solar heat gain coefficient (SHGC) of 0.30. The SHGC requirement fails to recognize the benefits of windows for passive solar heating. *EBN* sought to uncover how these criteria came about and understand the implications.

The Energy Policy Act of 2005 (EPAct 2005) offered a $200 tax credit for window replacement. The performance requirements for that tax credit (that windows meet standard energy codes) were widely panned for being too lax, with nearly all windows meeting the requirement. Well over half of the taxpayer money spent on the EPAct 2005 tax credits went toward window replacements—even with the $200 limit. Given the popularity of the window replacement tax credit under EPAct, policymakers were concerned about its cost under the Recovery Act—because the cap for the tax credit was raised from $200 to $1,500.

There was thus an effort with the Recovery Act to make the criteria tougher. According to Lowell Ungar, the director of policy at the Alliance to Save Energy (ASE), a Washington-based energy policy organization, this task fell to the Joint Committee on Taxation, a quasi-independent committee of Congress that oversees the costs of legislation. "They wanted to set more stringent criteria so that only the best windows would qualify," Ungar told *EBN*.

It remains unclear exactly where the specific U-factor and SHGC recommendations originated, but various experts who spoke with *EBN* suggested that the recommendations came from policymakers rather than energy experts. "It was beyond their expertise," said Ungar.

Many people involved with window energy performance, including Nils Petermann at ASE, who manages the Efficient Windows Collaborative, and John Carmody at the University of Minnesota's Center for Sustainable Building Research, are unhappy with the approach. "I don't think it's a good idea to have the same criteria for the whole country," Petermann told *EBN*. "It is probably flawed," agreed Carmody.

Stephen Thwaites of Thermotech Fiberglass Fenestration in Ottawa is a little less reserved in his observations: "This approach pretty much confirms that passive solar is the Rodney Dangerfield of energy solutions. After the indignity of the Energy Star program saying that any SHGC is okay for the north for years and years, this tax credit scheme just put salt in the wounds of the low-energy housing community."

Of concern is the fact that windows not only reduce energy costs by blocking heat loss but also by allowing beneficial solar heat gain. This is important on south-facing walls, particularly in northern climates. To function well for passive solar heating, windows should have a high SHGC—over 0.50, if not higher. Even in warmer climates, where the goal is to reduce unwanted solar heat gain, it can still make sense to provide for significant solar gain on the south side of a building. This can be achieved by "tuning" glazings by orientation—installing high-SHGC windows on the south and low-SHGC windows on the east and west, where unwanted solar heat gain is the biggest problem.

–Alex Wilson

For more information:

Alliance to Save Energy
Washington, D.C.
202-857-0666
www.ase.org

Seattle Bends Rules for "Living Buildings"

A new ordinance in Seattle will pilot-test exemptions for projects attempting to use innovative onsite water and energy strategies that currently run afoul of codes.

The ordinance will allow code exemptions for up to 12 buildings seeking certification through the Living Building Challenge (LBC). The exemptions will allow the buildings to meet LBC prerequisites that require techniques, such as onsite water treatment, that conflict with current land-use and building codes in Seattle (as well as in many other areas of the U.S.). City officials will use the review process to inform future code changes that could make the regulatory landscape friendlier to onsite water and energy strategies.

Buildings pursuing LBC certification are held to a stringent rule: all energy used in the building must be produced onsite, and all water must be collected and treated onsite (see *EBN* June 2009). When the design team for the Bullitt Foundation headquarters in Seattle decided to pursue LBC certification, it discovered that many of the requirements for the rating system conflicted with local codes. The team approached the Seattle Department of Planning and Development (DPD) to see what could be done, and the ensuing conversation provided the beginnings of the pilot project.

According to Brennon Staley, a land-use planner with DPD, Seattle has been working to green its codes for several years, focusing mostly on building, mechanical, and electrical codes. For projects pursuing LBC certification, however, the conflicts arose in the area of land use. Some of the green technologies being considered, Staley said, might be discouraged or prohibited by the regulations.

In order to gain the exemption, projects must earn LBC certification or meet the alternative standards set by the City—achieve 60% of the LBC prerequisites (12 of 20 prerequisites in the latest version of the system). In addition, total building energy and water use must be at least 25% below average for similar building types, and at least 50% of stormwater must be captured and used onsite.

To accommodate the code exemptions these buildings will require, says Staley, DPD will "expand the existing design review process to address conflicts in a manner that could balance sustainability and design issues." Design reviews for individual projects will be used to test potential changes to the land-use code.

Eden Brukman, vice president of the International Living Building Institute, says the ordinance is a huge step forward for LBC. "This could help eliminate some of the current regulatory barriers to achieving the Challenge, setting a precedent for alternative compliance paths," she said. "It could also result in twelve new Living Buildings in Seattle," she added.

– Allyson Wendt

For more information:

Seattle Department of Planning and Development
www.seattle.gov/dpd/

International Living Building Institute
www.ilbi.org

Photo: Joe Angeles, Washington University in St. Louis

Opened in May 2009, the Tyson Living Learning Center at Washington University in St. Louis aims to be the first project to be certified by the Living Building Challenge. Seattle's ordinance may clear some of the code hurdles for other buildings pursuing the "Living Building" designation.

Newsbriefs

California Adopts Nation's First Statewide Green Building Code—In a unanimous January 2010 decision, the California Building Standards Commission approved the Green Building Standards Code—a.k.a. "Calgreen"—the first mandatory statewide green construction code to be adopted in the U.S. Scheduled to take effect in January 2011, Calgreen will require all new buildings to reduce water consumption by 20%; divert 50% of construction waste from landfills; separately meter indoor and outdoor water use (nonresidential only); and submit to mandatory inspections of mechanical system equipment (nonresidential buildings over 10,000 ft^2, 930 m^2, only). According to the California Air Resources Board, these provisions should reduce California's greenhouse gas emissions by 3 million metric tons carbon-equivalent by 2020. Calgreen was developed from voluntary green building standards enacted across the state in 2008 (see *EBN* Sept. 2008), and it does

not preclude local jurisdictions from instituting stricter green building regulations, which more than 50 California municipalities already have in place.

Photo: Vanguard Homes

WaterSense certified homes must use WaterSense-labeled fixtures like those in the bathroom of this WaterSense pilot home near Chapel Hill, North Carolina.

Final WaterSense Specification for Homes Released—After a three-year development process that included several public comment periods and a pilot program, the U.S. Environmental Protection Agency (EPA) has released the final WaterSense specification for single-family homes. Homes that meet the specification should use 20% less water (about 10,000 gallons or 38,000 liters) than those built to code, saving homeowners an average of $200 a year, according to EPA. To be certified, homes must use WaterSense-labeled plumbing fixtures, Energy Star-certified appliances, water- and energy-efficient hot water systems, and water-efficient landscaping. An onsite inspection verifies a homebuilder's or owner's claims before certification is awarded. More information is available at www.epa.gov/watersense/.

Product News & Reviews

Mobile Photovoltaic Power Generators

Mobile photovoltaic (PV) generators consist of PV panels, charge controllers, lead-acid batteries, and inverters mounted on easy-to-tow trailers. They offer an environmentally responsible, silent alternative to the diesel or gasoline generators typically used for construction jobsites, lighting, or other off-grid power requirements.

Mobile PV generators use components similar to those found on stand-alone (non-grid-connected) PV systems, but are configured for the harsh demands placed on portable generators. The PV panels are designed to handle rough conditions on a jobsite and are mounted on a trailer to minimize travel damage. Mobile Solar Power (one of BuildingGreen's Top-10 Green Building Products for 2009—see *EBN* Dec. 2009), Mobile Green Power, and Energy Acumen make enclosed trailers that protect electronic components from the elements, while Pure Power Distribution and SolaRover opt for an open-trailer design.

Since solar access and intensity vary and construction equipment often draws a lot of power, mobile PV generators require batteries that are capable of being discharged repeatedly. Most common today are deep-cycle, lead-acid batteries, though if costs come down on other options, such as lithium-ion and nickel-zinc, we may see those as well. A charge controller monitors the batteries and adjusts the current to maximize charge and prolong the life of these batteries. "When the battery is at a low state of charge, the charge controllers we use will increase their charge voltage; this allows the battery to be charged more rapidly and efficiently," according to Travis Semmes, founder and president of Mobile Solar Power. His company uses either OutBack or Blue Sky Energy charge controllers to maintain its 24-volt lead-acid battery banks, which are capable of storing between 9.3 and 45 kWh (390 and 1880 amp-hours) of power at a 20-hour discharge rate, depending on the configuration.

The direct current (DC) generated by the PV panels and stored in the batteries has to be converted to 120V or 240V alternating current (AC) by an inverter before use. These inverters are rated for continuous power *and* surge power and, along with the PV array and batteries, should be sized appropriately for the job. "Construction sites tend to run large

MOBILE PV GENERATORS

Company	Number of Panels	Battery Storage Capacity	Trailer length	Cost
Mobile Solar Power	1–16 (175 or 210 W panels)	9.3–45.0 kWh (390–1880 amp-hours)	6'–20'	$9,350–$48,850
Mobile Green Power	8–16 (175 W)	22.6–45.0 kWh (941–1,568 amp-hours)	12'–20'	$52,900–$79,900
SolaRover	10–24 (210–240 W)	31–80 kWh	24'	$75,000–$132,000
Pure Power Distribution	8–36 (200 W)	24.5–367.2 kWh (510–2,550x3 amp-hours)	12'–48'	NA
Energy Acumen	3–16 (130 W)	10–76 kWh	8'–16'	$7,900–$29,000

Photo: Mobile Solar Power

Mobile Solar Power's PV generators keep all equipment except PV modules in a protected trailer.

loads for short periods of time," said Semmes, "so they may need larger inverter outputs but smaller battery sizes." Motors draw significant surge power at start-up but require much less continuous power while running. To size mobile PV generators appropriately, manufacturers can help perform the complicated load calculations necessary based on equipment power demands, power output from the solar array, amount of battery backup, and amount of inverter power required.

It is important to purchase inverters that create *pure sine wave* power—which is as good as, or better than, that obtained from utilities—rather than modified sine wave power that could interfere with sensitive electronics. Pure sine wave inverters from OutBack and Xantex are found on most manufacturers' mobile PV units, including those from Mobile Solar Power, Pure Power Distribution, and Energy Acumen. These inverters can also recharge the battery banks rapidly using power from another source, such as the grid or a diesel generator run for a short time, during high-demand use or prolonged periods without sun. Most mobile PV generator companies offer hybrid models that incorporate propane or diesel backup generators, and biodiesel options are available through Mobile Green Power, Energy Acumen, and Pure Power Distribution.

If sized appropriately, a mobile PV generator can serve as a cost-effective replacement for a fossil-fuel-fired model. Most mobile PV generators range from $10,000 to $100,000, though much larger custom models are available from SolaRover and Pure Power Distribution. Leasing options are available, but with few maintenance costs, no fuel expenses, and a possible 30% federal tax credit, these generators could be considered a bargain in the long run.

Tom Weinberg, superintendent for Frank Schipper Construction, has been using Mobile Solar Power's MS 225 as the primary power source on the 18-room Serenity House hospice project in Santa Barbara, California. Because the site is in a residential neighborhood, the PV generator's silence and lack of fumes are key assets. The PV generator is running job trailers, computers, lighting, heaters, skill saws, grinders, compressors, and hand tools for about 25 workers, mainly for site work. Once construction of the main building begins, "it would not be able to keep up with the full capacity of the job," he confided, "but on a small job like this, the generator will carry us through until power is installed." Weinberg calculates that the unit will pay for itself in about two years. "We are totally impressed with it. The only problem is people take more time looking at it than they do my building."

– Brent Ehrlich

For more information:

Energy Acumen
www.ohmstation.com

Mobile Green Power
www.mobilegreenpower.com

Mobile Solar Power
www.mobilesolarpower.net

Pure Power Distribution
www.purepowerd.com

SolaRover
www.solarover.com

Dow Styrofoam Cradle to Cradle Certified

In a surprising development, Dow Chemical's Styrofoam brand extruded polystyrene (XPS) insulation has been awarded Cradle to Cradle Silver certification by McDonough Braungart Design Chemistry (MBDC). When asked about the styrene chemistry and brominated flame retardant in XPS, Steve Bolton, the manager of business development at MBDC, explained that the Cradle to Cradle (C2C) product evaluation is the same for every product. "We look at everything from material health to recyclability," he told *EBN*, adding that the company also examines energy use at the manufacturing plant, water quality issues, and corporate social responsibility.

As for brominated flame retardants, Bolton said that these chemicals "are definitely a concern," but that at the lower certification levels (Basic and Silver) these compounds can be present, as long as there are plans to improve the products over time. (XPS contains the brominated flame retardant HBCD—see *EBN* Aug. 2009.) At the Gold level, red-listed chemicals, such as brominated flame retardants, are not permitted, according to Bolton.

"It is shocking that a product containing a persistent organic pollutant such as HBCD can be considered green," said *EBN* Advisory Board member Arlene Blum, Ph.D., about the certification. Her associate at the Green Science Policy Institute, Alex Madonik, Ph.D., is also surprised. "This certification in no way justifies the continued use of the brominated

flame retardant HBCD," he said. "Since there is no doubt that HBCD will be controlled (and eventually banned) under REACH [the European Union's Registration, Evaluation, Authorization, and Restriction of Chemicals], Dow should tell us what they are doing to replace it."

According to Bolton, when a client such as Dow engages MBDC, it commits to regular review and improvement. "We will check in at least once per year, if not more often, to make sure that the client is working on problems and making progress," he said. Bolton explained that the timeline for making an improvement, such as eliminating brominated flame retardants, depends on how challenging the problem is. *EBN* was not able to confirm with Dow or MBDC a specific timeline for eliminating HBCD from Styrofoam.

Concern about the Silver certification of Styrofoam XPS illustrates a widespread misconception about the C2C program. As explained in *EBN*'s article "Cradle to Cradle Certification: A Peek Inside MBDC's Black Box" (*EBN* Feb. 2007), at the Basic and Silver levels the C2C standard for chemical safety means only that a product is being carefully examined by MBDC and that the product's manufacturer knows what is in it and has committed to improving it. Designers expecting a C2C logo to provide assurance that a specific product is free of hazards may want to read the fine print. Red-listed chemicals, such as brominated flame retardants (though not PVC), may be present in products carrying those lower levels of certification, but not in products certified to Gold and Platinum levels. MBDC is aware of this confusion and has told *EBN* that they are trying to address it.

– Alex Wilson

For more information:

McDonough Braungart Design Chemistry
Charlottesville, Virginia
434-295-1111
www.mbdc.com

Commercial Kitchens *(from page 1)*

inefficient kitchen equipment was made to last for decades and is often kept as a matter of tradition, passed from chef to chef as restaurants change hands. New restaurant owners trying to save on start-up costs—particularly if they are renting the building space—may look for bargains in used kitchen equipment, weighing first costs against restaurant failure rates that approach 60% in the first three years of operation, according to a study by researchers at Ohio State University. And while chefs are often involved in equipment selection, they usually don't pay the bills, and so are unmotivated to save.

Focusing only on lower first costs can be a poor business decision, however, even considering the chances of failure. Large utility bills month after month cut into profits, while new energy-efficient equipment can often pay for itself in as little as a year. Faced with a future likely to include higher utility costs and a challenging business climate, commercial kitchen owners and renters alike are beginning to view energy and water efficiency as both an environmental and business necessity.

Into the Fire: Touring the Commercial Kitchen

To the uninitiated, a tour through a commercial kitchen during the dinner rush can be like walking into an inferno. Flames leap from broilers and stoves, deep fryers sizzle, and steam rises from dishwashers and steamers while ventilation hoods roar overhead. All the while, refrigeration and freezer units, includ-

Equipment Testing, Standards, and Specifications

Until the late 1980s, there was scant baseline data or standards available for commercial kitchen equipment, making it difficult for the industry to measure and improve efficiency. In 1987, with funding and input from the National Restaurant Association, gas and electric industry trade groups, and Pacific Gas & Electric, the Food Service Technology Center (FSTC) began developing standard testing methods for commercial kitchen equipment. Now funded by California utility ratepayers, FSTC has become an industry leader in commercial kitchen information and continues to develop standards out of its 9,000-square-foot (836 m^2) testing facility in San Ramon, California, generating performance data that are used by Energy Star, the Consortium for Energy Efficiency (CEE), manufacturers, and utility rebate programs throughout the U.S. and Canada.

Energy Star now provides information, standards, and updated product lists for eight commercial kitchen product categories—dishwashers, fryers, griddles, hot-food holding cabinets, ice machines, ovens, refrigerators and freezers, and steam cookers—and is the first place to look for energy-efficient cooking specifications. Energy Star also partners with CEE, a nonprofit comprised of representatives from Canadian and U.S. utilities, research organizations, as well as the U.S. Environmental Protection Agency (EPA) and Department of Energy (DOE), to promote the use of energy-efficient products, technologies, and services. CEE currently shares the same product category list as Energy Star but creates its own specifications, differentiating levels of performance using tiers 1, 2, and 3, with Energy Star specifications being tier 1, in most cases, and more rigorous specifications designated as tiers 2 and 3. PG&E, for example, uses CEE tier 3 specifications for its ice machine rebate program.

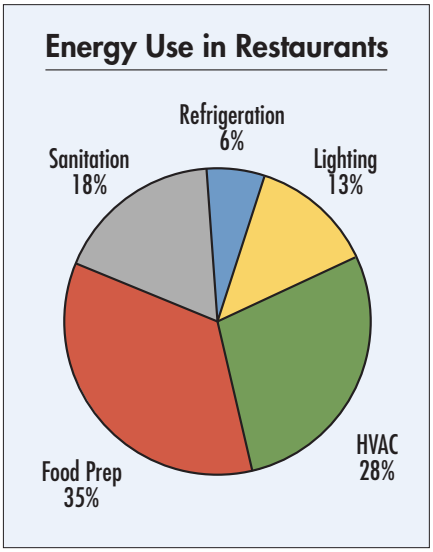
These rebate programs are among the main forces driving the purchase of energy- and water-efficient equipment. Run by organizations, states, or utilities across the U.S., rebate programs provide cash incentives for the purchase of energy-efficient equipment and typically include more product categories than either Energy Star or CEE. Performance data and specifications in these additional categories are usually based on testing performed by FSTC but not yet implemented by Energy Star or CEE. The rebates can be substantial but may differ from program to program. California's statewide incentive program has demonstrated annual energy savings of over 20 million kilowatt hours of electricity and 500,000 therms of natural gas.

ing walk-ins and reach-ins, battle against the heat, consuming additional energy as their compressors add even more heat to the cooling load. From an energy- and water-efficiency perspective it's a daunting scene, but a closer look at the equipment reveals huge opportunities to save energy and water at every turn—without negatively affecting food production.

Dishwashers

Commercial dishwashers (or "warewashers") come in a variety of sizes and configurations, depending on the size and needs of the kitchen. Energy Star specifications cover four categories: under-counter and stationary single-tank door models, and single- and multiple-tank conveyor models. These units are labeled high-temperature if they sanitize dishware using potable hot water (180°F/82°C) supplied by internal or external booster heaters, or low-temperature if they use lower temperature water (140°F/60°C) and disinfectant chemicals. The stationary models, which are appropriate for smaller kitchens, wash a single rack of dishes using a series of wash and rinse cycles (usually very quickly—sometimes in just a minute or two for lighter loads such as glassware). Conveyor models, used in larger kitchens, pull dish racks through a series of wash and rinse tanks on a continuous or intermittent basis. Separate machines are also available for sanitizing flatware.

Energy Star's specifications are based on how much energy a machine's tank heater uses when idle and how many gallons of water it uses per rack. There are separate standards for all four dishwasher types in both low- and high-temperature models. Models that use chemical sanitizers consume less energy but considerably more water, and prospective buyers should also consider the cost and potential negative environmental impacts of using chlorine-based sanitizers.



Source: Food Service Technology Center

Problem: Commercial dishwashers are one of the biggest energy and water consumers in the kitchen. Much of the energy is used to heat the water, particularly in high-temperature models that use booster heaters.

Solutions: Soak heavily soiled items to maximize cleaning. Fill every rack completely before running the machine. Turn off the machine at night or when idle for extended periods of time. Use infrared burners and heat exchangers to boost efficiency. Choose advanced units like Hobart's ventless model (www.hobartcorp.com), which recovers heat by condensing the steam from its operation. Using an Energy Star-qualified dishwasher in place of a standard model can save a business 90 million Btu of energy and 52,000 gallons (197,000 l) of water annually. In the future we'd like to see models with improved insulation, more efficient burner technology, and water-conserving spray heads.

Ovens

From small microwaves to conveyor-driven models, the oven is one of the most heavily used pieces of equipment in a kitchen. The most common ovens in use today are convection models that use fans to circulate air and cook foods faster, more evenly, and at a lower temperature than conventional ovens. These are efficient because they can be fully loaded without compromising performance. Combination models incorporate a convection oven with steam or microwave capabilities.

Models using steam are common and have tight seals that can improve convection performance, but in combination mode they can use twice the energy and 40 gallons (151 l) of water per hour if not used wisely. Rack ovens employ movable racks that are rolled into tall ovens capable of cooking up to 40 sheet trays of food at once. Some of these units incorporate a steam feature for baked goods. Energy Star has standards only for gas and electric convection ovens, but some rebate programs specify equipment efficiencies for other, non-Energy Star products based on FSTC data.

Problems: Traditional ovens take a long time to warm up and are not very efficient at heating food.

Solutions: Create a schedule for turning on appliances to reduce standby energy loss. Fill ovens to capacity whenever possible. Though not new, energy-efficient ovens that incorporate microwave or infrared technology can speed cooking times and increasingly fill specialized niches. TurboChef's oven technology (www.turbochef.com) combines microwaves, forced air, sophisticated controls, and catalytic converters to cook foods quickly and efficiently using conventional metal cookware. FlashBake oven technology, manufactured by Vulcan (www.vulcanhart.com), uses visible and infrared light to cook foods at speeds similar to microwave ovens. Though not direct replacements for convection ovens, these technologies consume no standby energy and may not require additional ventilation. Use of an Energy Star-qualified oven can result in annual savings of 30 million Btu (gas) or 1,870 kWh (electric). Developments that should

Photo: Mark File

Quieter hood fans, the result of lower exhaust rates, along with tempered make-up air, create a more comfortable working environment for the cooks at Print Works Bistro.

be encouraged include insulation, better seals, improved controls, and heat recovery.

Fryers

Fryers are simple machines that get a lot of use and are little more than a container that holds vegetable oil heated by gas flames or a submerged electric element. Advancements in efficiency, driven mainly by fast-food chains (or quick-service restaurants), have made fryers among the greenest commercial appliances, with some electric models boasting efficiencies greater than 87%. Unfortunately, inexpensive, inefficient fryers still dominate the market, with Energy Star models comprising only 7% of nationwide sales, according to Don Fisher, president of FSTC. Chain restaurants adopting efficiency measures have helped spearhead innovations that save energy and oil, which needs to be filtered regularly. Energy-efficient fryers heat quickly, which also speeds production.

Problems: Heat transfer from source to oil can be inefficient, insulation is often poor, and cumbersome filtering can result in wasted oil.

Solutions: For electric models, advanced controls and heat elements regulate heat for greater efficiency, especially during start-up, and improve heat transfer. For gas models, infrared burners and recirculating heat-exchange tubes boost performance and lessen waste heat going into the kitchen or up the vents. Low-oil-volume (LOV) models heat quickly and often combine automated filtration and integrated oil reserves to save significant amounts of oil and energy. Use of an Energy Star-qualified fryer can result in estimated annual savings of 50 million Btu (gas) or 1,100 kWh (electric). We would like to see fryers with better insulation, induction technology, improved heat transfer, and reduced oil use.

Refrigerators and freezers

Refrigerators and freezers are used for chilling everything from produce to beverages and include reach-ins, under-counter models, pass-through units that can be accessed from both sides, and roll-in and roll-through units large enough for roller-mounted racks. Energy Star certifies energy-efficient solid-door and glass-door refrigerators and freezers under its most recent v2.0 standard.

Problems: Refrigerators and freezers often have inefficient compressors, leaky gaskets, and minimal insulation. Defrosters in freezers and anti-sweat heaters that keep condensation off the glass in glass-door models add heat into the units, as do conventional light bulbs.

Solutions: Use efficient fans and compressors with electronically commutated motors (ECMs) when possible. Use LED lighting that generates less heat. Instead of electric strip heaters to control frost and sweating, use alternate methods such as on-demand defrost or "hot-gas defrost" that uses waste heat from the compressor. Maintain the units by replacing gaskets, cleaning the evaporator and compressor coils, and recharging refrigerant. Purchase units with as much insulation as possible. In the future, look for hydrocarbon refrigerants that minimize ozone depletion and global warming potential (GWP), vacuum insulation, and improved compressor technology, such as scroll compressors. Energy Star estimates as much as 35% energy savings and a 1.3-year payback for use of current certified models.

Walk-in refrigerators and freezers

Walk-in refrigerators and freezers are large enough to walk into; they store much of a kitchen's food and operate all day long, every day. They are built using foam-core panels, typically with either stainless steel or aluminum skins, and can be assembled at the factory or built on-site. Compressors can be self-contained as part of the unit or installed remotely.

Walk-ins can be constructed to almost any size, but recent DOE regulations (there is no Energy Star standard yet) cover units smaller than 3,000 square feet (279 m^2) and require minimum R-values for walls, ceilings, and doors of R-25 for refrigerators and R-32 for freezers. Walk-in refrigerator floors are usually uninsulated concrete, but freezer floors

require a minimum R-28 insulation. To control air infiltration, doors require strip curtains, automatic closures, or air curtains, but most use a self-closing mechanism. In December 2009, the Air-Conditioning, Heating and Refrigeration Institute (AHRI) published its Performance Rating of Walk-in Coolers and Freezers, opening the way for product specifications.

Problems: Because they operate constantly, small inefficiencies add up. Low insulation levels, leaky seals around the doors, dirty or leaking compressor coils, lighting that generates heat inside the units, and inefficient defrost cycles all waste energy.

Solutions: Use thicker panels for walk-in walls, though this intrudes on precious kitchen space. Insulate floors and ceilings well. Maintain the units through gasket replacement, cleaning evaporator and compressor coils, and recharging refrigerant. Provide shade to remote compressors. Use ECM motors or equivalent. Other energy-saving features include demand and reverse-cycle defrost, LED lighting, door alarms that sound when open, and scroll compressors, which can be 20% more efficient. Digital controls such as CoolTrol can significantly improve performance by incorporating energy-saving technologies, including use of outside air in cold climates. Economizers, such as those made by EWC Controls (www.ewccontrols.com), can be used on their own to bring in cold outside air to aid in chilling. When possible, insulate the concrete slab.

Ice machines

Ice machines use compressors and evaporators to freeze water into cubes of flakes that are then harvested and stored. Ice machines are available with compressors that are either air- or water-cooled. Though some water is wasted using both methods (i.e., to wash off ice to create clear cubes), Energy Star certifies only air-cooled models using 25 gallons (95 l) of water or less per 100 pounds (45 kg) of ice. (Water-cooled models can consume as much as ten times this amount.) Compressors, ice-making heads, and storage units can be integrated or supplied as separate units. Energy Star does not currently certify flake and nugget models.

Problems: Aging, inefficient compressors and dirty fans and coils limit performance. Ice machines are often placed in areas that limit ventilation and cooling to the compressor. Heat from the compressor can add to the cooling load inside the building.

Solutions: Allow adequate ventilation around the compressor, since higher air temperature forces the compressor to work harder. Clean compressor coils and fans regularly and maintain compressor fluid levels. Use timers to create ice during off-peak hours. Replace water-cooled ice machines with efficient air-cooled models. Use of an Energy Star-qualified ice machine can result in annual savings of 1200 kWh and 2,500 gallons (9,500 l) of water, with significantly greater water savings if used in place of a water-cooled unit. In the future we'd like to see improved insulation and use of next-generation refrigerants to reduce GWP and ozone depletion.

Steam cookers

Steam cookers (steamers) inject steam—which contains six times the energy of boiling water—into sealed cabinets that typically contain three to six racks. Conventional steamers use boilers as a steam source, and steam that doesn't condense on the food flows down the drain as wastewater—wasting more cold water to cool the condensed steam. These units can also require expensive maintenance to flush the system. Connectionless models use a pan as a water source and generate their own steam. Any steam not used for cooking condenses back into the pan. Available as countertop, wall-mounted, and floor models, they can include convection fans to improve circulation. Energy Star models must achieve 50% efficiency for electric models and 38% for gas.

Problems: Conventional boiler-based steamers can consume 40 gallons (151 l) of water an hour.

Solutions: Use Energy Star-qualified connectionless steamers. When possible, make sure steamers are fully loaded before running in order to maximize efficiency. Maintain seals. Using an Energy Star-qualified connectionless steamer can save approximately 33 million Btu (gas)/4930 kWh (electric) and 135,000 gallons (511,000 l) of water annually—a 90% savings.

In the future, we'd like to see improved insulation, better use of vacuum technology to lower operating temperature, and use of advanced controls.

Photo: Martin Air Systems

Martin Air's exhaust system uses a heat exchanger to capture waste heat from the kitchen, which can then be used to preheat make-up air or water.

Photo: Webb Design

Balancing aesthetics and energy savings can be difficult in cafeteria lines and display kitchens where cooking becomes part of the dining experience.

Griddles

Griddles are one of the most common pieces of kitchen equipment, used throughout the day to cook everything from eggs to hamburgers to seafood. They are available in gas or electric models and use a variety of cooking surfaces—standard one-sided models and double-sided, or clam shell, griddles, which are typically used to cook hamburgers in fast food restaurants. Energy Star only specifies thermostatically controlled griddles.

Problems: Manual thermostats allow the griddle to run on full whether cooking or not.

Solutions: Purchase Energy Star-qualified models and maintain a schedule for turning off the griddle. Use an induction griddle; South Korean distributor DIPO (www.dipoinductionusa.com) now offers a commercial model. An Energy Star-qualified griddle can result in annual savings of 2,270 kWh (electric) or 15 million Btu (gas).

Hot food holding cabinets

Hot food holding cabinets are essentially metal boxes with racks that use heating elements to keep food warm. They are made using a corrugated metal construction for additional strength, but that can compromise insulation.

Problems: Hot food holding cabinets may not be insulated, may be opened and closed frequently, and are often left on all day—and sometimes accidentally all night.

Solution: Add insulation and turn them off when not in use. Purchase models with automatic door closers and magnetic door seals.

Broilers

Broilers are available in overfired models used to melt cheese and finish dishes and underfired models that are similar to gas barbeque grills. These are the rock stars of the kitchen. They create flames and smoke—as well as some of the most aesthetically pleasing, best-tasting food—and are often the centerpiece of "exhibition" kitchens. Overfired models often use infrared burners. There are no Energy Star ratings for broilers.

Problems: Like many rock stars, these units have a dark side. Broilers are inefficient, have no thermostats, and are usually left on all day. A three-foot (91 cm) model can consume 126,000 Btu per hour, according to FSTC, with first-year energy costs exceeding the cost of the broiler. The exhaust from a broiler is filled with smoke, grease, VOCs, and other toxic compounds, and the kitchen's hood and ventilation system have to be larger in order to deal with the emissions, which adds to the energy consumption of the entire restaurant. The smoke from broilers is increasingly viewed as a health threat, and California's Bay Area Air Quality Management District now regulates emissions from underfired broilers for restaurants cooking more than 1,000 pounds (454 kg) of beef per week.

Solutions: Cut down on standby energy waste and preheat the broiler only before use. Whenever possible, use a griddle, which is more energy-efficient and won't heat up the kitchen as much. A more drastic option is to change cooking habits and eliminate the broiler altogether. Some Burger King franchises are using flexible batch broilers that cook multiple burgers at a time in an enclosed space rather than using an inefficient conveyer broiler.

Commercial Kitchen Ventilation

Commercial kitchen ventilation (CKV) is the most complicated system in the entire kitchen and deserves a more extensive review. CKV consumes energy in two ways: directly in powering the exhaust fans and indirectly through the removal of conditioned air. These systems require a balance between the air exhausted and the amount that replaces it (make-up air), and there are many factors that can affect that balance.

Available in freestanding island hoods, wall-mounted canopy hoods, and proximity hoods, CKV systems are customized to meet the needs of individual kitchens and are typically made up of stainless-steel hoods, ductwork, rooftop-mounted fans and controls, dampeners to control fire risk, and grease removal filters. Demand control ventilation systems

use sensors to monitor heat and smoke from the equipment, varying the hood fan speed based on cooking conditions. This reduces the amount of conditioned air removed unnecessarily from the building and makes for a quieter working environment. Most major hood manufacturers now offer these systems, either their own or they incorporate Melink's IntelliHood (www.melinkcorp.com). CKV systems may also offer additional grease removal in the form of UV or water-spray systems.

Restaurant CKV systems can run 24 hours a day, exhausting air at rates up to 12,000 cubic feet per minute (institutional kitchen rates can be as high as 50,000 cfm). All that air has to be replaced by make-up air that usually comes from the conditioned building space. Light-, medium-, and heavy-duty units are specified based on the equipment used under the hood—a broiler typically requires a heavy-duty system. Companies that design hoods may or may not provide exhaust fans, but they usually have consultants who work with the HVAC engineers.

"Designing commercial kitchen ventilation is orders of magnitude more complicated than static plans and specified CFMs," asserts Fisher, a leading authority on CKV. Problems arise with ventilation because of a lack of communication between the food-service consultant and the mechanical systems designer. He suggests finding a local rep and working with the hood supplier and mechanical engineer. When looking for a hood, UL- and ASTM-tested units can provide 30% greater efficiency over untested models, but there is still a wide range in performance. According to Fisher, all of the models FSTC has tested perform well, but there are some steps restaurant owners can take to maximize performance and improve energy efficiency (see sidebar at right).

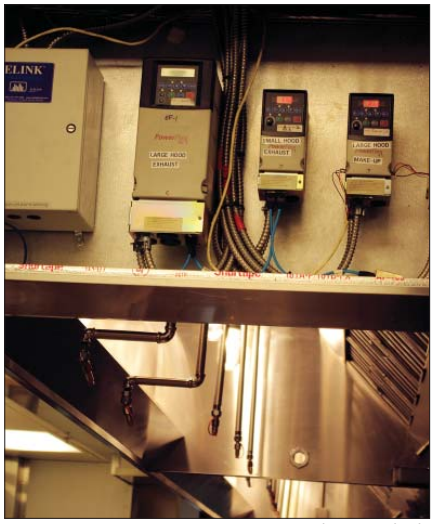


Photo: Mark File

Print Works Bistro's Melink demand control ventilation system lowers the exhaust rate to 40% until it senses heat and smoke from the equipment.

Innovative Technologies

Though energy- and water-saving equipment is becoming more common in commercial kitchens, there are other technologies, both old and new, that can be used to capture waste heat—and to limit the creation of excess heat in the first place.

Reclaiming heat

Capturing the heat from CKV seems like common sense, and the technology has been around for years, but major manufacturers no longer sell systems, mainly because of one big problem: grease.

Grease in cooking effluent accumulates on hoods, ducts, fans, and even building roofs, and it poses a serious fire hazard. Heat exchangers provide an ideal spot for this grease to accumulate. The typical method for removing the grease from these systems is through an automatic washdown system, but these can be expensive to buy and maintain, and they consume a lot of water. Despite these challenges, heat-exchange technology is poised for a comeback. Innovent (www.innoventair.com) is selling a flat-plate heat exchanger for CKV that includes automatic washdown. The company does not recommend the unit for use with broilers or other heavy-duty equipment, but it could be cost-effective in an institutional setting or school cafeteria.

Martin Air Systems (www.martinairsystems.com) takes heat recovery a step further. The company manufactures a pre-packaged exhaust and make-up air unit that incorporates demand control ventilation as well as an energy-recovery system comprised of a flat-plate heat exchanger and a closed glycol loop. "We put it all in one box," said Jeff Martin, president and founder. "The glycol loop runs through both the exhaust and make-up air ducts, so the waste heat can be used to pre-heat make-up air." A sensor in the make-up air duct determines whether pre-heating is required. If not, the heat can be routed for other uses. "We chose the closed glycol loop because it also offers the opportunity to pre-heat domestic water," he explained.

The system addresses the grease problem by forcing the exhaust air at high speeds through a 90° bend, which "impinges" much of the grease out of the exhaust, where it drains away for collection. Martin claims that the system does not increase static pressure yet removes

Maximizing CKV Performance

- Use custom-designed *proximity hoods*, which exhaust less air, instead of larger hoods.
- In wall-mounted canopy units, maximize overhang to 54–60 inches (137–152 cm) rather than 48 inches (122 cm), and lower the hoods when possible.
- Use end panels or partial end panels to minimize cross breezes.
- Locate heavy-duty equipment in the middle rather than at the end of the cook line. This can cut the ventilation rate in half (though it may present kitchen workflow challenges).
- Minimize make-up air speed and avoid four-way HVAC diffusers near the hood to reduce the turbulence inside the hood.
- Equipment may be moved during cleaning; if so, make sure it is moved back against the wall.

Photo: Mike O'Brien

David Yudkin installed a heat exchanger on top of his convection oven to heat water for his HotLips Pizza restaurant in Portland, Oregon.

enough grease that it needs to be cleaned only as part of regular CKV maintenance. The system can pay for itself through energy savings in less than a year, according to Martin.

The recovery of waste heat has also been approached on a more "grass roots" level. David Yudkin of HotLips Pizza in Portland, Oregon, installed a heat economizer (basically a heat exchanger) from a boiler on top of his first restaurant's forced-air convection oven. The system raises the water temperature by 100ºF (56ºC) and now produces more than enough hot water to meet his restaurant's needs. On his newer restaurants he has created heat exchangers out of copper tubing resting atop his pizza ovens.

Minimizing heat production

Reducing the amount of heat produced at the source should be a priority as well. Induction cooking, which uses electromagnetic fields to heat iron-based cooking pots or surfaces at efficiencies of up to 90%, offers that possibility. With induction cooking, the surface of the burner does not get hot, and no power is drawn when a pan is removed from the surface.

Induction cooking is being used extensively in Europe and Asia in commercial applications, but in the U.S. its use has been limited to small, single-burner models used primarily for buffets. South Korean manufacturer DIPO is now distributing products in the U.S., including griddles that have an added cooking surface, stock pot ranges, and burners capable of handling back-of-the-house production demands. They also have fryers already in use in Asia. CookTek (www.cooktek.com) also sells a stock pot range and is planning to introduce a six-burner range in the first quarter of 2010 and a four-burner model shortly thereafter. Induction cooking offers precise temperature control and a flat surface that is easy to clean. There are no combustion gases to exhaust, so ventilation demands can be reduced.

Eneron's (www.eneron.us) Turbo line of pots and pans for gas ranges uses a series of fins across the bottom of the pan that act as a heat sink. The fins transfer significantly more heat to the cooking surface. FSTC testing shows a 50% improvement in efficiency over conventional cookware, which means flames can be lowered to achieve the same results. The company makes saucepans, sauce pots, and both aluminum and stainless steel stock pots.

Reduce, Reuse, and Recycle

Kitchen waste in the form of food, oil, cardboard, and plastic takes up valuable space and creates an ideal habitat for insects and rodents. Cardboard, glass, and plastics can be managed through the use of compactors and local recycling centers, and oil can be collected for processing into biodiesel. Food waste presents more of a challenge. At the dishwasher, a garbage disposal (or grinder) grinds food waste and sends it down the drain, using up to 8 gallons (30 l) of water per minute and introducing organic material into the wastewater. Instead of a disposal, use a scraper and strainer and compost when possible, and use pulpers in larger kitchens. Pulpers chop food waste and press it to extract water. The water is sent down the drain (with far less organic matter than with a disposal), and the solids are disposed of as solid waste or composted. If food waste is being landfilled, a pulper can reduce the volume by as much as 80%. The Oregon Health and Science University in Portland, which serves about 8,000 meals a day, uses a pulper to divert four tons of waste from the landfill for use as compost each week.

Putting It All Together

Chefs, architects, and kitchen designers will have different ideas about what makes an ideal kitchen. Chefs base equipment choices on products familiar to them, which may be different from the products routinely specified by architects, and the environmental benefits and long-term financial savings of energy-efficient equipment can get overlooked. "We always have energy efficiency in mind," stated Jim Webb, principal at Webb Design food service design consultants, whose firm has designed many large insti-

Photos: CookTek and Dipo Induction

Induction cooktops operate at 90% efficiency and do not generate any combustion gases. Shown here are CookTek's Stock Pot Range and Dipo's Induction Griddle.

tutional kitchens. His team works with the chef and architect, first to establish the equipment and design, and then to specify environmentally responsible equipment. Though his firm advocates for energy-efficient equipment and provides a number of examples demonstrating savings over time, higher first costs still pose a challenge.

Fortunately, first cost is not the only motivator. Webb said that the LEED for Retail pilot has been very well received. Past versions of LEED made it difficult for restaurants to be certified because kitchen equipment was considered a process load and not a regulated load, and modeling kitchen energy was difficult. But according to Webb, modeling is now available through PG&E, and includes Energy Star and rebate-eligible equipment. Once adopted, LEED for Retail should provide a strong incentive for owners to take another look at their kitchen designs, equipment choices, and energy use.

The Print Works Bistro, which is part of the Proximity Hotel in Greensboro, North Carolina, didn't wait for LEED for Retail. In 2008 the restaurant became the first to receive LEED Platinum certification. Bart Ortiz, vice president of operations at parent company Quaintance-Weaver Restaurants and Hotels, was instrumental in the kitchen's design. "We started from the ground up looking at sustainability," he said, "but we were light-years ahead of all our vendors in terms of knowledge and what we wanted to achieve."

The restaurant is a showcase of both conventional and innovative energy- and water-saving technologies. Solar panels on the roof provide over 60% of the kitchen's hot water; a closed-loop geothermal system replaces multiple compressors for the walk-in refrigerators and freezers; induction cooktops are used on buffet lines; heat exchangers in the hotel's ventilation system temper make-up air; and a Melink demand control ventilation system runs at 40% until it senses smoke, making for a more efficient, quieter kitchen. To save water, the building uses touchless, low-flow faucets in the kitchen, an Energy Star dishwasher, and a low-flow pre-rinse spray valve that consumes less than 1.6 gallons (6 l) per minute, which if used for three hours a day could save 180 gallons (681 l) of water a day over a conventional model.

Energy and Cost Savings, Efficient vs. Standard Equipment

Technology	Standard equipment and use ($/yr)	Efficient equipment and use ($/yr)	Cost savings per year	Percent energy savings
Solid reach-in refrigerator	210	97	113	54
Solid reach-in freezer	432	281	151	35
Walk-in freezer/cooler	118	39	79	67
Hot food holding cabinet	767	438	329	43
Fryer	1,170	806	364	31
Convection oven	1,050	731	319	30
Prep table	406	182	224	55
Toaster	964	128	836	87
Broiler	3,540	2,880	660	19
Water heater	11,500	10,400	1,100	15
Combination oven	4,160	2,600	1,570	39
Pre-rinse sprayer	1,970	1,050	920	47
Dishwasher	7,660	6,430	1,230	16
Ice machine	3,650	2,940	710	20
Demand control exhaust hood	7,500	5,000	2,500	33
Griddle	1,120	1,060	60	5

*This table assumes costs of $.10/kWh, $1.00/therm, $2.00/CCF water, and $3.00/CCF sewer. Spray valve savings consider water and sewer costs and assume gas water heating. Source: Energy Star

Final thoughts

While equipment may dominate the discussion of sustainability in commercial kitchens, there is a human element that is equally important. Ortiz's staff has worked to reduce waste, and they recycle glass and cardboard like many restaurants, but they have also developed relationships with vendors to reuse boxes for produce and wine. The local farms that deliver his produce now also pick up his compost. In terms of operations, his staff has a schedule for turning on equipment, and they turn it off when it's not in use. But Ortiz says that his staff doesn't really need the schedule because they already practice energy and water conservation in their own lives. "Our restaurant draws people who have a passion for sustainability," he said.

FSTC, Energy Star, CEE, utilities, and manufacturers have made great strides to inform the public and improve product performance over the past decade, but the food service industry will need the kind of commitment shown by Ortiz and his staff if commercial kitchens are to thrive in a future with dwindling resources.

For more information:

Food Service Technology Center
www.fishnick.com

Energy Star
www.energystar.gov

Pacific Gas & Electric
www.pge.com

Consortium for Energy Efficiency
www.cee1.org

National Restaurant Association
http://conserve.restaurant.org

Environmental Building News
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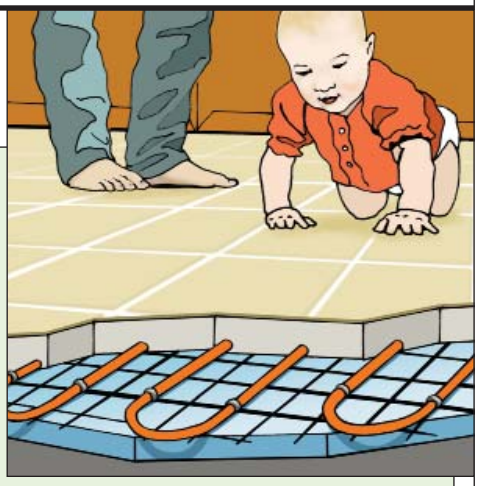
BackPage Primer



Radiant Floor Heating: Wrong Choice for Green Homes?

Radiant-floor heating is popular for some good reasons. It provides very comfortable, uniform heat, owing to the relatively low temperature and the large surface area from which the heat is radiated. It does not interfere with furnishings in a home as most other heat distribution systems do. It's quiet. And, according to proponents, it can save energy by warming people directly (rather than heating the air)—thus allowing occupants to keep the thermostat (air temperature) lower.

Indeed, people living in houses with radiant-floor heat are often effusive in their enthusiasm. Walking around with bare feet on warm floors is very appealing.

Radiant-floor heating systems commonly involve PEX (cross-linked polyethylene) tubing embedded in a concrete slab; hot water is pumped through the tubing. The slab warms up and slowly radiates heat into the room. Radiant-floor heating systems can also be achieved with tubing under wooden floors.

While radiant-floor heat makes sense in certain buildings, it is *not* well-suited to highly insulated green homes for a number of reasons. First, in a home with a tight envelope and a very small heating load, even a small amount of heat can cause overheating, and the thermal mass in a radiant floor system (especially with concrete-slab systems) increases the risk of overheating. This is particularly true in buildings with some level of passive solar gain—the radiant floor may still be delivering heat even after solar gain raises the air temperature.

Second, when the heating load is very small, the radiant slab has to be maintained at no more than a few degrees above room temperature to prevent overheating, and this means that the slab isn't likely to be warm to the touch. A slab maintained at 74°F (23°C) will be cooler than an occupant's skin, so bare feet will conduct heat *into* the slab.

Third, radiant floor slabs and the mechanical equipment needed to heat them are expensive. For a typical house, such systems often cost well over $10,000. Again, in a highly insulated house, that is a lot to spend for a few hundred dollars worth of heat per year.

Fourth, there is little if any evidence that radiant-floor heating actually saves energy. The argument that homeowners will keep their thermostats set lower with radiant heat is not supported by (admittedly limited) research. And with slab-on-grade homes with typical levels of insulation beneath the slab—rarely more than two inches (50 mm)—there may be significant heat going into the ground.

In short, radiant-floor heating is a great heating option for homes with average or below-average levels of insulation, but it is not well suited to highly insulated homes, especially such homes with moderate solar gain (passive solar heating). For more on these issues see "Radiant Floor Heating: When it Does—and Doesn't—Make Sense" in *EBN* Jan. 2002.