A Roulette Wheel of Energy-Efficiency Technologies
By Rachel Reiss Buckley

Staying abreast of new energy efficiency technologies can be confusing even to energy professionals. Too often vendors are selling snake oil, hawking products that don't work as described. As with roulette, where you never know what number will come up, when investigating unknown technologies, you never know what you are going to get.

A few categories of new technologies are presented below — some underutilized technologies may provide good opportunities for utility DSM programs, some technology opportunities should be avoided, some provide quick paybacks in certain applications, and other technologies you may have heard about are appropriate only in niche applications. This paper will recommend when to call a vendor's bluff and tell you how to up the ante by using technologies to get the most bang for your buck.

In addition to the technologies listed below for which categorization is provided, energy professionals will surely be presented with other technologies to evaluate for their worthiness in DSM programs and end-use applications. When that is the case it is wise to ask vendors for the following information before making a determination:

- Case studies and testimonials from numerous customers in your geographical area or climate zone
- Test data that demonstrates performance in the field under a variety of conditions, not just in the lab
- Condition of equipment before energy-saving devices were installed. For example if a chiller needed major maintenance and an energy-saving device was installed and the equipment was tuned up, it is important to know those other variables as well.

In any case, independent equipment evaluations are also good resources for determining how to proceed with a certain type of technology.

<u>Underutilized technologies that may provide good opportunities for utility programs</u>
Many technologies have not reached full market potential because the vendor is a small start-up company, no maintenance network is in place, the price is high relative to similar technologies, or the application is not cost effective. Nevertheless, these technologies may provide good opportunities for utilities seeking to expand their DSM product offerings.

Drain heat recovery water heaters. Most non-energy professionals fail to realize the amount of energy going down the drain with wastewater. Drain heat recovery water heater technology replaces vertical sections of building drainpipes and, in most applications, captures as much as 60 percent of the heat from the wastewater for reuse. As hot wastewater flows through the drain, incoming cold water passes through a coil of half-inch copper supply pipe wrapped around the drain, capturing the heat from the wastewater. Use of the technology is limited to times when wastewater is generated, for example, when hotel guests are taking showers.

The equipment includes no moving parts, no maintenance costs, and can last throughout a building's lifetime. Applications include motels and hotels, dormitories, health clubs, and single and multifamily residences. Importantly, the greater the use of hot water, the greater the savings,

and the shorter the payback period. Energy savings for lodging ranges from 40 percent to more than 50 percent. A field study by Pennsylvania Power and Light of five households using the drain heat recover water heaters, in which residents took two to eight showers a day, yielded paybacks of 2.1 to 6.5 years, based on the current installed price of $400 and electric water heating costs of $0.085 per kilowatt-hour (kWh).[1]

Rapid-cook ovens. For commercial food service establishments, fast cooking times are of the utmost importance. A new rapid-cook oven — the TurboChef—promises faster cooking times than conventional convection and conveyer ovens while maintaining food quality and saving energy. The technology uses microwaves and "impingement," where hot air is forced onto the food at high speed using jets of air. The effect is similar to convection cooking, where hot air gently circulates around the food to cook it from all sides, but significantly faster. After an initial slow start, the TurboChef began gaining ground in 2005 when the Subway sandwich chain bought 25,000 units for stores around the world. Subway's widespread adoption helped establish a necessary maintenance and service network of 4,000 people in North America.

Another beneficial feature of the TurboChef is that an exhaust vent isn't needed because a catalytic converter combusts food odors, grease, smoke and reduces it into CO2 and water. This is very attractive for facilities without spare vent capacity because new vents are $2,500-$7,500.

The product offers utilities opportunities for load growth, energy savings, fuel switching, and, increased customer satisfaction. Unlike competing countertop conveyer ovens, the TurboChef idles at 1,300 W rather than 5,000 W, yielding substantial energy savings. When compared with conventional electric ovens annual energy savings of approximately $650 are possible. Use of this equipment offers fuel switching opportunities since can be used to replace gas ovens. And load growth opportunities are possible because beverage and sandwich shops can economically add or expand their hot food menus.[2]

Emerging technology opportunities to track

The following technologies are not ready for prime time but promising demonstration projects are underway. If these projects demonstrate favorable results then in the next few years these technologies may present opportunities for significant energy savings.

Cool-colored roofs. The market for cool roofs -- roofs that stay cool on hot days -- has traditionally been limited to commercial facilities, but new research and developments should bring these roofs to the residential market as well. Conventional cool roofs are light-colored to reduce heat gain through the roof and thus reduce cooling loads. Although light-colored roofs may be acceptable for flat and low-sloped roofs of commercial facilities, homeowners typically prefer the aesthetics of darker-colored roofs for homes with roof slopes greater than 2 to 12 inches. Recently, manufacturers began introducing cool-roofing products in darker, more appealing colors, and several products now qualify for the Energy Star label.

A team from Lawrence Berkeley and Oak Ridge National Laboratories set up seven test sites in six different climate zones in California to test the performance of roofs using materials from several manufacturers. The sites ranged from far north to extreme south and represented climates from mild to severe. In completed tests, the researchers determined that, in general,

cool roofs are best suited for hotter climates because the heating load penalty in more moderate climates in winter offsets the quick paybacks available in more extreme temperatures. Sacramento Municipal Utility District (SMUD) is also measuring energy savings and changes in indoor temperature and humidity at test houses with cool roofs in its service territory.[3]

Evaporative condenser-based air conditioners. The Freus high-efficiency air conditioner for residential and commercial applications up to 10 tons currently possesses the highest efficiency of any equipment on the market. Rated at 17.5 EER, the next best EER for residential units is 14.5 and next best for small commercial units is 11.8. The Freus uses an evaporatively-cooled condenser instead of an air-cooled condenser. As such, it evaporates water off the coil to remove heat instead of blowing air across the coil. Unlike other evaporative coolers it does not add moisture to air. It also maintains efficiency under hot conditions better than air-cooled units.

More than 6,500 Freus units are in operation. In a Nevada test, the Freus produced 35 and 45 percent energy savings and demand reductions of 1.7 kW and 1.4 kW. In a study that SMUD researchers conducted, the energy savings were superior to the Nevada tests because they used newer units. SMUD achieved 50 percent energy savings when compared with 13 SEER units—the federal minimum efficiency standard—and 40 percent energy savings compared with 16 SEER units. Locations with long cooling hours and demand charges will benefit the most from using the Freus. In climates with below-freezing temperatures in winter, modifications, such as basin heaters and heat tape for intake lines, may be necessary to ensure that the water in the unit does not freeze.[4]

Limit these technologies to niche applications

Vendors claim significant energy savings for many technologies, but in reality such savings are available only from limited applications. In many cases, cost-effectiveness figures might not be favorable.

Tankless water heaters. Also called instantaneous or on-demand water heaters, tankless water heaters use less energy because they do not store water in a tank. Tankless water heaters only use energy when the hot-water is turned on, and the energy used is proportional to the volume of hot water used. Standard water heaters are constantly working to keep the water in the tank hot whether or not it is immediately used. Electric and natural gas tankless water heaters are available and have lifetimes twice those of tank-type water heaters. In most cases, tankless water heaters have a nine-year payback. Utilities should be aware that tankless water heaters impose a higher needle peak on their systems because the water heats quickly.

Applications in which tankless water heaters make sense include:

- Where space is limited—tankless water heaters can fit in small spaces, such as closets.
- If hot-water use is modest and taps must be located at a distance from the main water heater, a tankless water heater can supplement a tank-type water heater.
- If the availability of instant hot water is especially desirable.
- If natural gas is not available at the end use or if it is expensive to run pipes, an electric tankless water heater can supplement a gas tankless water heater.
- Intermittent use applications, such as vacation homes and recreational vehicles.[5]

Reduced-wattage fluorescent lamps. Approximately one of every five light sockets in the United States uses a standard T8 or T12 4-foot fluorescent tube. One option for making these lights more efficient is the super-T8 lamp, also known as the high-performance T8 lamp. These lamps provide higher efficacy, longer life, and better color quality than standard T8s. In the past few years, the major lamp manufacturers have been promoting a reduced-wattage version of these high-performance lamps and report that these versions now account for about 10 percent of all 4-foot T8 lamps sold. The typical 4-foot linear T8 lamp is rated at 32 watts, and the reduced-wattage versions may draw as little as 25 W. As such, reduced-wattage linear fluorescent lamps are stirring up the lighting marketplace.

The reduced-wattage versions of super-T8 lamps offer high efficiency and good color quality but suffer from several operational shortcomings: They are very sensitive to cold temperatures, provide lower levels of light output than high-performance T8s, and are incompatible with certain types of ballasts. However, they can be an effective option in certain retrofit situations, especially in temperature-controlled facilities where they may be used with existing electronic ballasts.[6]

Stay away from these technologies based on energy-savings claims alone

The products listed in the section below offer positive attributes for what they were intended to do. However vendors of each of these products have also touted their energy savings attributes. Evaluating these technologies based on energy savings claims alone will not produce attractive cost-effectiveness, rather it is better to evaluate them for what they were intended to do.

Transient-voltage surge suppression (TVSS). Many vendors selling these products claim to deliver substantial energy savings, however the evidence to date does not support their claims. To the contrary, the Federal Trade Commission recently charged one company with false representation for making energy savings claims for its TVSS products (see http://www.ftc.gov/opa/predawn/F93/solarsale8.htm for more information) and has issued a warning to a second company. The settlement judgment from the first case prohibited the company from repeating such claims unless it could provide competent and reliable evidence to substantiate them. Unless the manufacturers of these devices provides such evidence, potential purchasers should maintain a healthy skepticism.

TVSS devices are, by and large, designed only to protect downstream equipment from voltage surges and spikes. Typically, they serve this function quite well by shunting excess voltage to ground until the transient has passed. TVSS vendors have not been forthcoming with information or practical explanations substantiating energy savings. One manufacturer's marketing materials reduce the credibility of its claims by stating on its web site that its devices "filter out thermodynamics" and "reduce the resistance on all electrical equipment." Since thermodynamics is a branch of science, not susceptible to being filtered out, and resistance (or, more properly, impedance) of electrical equipment is a characteristic of its material components and component structure, both statements are unscientific and specious.

Most likely, energy efficiency claims are designed to raise the prices vendors charge for TVSS equipment compared with equipment from vendors that do not make energy-savings claims.

Before investing in TVSS equipment in hopes of saving energy, we suggest shopping around to be aware of any price premium.[7]

Lighting circuit panel power reducers. Power reducer equipment uses one of several means to reduce the voltage in a lighting circuit, thereby cutting energy use. These products do indeed cut energy use, but manufacturers often downplay, or ignore altogether, the fact that light levels are reduced at the same time. Actual savings will depend on the levels to which the lights can be acceptably dimmed in a given facility. There are also a number of limitations associated with implementation of the technology, including in the types of ballasts and circuits that will function with it. In many cases, upgrading to higher efficiency lighting is more cost effective and provides better quality light than installing power reducers.[8]

In summary, new energy technologies may provide opportunities to expand DSM programs. Energy professionals need to be patient to wait for the kinks to be worked out with the newest technologies and can help promote some under-utilized technologies. It is also important to be wary of vendors and understand the right applications so you won't get burned. Don't let the vendors double-down; play your cards right, and you can be a winner.

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[1] Kenneth Black and Clay Fong, presentation to Wisconsin Public Service.
[2] Peter Criscione, "Retrospective: In Spite of the Flashbake Oven's Fizzle, Rapid-Cook Ovens Are Rising," Emerging Technology Currents No. 45, E SOURCE (February 2006).
[3] Rachel Reiss Buckley, "Cool-Colored Roofs for Residences," *Emerging Technology Currents No. 31*, E SOURCE (April 2005) and Rachel Reiss Buckley, "At Home with Cool-Colored Roofs," *California Energy Commission Public Interest Energy Research Technical Brief No. 15* (March 2005).
[4] Peter Criscione, "The Freus High-Efficiency Air Conditioner Is Still Climbing the Mountain," *Emerging Technology Currents No. 46*, E SOURCE (May 2006).
[5] Kristin Kamm, "Proper Residential Applications for Electric Tankless Water Heaters," *E SOURCE Question of the Month.*
[6] Ira Krepchin, "Reduced-Wattage Fluorescent Lamps: Not-So-Super T8s", E SOURCE Report ER-06-10 (July 2006)
[7] Dan Greenberg, Energy Saving Capabilities of Transient Voltage Surge Suppression Systems, *E SOURCE Question of the Month*.
[8] Ira Krepchin, "Lighting Circuit Power Reducers: Are They (Cost) Effective?" *E SOURCE Report ER-03-12* (July 2003).