With energy prices soaring and states required to comply with ASHRAE 90.1, now is the time to push for better energy conservation measures

Killing Kilowatt

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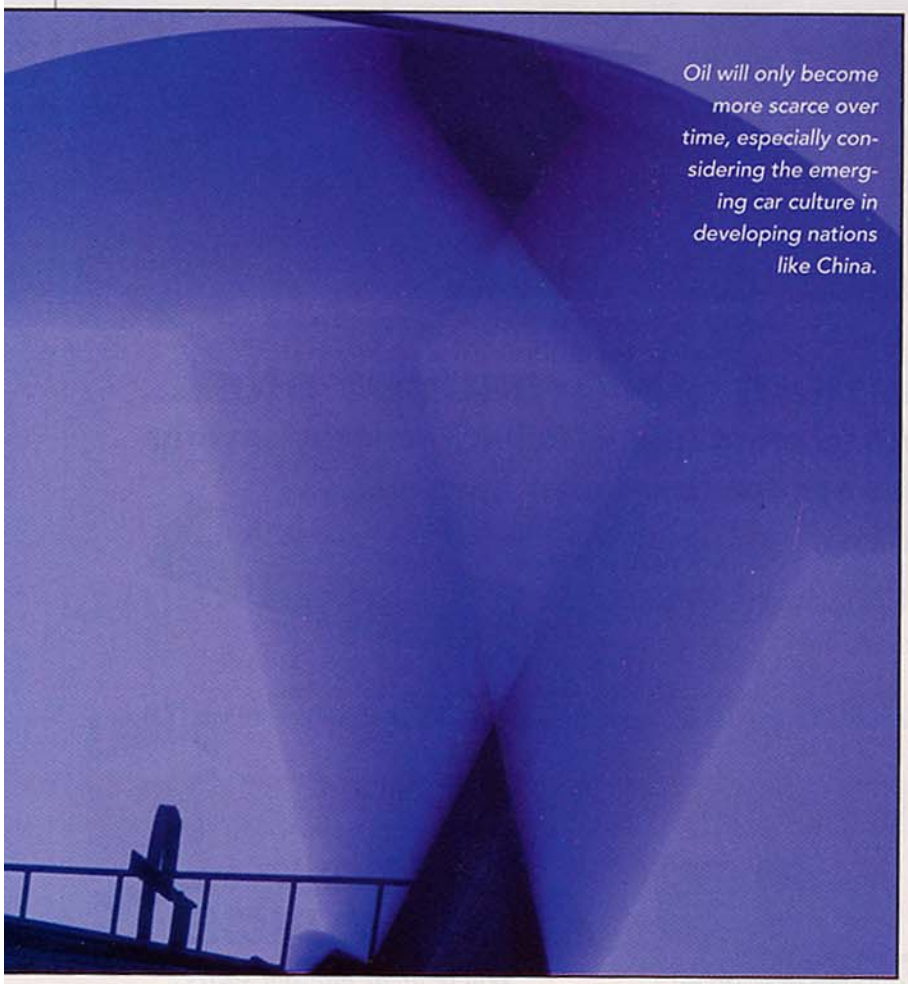

Oil will only become more scarce over time, especially considering the emerging car culture in developing nations like China.

If you've taken a trip to the gas station lately, you've no doubt paid more money to fill your tank than you did a year ago—maybe even just a few months ago. That is, unless you've recently traded your vehicle in for a smaller one.

While many people tend to groan about higher prices at the pump, cursing the oil companies as they fill their tanks, most of us forget how good we've got it. "We're energy spoiled," says Chris Kirchner, a senior mechanical engineer with Smith-Group, Inc., Detroit. "We take energy for granted. But when you travel through Europe and you see what they pay for a liter of petrol [currently U.S. $6 per gallon], you realize how fortunate you are."

What's worse is that many Americans don't look at the bigger problem—that fossil fuels are a limited resource. The question isn't if we'll run out of oil and other fossil fuels, but when.

"World electrical energy consumption is forecasted to double between 2002 and 2030," says Kent Peterson, a former vice president of ASHRAE and a principal with P2S Engineering in Long Beach, Calif. "Over 90% of this increase in energy is expected to come from the use of fossil fuels. This is a precious limited natural

A 536-kW solar power system provides 20% of the electricity to a Toyota facility in Torrance, Calif. (right)

Photo: **Ben Rice/Superstock**

Hours

resource that we may not be able to sustain in the future."

Assuming this is all true, a decision has to be made as to when to act—down the road, when fossil fuels are near depletion, or now, when the implementation of alternative energy sources can help sustain this rapidly dwindling resource.

While some may argue that there is plenty of oil left—notably, the "hard-to-get" reserves, such as the Canadian tar-sands—consider this: *National Geographic* reported earlier this year that there are currently 774 vehicles per 1,000 people in the United States. But we're not alone. In China, arguably positioned to be the most up-and-coming nation in the world, there are only 16 vehicles per 1,000 people. But as the country's overall per capita wealth—and population—increases, so will the demand for automobiles, buildings and fuel.

Given this inevitability, it's difficult to argue against the need for a truly comprehensive search for alternative energy sources and more energy-efficient equipment and building systems. The question is where energy and resources can best be focused.

"Education and economics are the two driving forces behind getting people to pay attention to [conservation]," says Kirchner. "We get a lot of reminders everyday of how much it costs to put things into buildings. Everyone is always focusing on that portion of it. But we don't get constant reminders of the [environmental] benefits of saving energy. It's not one of those things that's discussed on a frequent basis."

While the environmental gains of energy conservation are apparent, they continue to elude many building owners and facility managers. However, the cost-cutting aspect is a big attention-getter. Les Sladen, a national operations manager for performance contracting with Siemens Buildings Technologies, Inc., Buffalo Grove, Ill., suggests that reduced energy use and increased savings are best realized through the execution of an energy management plan or energy audit. "As with anything, to decide where you want to go, you have to determine where you are today," he says.

Photo: courtesy PowerLight

Whether employing an energy service company or consultant, or having the work done in-house, the initial steps of an energy management plan include analyzing utility bills for the previous 12 to 24 months to determine optimal use of rate structures; a comparison of the audited facility to other facilities of the same type; an overall look at the facility to determine when and where energy is being used; and an analysis of what equipment is being used (see "Energy Audits 101" p. 40).

Lights out

According to Sladen, many of his company's audits reveal that lighting systems are often the largest energy consumers in a facility. Luckily, it's an area where there are many opportunities for savings. "Lighting technology, particularly fluorescent, has improved significantly in the last 10 to 15 years," Sladen says. "Going from the incandescent to the compact bulbs, and those types of things, has allowed the retrofits to generate significant savings that are then reinvested into other retrofits in the building or can be used to pay off a project quickly."

SmithGroup's Kirchner also recognizes lighting as a no-brainer for energy savings. But a trend of note is the proliferation of high-efficiency T5 fluorescent lamps. At Visteon Village, a 1,000,000-sq.-ft. automotive laboratory and office complex in Van Buren Township, Mich., Kirchner says T5s will be used exclusively.

Keith Lane, P.E., RCDD, LC, LEED A.P., and vice president of engineering for SASCO, Woodinville, Wash., says it's not that T5 fixtures provide more lumen output per watt than T8s, but the smaller lighting package does allow for better use of reflectors that, in turn, provide better use of the light output. At the same time, Kirchner adds that T8s are approaching the efficiency of T5s.

While evolving lamp technology is clearly making headway with utility bill reduction, dollars are also saved when less lighting is used. For example, the headquarters of the Chesapeake Bay Foundation in Annapolis, Md.—the first building to receive a LEED-Platinum rating—uses a passive solar design that incorporates daylighting and solar shading. Its open office plan also allows natural and artificial lighting to be used more efficiently and uniformly. The building, a sustainable demonstration project, generates 35% of its energy from renewable sources and uses 50% less energy than a similarly sized, but typically designed, office building.

Building orientation to maximize sun exposure is one non-mechanical method of reducing energy costs. (photo: courtesy Siemens Building Technologies)

Next up: ventilation

Besides lighting, alternative air-handling strategies offer yet another opportunity to cut down on energy consumption and utility costs. According to Gerrit Reinders, director of advanced solutions with Johnson Controls (JCI), Milwaukee, the European innovation of splitting HVAC systems into separate, smaller systems is catching on in the U.S. "The split-fan system approach separates the handling of the heating and cooling services [no outdoor air] and IAQ services," he explains. A second notable trend, he says, is the increased use of underfloor air distribution (UFAD) and low-temperature primary air systems.

Like lighting technology, mature HVAC equipment has advanced with the 21st century. For example, Siemens' Sladen points out that chiller efficiency has improved significantly over the last few years. If this weren't enough of a reason to replace older chillers, phase-out of older refrigerants, he says, is likely to force many facility personnel to look into new units.

Beyond the obvious

Lighting and HVAC upgrades are usually obvious places to improve efficiencies, but according to Chach Curtis, with the on-site generation group of Northern Power Systems, Waitsfield, Vt., such efforts should just be step "A" in a comprehensive upgrade plan. "Those types of investments have the quickest payback, and we encourage customers to implement these kinds of projects first to bring down their demand," he says. "But the cheapest kilowatt-hour is the one you never have to buy."

Curtis believes building operators should consider options like on-site generation or

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Engineers and owners have recognized the economic and environmental benefits of compact-fluorescent lighting, variable-frequency drives and underfloor air distribution for a while now, and these technologies have seen increased use in recent years. And like most engineers, Chris Kirchner, a senior mechanical engineer with SmithGroup, Inc., Detroit, also has his eye on the next generation of efficient technologies.

One that's particularly impressed him is the use of magnetic bearings for compressors, which basically utilizes a "levitating" bearing. Instead of a traditional oil bearing, the drive shaft floats in a magnetic field, eliminating friction and oil and increasing efficiency for compressors and motors. He notes that the technology is only available for smaller motors at this time, but will eventually reach capabilities for larger units.

Another emerging technology that Kirchner notes cuts down on oil use is the aptly named oil-free chiller, which eliminates the entire oiling system. This, in turn, rids the chiller of secondary power consumers that are doing nothing but circulating oil.

Zero-degree heat pumps are a another technology that Kirchner says is not quite ready for prime time but has promise for implementation in the near future. Currently, heat pumps are limited by exterior temperatures, but headway has been made in the lab to get them to operate in temperatures down to zero degrees.

Kirchner also recently participated in a seminar on packaged fuel cell cogeneration units, which can provide electricity, hot water and cool-

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cogeneration to save money on the kilowatt-hours they're still buying. Not only is this a way to further increase savings, but it also increases reliability.

Curtis has noticed a growing acceptance of cogeneration, or combined heat and power, and says that there's a much higher level of understanding among customers that the utility is no longer the only source of power. "Three years ago, no one really knew much about the concept [of cogen]," he says, but people began to recognize the environmental and financial benefits. He admits that cogen is much easier to sell in areas where energy costs are high, such as California. But he feels that the energy-savings potential of the heat side of cogen is underemphasized, even though it can deliver more value than the electricity side in many cases.

Other hybrid systems, including microturnines, offer much potential, especially in remote locations where the high cost of transporting large amounts of diesel fuel can obligate facilities to take advantage of locally available resources.

BAS encourages cooperation

Another technology that's greatly underutilized is building automation, says SASCO's Lane. "Building automation systems and interoperability between other systems can greatly affect energy usage," he says. "These 'smart' systems can work together to monitor peak loads and to self-regulate usage... With a single monitor or even web-based remote monitoring, an owner can monitor usage and trends and tweak the systems for further efficiency."

SmithGroup's Kirchner says that the primary advantage of BAS is the ability to schedule and control all of the energy consumers in the building. "Once you've got that type of control, you can then manage all of those things based on occupancy patterns and the required use for the facility," says Kirchner, touting capabilities like load shedding, dimming lighting at peak levels and managing the amount of ventilation air coming into and out of a building so as not to overventilate a space.

BAS also allows cooperation between systems that would otherwise never interact with each other. JCI's Reinders explains that BAS can integrate systems in such a way that a facility manager can use a building's card-access and motion-detector systems to detect when spaces are being occupied and schedule lighting and HVAC accordingly, as opposed to having these latter two systems set to an arbitrary schedule.

Additionally, Reinders says, designers should be on the lookout for recent developments in advanced controls and adaptive control algorithms that make controls and sensors more intelligent. By giving controls more diagnostic abilities, such as determining inefficient system performance, systems will be able to extract more information from existing sensors rather than adding large amounts of costly instrumentation.

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Motors play a large role in HVAC efficiency. SmithGroup, Detroit, recommends premium efficiency motors—90% efficient and higher.

Facility managers should also ensure that the BAS is running as it should be. John Van Gorp, CEM, manager of industrial markets with Power Measurement, Saanichton, B.C., promotes the idea of continuous commissioning with BAS—in other words, looking at the system every year or so to make sure that it's properly tuned. A reason for this, he says, is that many people like to "tweak" the system to their liking. "A lot of engineers I've spoken to say it's not unusual to find folks who have actively tried to counter the [BAS]," he says. "Just having it run the way it was intended can make that much of a difference." (Visit the HVAC and Building Automation com-

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ing all from one unit. He says the current cost has prohibited the technology from penetrating the market except for specialized locations, but notes that it might see more mainstream use in five to six years.

On the lighting side, hybrid fluorescent/sunlight fixtures use standard compact fluorescent lamps connected via fiber optics to mirrors on a building's roof. It's much simpler than PV, says Kirchner, as the lighting is not converted but physically beamed and focused through the fiber optic filaments. "I'm not sure if it will ever make it out of R&D, but as the cost of fiber optics goes down, we might see it in the future," he says.

Speaking of solar power, another technology Kirchner feels has potential is architecturally integrated solar voltaics, where photocells are adhered to window/glazing systems (vision and non-vision) to, in effect, turn the skin of the building into one big solar panel. He notes that the technology is very expensive right now, but may eventually see large-scale use.

Lastly, Kirchner encourages engineers to look into a technology that has potential to eliminate refrigerants and that has already seen use in a Ben and Jerry's ice cream store: acoustical refrigeration. Essentially, the refrigeration unit uses a modified loudspeaker to generate high-amplitude sound energy in pressurized, environmentally safe inert gas and converts the energy into cooling.

munity at csemag.com for "Energy Management 101," a white paper on the subject of campus energy control.)

Beyond technology-oriented solutions, applying simple methods can often yield increased energy savings. Raj Gupta, P.E., president of Environmental Systems Design, Inc., Chicago, suggests tactics such as reorienting a building on its site to maximize sunlight exposure and reduce lighting and HVAC use. "That pays for itself every year," says Gupta. "There are no moving parts. It's not always about getting the latest gizmo. It's about keeping it simple and thinking holistically."

He also points to his firm's home in downtown Chicago, a 1920s-era building with a central atrium—a feature that offered a simple, non-mechanically driven opportunity to save energy. As the middle of the building is hollow, the surface area was almost doubled, and a significant amount of heat was lost in the winter. ESD sealed the top with a skylight, retaining that heat yet still allowing light to penetrate. With the cavity closed, air within is preheated in the winter. Additionally, the atrium is used as a return-air shaft, avoiding the need to install vertical shaft space in the historic building.

Photo: courtesy Johnson Controls

System upgrades and green-building operating practices at the National Geographic Society's 840,000-sq.-ft. headquarters complex in Washington, D.C. led to a 10% savings in energy costs.

Upholding standards

While economics would appear to be the main driver for more efficient systems, many building operators may not have a choice, as new regulations are being mandated at the state level. This, of course, is most notable in the form of ANSI/ASHRAE/IESNA Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*. 90.1 is the most widely accepted energy standard. The 1992 Federal Energy Policy Act (EPACT) uses it to set the minimum requirements for state energy codes, and the NFPA 5000 Building Construction and Safety Code uses it as the sole criteria for energy conservation. 90.1 will continue to raise the efficiency bar, but Kirchner says it can only be so strict. "[90.1] has to play a very delicate balancing act between what's readily available and what's economically viable," he says. "At the same time it must try to push the envelope of efficiency." As such, he notes it will probably always lag just behind cutting-edge technology until that technology becomes financially feasible.

P2S' Peterson agrees that 90.1 can move forward only at the will of the market and the construction community. However, he says that complying with it is not difficult and notes that exceeding the standard by a substantial amount is certainly feasible. "It's been undocumented, but pretty well proven by practitioners, that you can exceed [90.1] by almost 30% with today's technology, and there are a number of different buildings that have done that," he says.

Peterson acknowledges that ASHRAE can't simply alter the standard to ask for a 30% increase in efficiency overnight. But it can point people in the right direction and has developed a guideline for mechanical designers to do so. Peterson notes that this applies to the entire building, not just mechanical systems. He believes an efficiency of 50% better than 90.1 can be achieved within the next few years and hopes to see zero percent net-energy buildings come to be in the next 25 to 30 years with advancements in solar and cogen technologies.

Conservation as a given

While engineers have long promoted energy conservation, in the end, it's the owners and general public that will have the final say. That being said, the design and energy-management communities can act as an influence, as can the current state of affairs.

"You have to do your due diligence with both first cost and life-cycle cost and once again, try to help the client understand what the costs and benefits are and have them make their own analysis," says Kirchner.

"As energy prices increase and technologies improve, there should be a [growing] trend toward providing more efficient buildings," Lane adds.

Power Measurement's Van Gorp notes that the current angst over gas prices is similar to that of the energy crisis in the 1970s—there's concern until energy prices drop, then it goes away. The difference this time, he says, is that there are now more choices when it comes to efficient technologies that give opportunities to show savings. Also, there are more financing choices nowadays, and energy services can be outsourced. And, environmental awareness, in general, is higher. All of this, he says, will sustain the energy concern this time around.

Aside from high gas prices, Curtis has already noticed a change in the attitude toward energy management. "Looking back four years, none of these companies had an energy manager," he says. "The role didn't exist. Now, every one of them has one."

Yet another reason for companies to commit to energy awareness, according to Reinders, is that corporate accountability and broader excellence in environmental management bring positive public relations. "Except for the utilities that lose the revenue clients save by implementing sustainable energy management programs, every stakeholder wins."

Clearly, there are plenty of technological opportunities to conserve energy. But human behavior is just as important, and people should take a lesson from the technologies they create. If a BAS can learn to turn off lights, so can we.

"If we think about energy conservation and efficiency and include that in our lives, we will not only benefit ourselves by reducing our utility bills and gas for our car, we will also benefit the country as a whole, both economically and environmentally," Sladen says. "And those are easy wins." csel