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Environmental Energy Technologies Division NEWS

ADVANCED ENERGY TECHNOLOGIES | ATMOSPHERIC SCIENCES | BUILDING TECHNOLOGIES | ENERGY ANALYSIS | INDOOR ENVIRONMENT

For Millions of Bangladeshis, Ash May Offer Hope

Innovative filter could also help California comply with tighter U.S. EPA arsenic drinking-water standard.

Ashok Gadgil, a scientist in the Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory (Berkeley Lab), is developing a cheap and effective way to provide safe drinking water to 60 million Bangladeshis who live with the threat of arsenic poisoning. Gadgil's idea is to create arsenic filters from coal ash, the fine gray powder that piles up, waiting to be discarded, at the bottom of furnaces at all coal-fired power stations.

"It's just coal ash, nothing fancy," says Gadgil. "But it could save so many lives."

Arsenic poisoning in Bangladesh has been called one of the largest mass poisonings in human history, expected to cause 10 percent of all future adult deaths in the impoverished nation of 130 million. For reasons not entirely understood, the shallow tube-wells that Bangladeshis depend on for water contain dangerous concentrations of the toxic substance; if ingested at these concentrations over long periods of time, arsenic leads to debilitating lesions, cancer, and death.

Although still in the investigational stage, Gadgil's technique would involve coating the ash with a compound that attracts arsenic, filling tea bag-sized pouches with the powder, and distributing the filters throughout the countryside, one per family per day. Water drawn from any one of the millions of contaminated wells that dot Bangladesh could then be poured through the filter and safely consumed.

It's difficult to believe that one person, armed only with a handful of ash and a few promising lab tests, might derail a catastrophe looming on the other side of the globe, but Gadgil has an uncommon drive to find affordable ways of providing safe drinking water to thousands of people. In November 2004, he received an award from California's Tech Museum of Innovation in San Jose, which honors people who use technology to help humanity, for developing a water-purification system that kills bacteria with ultraviolet (UV) light. The system, called UV Waterworks and marketed by WaterHealth International, Inc., is used daily by about 300,000 people in Mexico, the Philippines, and several other countries, and several systems will soon be installed in Gadgil's native India. Now, Bangladesh weighs heavily on his mind.

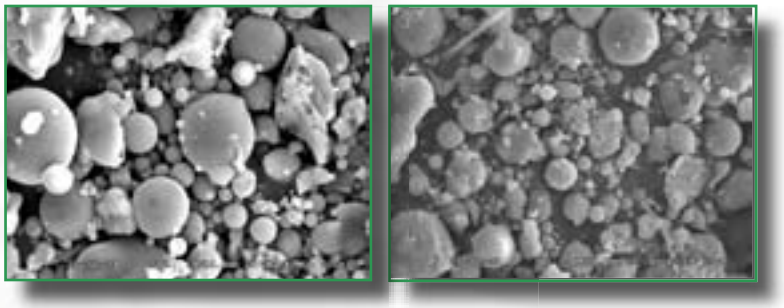

Figure 1. *Bottom ash before (left) and after coating with ferric oxide*

"The magnitude of the problem is overwhelming. We have to develop a solution that is affordable and effective," says Gadgil.

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After receiving $5,000 in seed funding from the Berkeley Lab Technology Transfer Department in 2003, Gadgil set out to develop a filter that meets these criteria. His options quickly narrowed: he needed a material that has a high surface-to-volume ratio, is pathogen free, and is available in large quantities at low cost. Reflecting on carbon as a commonly used filtration medium, Gadgil thought about left-over coal ash, the large piles that collect at all coal-fired power stations, waiting to be sent to landfills. An additional $20,000 in seed funding from the Blue Planet Run Foundation helped him explore this option.

Figure 2. *Researcher Christina Galitsky filters water after it has been mixed with the arsenic removal medium.*

Coal ash is composed of particles that measure between one and 10 microns in diameter, much smaller than a 100-micron-diameter human hair. This means that even a small volume of the powder has a lot of surface area, maximizing the opportunity for surface reactions to snare arsenic. The ash is also heated to 800 degrees Celsius during the coal burning process, so it's sterile and free of volatile compounds. And it's plentiful. Coal-fired power plants provide most of neighboring India's electricity, and the locally mined coal used is uniquely suited for Gadgil's purposes: it's only 60 percent carbon, meaning 40 percent becomes ash.

After obtaining some ash from India, he assembled Team Arsenic, which includes Lara Gundel, Yanbo Pang, Christie Galitsky, Duo Wang, and Anna Blumstein. Together, they developed a way to coat each ash particle with ferric hydroxide, a chemical that reacts with arsenic and forces the element to precipitate onto the particle (see Figure 1). Initial tests indicate this specially treated coal ash makes a very powerful filter. After spiking lab water with so much arsenic that its concentration soared to an extremely toxic 2,400 parts per billion (ppb), the team found that the filter lowered the water's arsenic concentration to 10 ppb (see Figure 2). The Bangladeshi standard for safe drinking water is 50 ppb.

Gadgil estimates that five grams of filter material could render about three gallons of Bangladeshi well water—with an average arsenic concentration of 400 ppb—safe to drink. Put another way, a filter the size of a tea bag could provide drinking water for a family of six for one day. He also estimates the technique will cost about thirty cents per person per year. The next-best option is a filter developed by a Bangladeshi engineer, backed by the non-profit organization IDE-International, that uses pulverized brick instead of ash. It would cost $9.70 per person per year.

Closer to home, the California Energy Commission's Public Interest Energy Research program recently awarded Gadgil $250,000 to explore whether a variation of this technique can help the state comply with a U.S. Environmental Protection Agency rule, effective in 2006, that tightens the U.S. arsenic drinking water standard from 50 ppb to 10 ppb. Currently, 600,000 California residents consume water with concentrations above 10 ppb. Gadgil will determine whether ash derived from U.S. coal can be developed into a filtration system and whether such a system can work at small municipal water treatment facilities.

Initial results appear promising. Currently, the cost of arsenic removal at small municipal water systems ranges from $58 to $327 per household per year. Gadgil estimates that his method would cost less than $1 per household per year, not including the one-time cost of coating the ash with ferric hydroxide.

In addition to this research close to home, Gadgil will also intensify his efforts to help Bangladesh—if he secures more funding. His filter requires many more tests and refinements, but he knows the payoff could be huge.

"If this succeeds, it will be a life-saving and affordable technology for tens of millions of people," he says.

—Dan Krotz

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This research is funded by the Lawrence Berkeley National Laboratory's Technology Transfer Department and the Blue Planet Run Foundation, and the California Energy Commission's Public Interest Energy Research Foundation.

A Next-Generation Community College Curriculum for Energy-Efficient High-Performance Building Operations

Advanced cognitive skills, including problem solving and systems thinking, are critical for success in today's information-based workplace. The need for these skills is particularly compelling for those who manage the equipment, systems, and energy use of buildings.

With these issues in mind, the Lawrence Berkeley National Laboratory (Berkeley Lab) Environmental Energy Technologies Division (EETD), and the Peralta Community College District, which includes Laney College in Oakland, California, conducted a focus group and follow-on interviews with approximately 50 building industry stakeholders to discuss building operator education at the community college level. Participants included heating, ventilation, air-conditioning and refrigeration (HVAC&R) and controls design and service companies; equipment manufacturers; commissioning providers; energy-management professionals; public and private building owners; local, state, and federal government representatives; and educators.

Figure 1. *Hands-on HVAC training facilities at Laney College*

Participants identified numerous gaps between current building operator education and workplace needs and agreed that many problems in achieving and maintaining energy savings in buildings can be traced to lack of knowledge about how building systems should be used, monitored, and maintained. Participants also noted many specific skills needed by building operators and technicians, ranging from technical knowledge to communications and financial analysis, which are addressed in graduate-level and continuing education programs but rarely in community college classes.

Based on the focus group assessment, EETD researchers are developing a new curriculum in collaboration with five community colleges, along with an innovative simulation-based learning tool to teach students how to commission and operate high-performance buildings. The materials emphasize energy efficiency and indoor environmental quality related to HVAC systems. The initiative will span three years, with support from the National Science Foundation.

This initiative resonates with the fact that public and private energy management R&D portfolios are moving away from a "stovepipe" approach to an "integrated systems" approach. Graduates of the new curriculum will be qualified for emerging professional specialties such as commissioning and retrofitting buildings, managing building energy use, maintaining optimal building performance, and analyzing and correcting common system faults.

Improved Laney College Curriculum & Learning Environment

In its current form, Laney College's 30-year-old Environmental Control Technology (ECT) program is similar to other community college HVAC&R programs (see Figure 1). The focus group helped define major updates and revisions to Laney's curriculum, including:

- adoption of new instructional technologies and methods;
- creation of new program strands associated with emerging occupational clusters;
- addition of physics, statistical methods, communications courses, and a rigorous associate degree option;
- addition of advanced courses to serve both current students and incumbent workers needing skills upgrades; and
- creation of an articulated sequence of courses, allowing students to transfer in from high-schools and, on to four-year institutions.

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A Next-Generation Community College Curriculum for Energy-Efficient High-Performance Building Operations

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This transformed curriculum includes 18 new courses and differs significantly from typical community college offerings. Among the unique subjects addressed are:

- building commissioning and retro-commissioning;
- advanced digital control systems operation as well as data collection, analysis, and correlation with operating equipment and systems;
- system-level analysis and troubleshooting;
- specialized topics such as high-tech facilities and ultra-cold facilities operation;
- indoor air-quality analysis;
- peak-load responsiveness analysis; and
- biological and chemical attack preparedness.

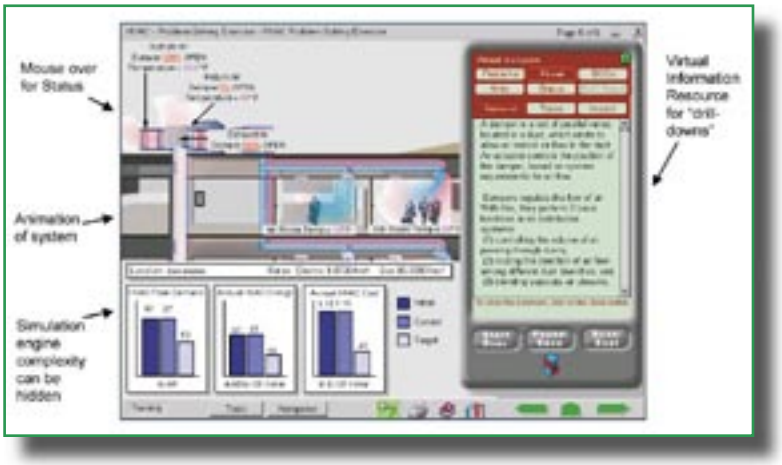

Figure 2. *GUI and elements of a problem-solving exercise*

A Buildings "Flight Simulator"

A new instructional tool will be developed and introduced: a computer-based simulator that immerses students in progressively more complex problem-solving scenarios, from components to systems. Field analysis of data and operating equipment will present students with real-world problems and issues.

The simulator will help students:

- understand the operating principles of HVAC system components;
- diagnose basic equipment problems at the component level;
- use goal-oriented, problem-solving methods at a systems level;
- focus on case-study exercises and learning-by-doing projects

The basic simulation engine for the computer-based education tool (CBE) will be the object-based program SPARK, which uses graph-theoretic methods to find computationally efficient solutions to problems described by sets of non-linear differential and algebraic equations. An "open-source" software approach will facilitate the refinement and expansion of the tool by instructors and other interested parties.

The tool's easy-to-use graphical user interface (GUI)—to be developed by the Deringer Group—will explain concepts and allow the user to alternate between component and system levels (see Figure 2). The tool will use both structured exercises and open-ended exploration and solutions (i.e., no single correct answer but instead a range of acceptable solutions). The GUI will also give feedback about HVAC system and component status, track student progress toward objectives, provide or hide "Hints" and other assistance, and record student progress and scores. The tool will be usable on CD or the web and will hide the complexity of the interfaces of the simulation programs used.

The tool will contain models of control functions for each HVAC component model within SPARK to simulate typical HVAC control loops. The simulation will be usable in two modes:

1. a virtual mode in which both the HVAC system and its controls are completely resident in software, and
2. a hybrid mode in which the controls are a "real" hardware interface to commercial control-system components. This simulation-based environment is a relatively low-cost, low-risk way for students to learn about the real-world behaviors of the large, complex HVAC systems typically found in commercial buildings. It is impractical and expensive to use laboratory or real environments for studying such systems; moreover, if a student makes a serious error during a simulation, no real damage is done. The exercises will be structured so that as students' skills increase, the problems to be solved will become progressively more complex. Simulation-based exercises demonstrate the symptoms of faulty component and system operation, and can be used to develop and test students' diagnostic abilities.

Outreach and Articulation with Pre-College Programs and Four-year Colleges

The existing Laney College program currently serves approximately 50 new students each year. Laney and several other community colleges will begin serving 600 new students per year as a result of the following activities:

- Berkeley Lab's Center for Science and Engineering Education will support participation of faculty-student teams from institutions across the country in buildings energy research, exposure to building operator and technician career opportunities, and activities to promote curricular improvements at community colleges.

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PROFORM: Assessing Energy and Environmental Impacts

How much energy is saved by spending X dollars installing energy-efficient lights, and what is the financial return on that investment? How many tons of carbon dioxide (CO_2) emissions are avoided by developing a 50-megawatt wind farm? How does switching from burning coal to burning natural gas in a generating plant reduce emissions? ProForm, a free spreadsheet program developed by researchers in Lawrence Berkeley National Laboratory's Environmental Energy Technologies Division (EETD), has been answering these questions for users all over the world since 2000, and its developers have just released a new, easier-to-use Version 4.0.

Energy-efficiency and renewable-energy projects are increasingly popular as governments and international agencies recognize the benefits of these efforts. Projects of this type help reduce the cost of supplying energy, improve the environment by reducing air pollution and greenhouse gases, lower citizens' energy bills, and increase the reliability of energy supply. ProForm helps users quantify these benefits.

ProForm's development was funded by the U.S. Department of Energy and the U.S. Agency for International Development, and the program now has more than 1,000 registered users in 60 countries. Roughly 60 percent of registered ProForm users are outside the United States. About 15 percent of these users are affiliated with domestic or international governments, 10 percent are with universities or other learning institutions, and 10 percent are with non-profit organizations. ProForm has been used to calculate financial returns and greenhouse-gas emissions savings from micro-hydro projects in Guatemala, photovoltaic installation programs in South Africa, and wind farms in Mongolia, among many other examples.

EETD researcher William Golove says, "We designed ProForm to make it easy to assess the environmental and financial impacts of renewable-energy and energy-efficiency projects. Give it the necessary data, and ProForm 4.0 calculates basic financial indicators and avoided emissions of CO_2 and local air pollutants expected from a project.

"We'd like as many potential new users as possible learn about ProForm; it's a very powerful, robust, and mature software tool that can really help ease the process of getting energy-efficiency and renewable-energy projects underway," adds Golove.

Used by project planners at both government and international agencies as well as private companies developing efficiency and renewables projects, ProForm is simple enough to quickly analyze projects on the drawing board, but it applies a sophisticated economic analysis to produce credible results.

"A typical application is a developer preparing a project proposal to submit to potential investors, financiers, or a national climate-change office," explains Golove. "ProForm allows project developers, financial institutions, and other parties to investigate how changes in basic assumptions affect the key parameters of a project."

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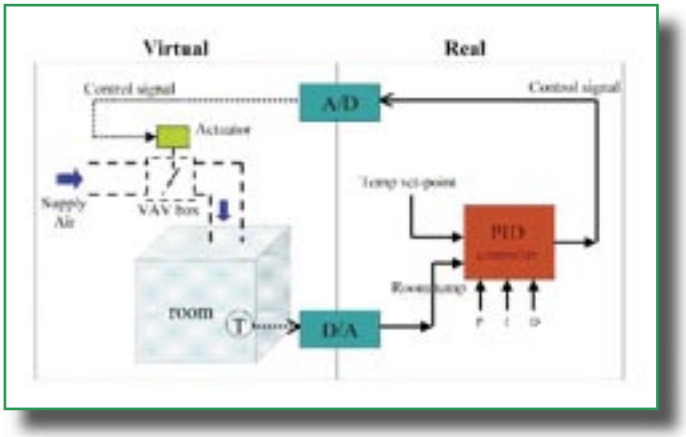

Figure 3. VAV control simulator example: hybrid software-hardware configuration

- Berkeley Lab will support community college faculty and students at colleges with environmental controls technology associate degree programs so they can use the updated curriculum and innovative tools developed through this partnership. The first workshop to promote the dissemination of the tools will be held in summer 2005.
- Students completing associate degree programs and interested in pursuing four-year degrees will be able to participate in buildings sciences research at Berkeley Lab.
- Berkeley Lab will design, in collaboration with high school teachers, a summer physics course that allows high school students to earn concurrent credit at Laney College and Oakland Unified School District. The course will teach core physics concepts through hands-on experiences in environmental controls and technology and will introduce students to careers in environmental control technologies and energy-efficient building sciences.

—Evan Mills, Phil Haves, and Roland Otto

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PROFORM: Assessing Energy and Environmental Impacts

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The new version of ProForm has an easier-to-use interface and is much more powerful and complete than the previous version, thanks to changes suggested by users. For example, Version 4.0 can analyze two new types of projects: fuel switching and landfill methane-gas capture. Fuel-switching projects involve substituting a less carbon-intensive fuel for a more intensive one. Landfill methane-gas-capture projects make use of the methane generated by solid-waste decomposition to generate energy. The captured methane is used either to generate electricity or provide heat.

The new Proform 4.0 also allows more detailed financial calculations of project revenues and expenses and more complicated financing methods than the previous version. For example, a user can analyze projects that rely on more than one loan for financing.

The newly updated tool is now available for download at: http://poet.lbl.gov/Proform/.

The download includes a brief introductory document, a detailed new user manual, and five case studies demonstrating how to use ProForm for a wide variety of projects.

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Improved Control Algorithm Appears in a Next-Generation Daylighting Product

The commercial market has recognized the energy-saving potential of this algorithm, first proposed in 1984.

Seeking ways to save billions of dollars in lighting energy by using daylight to reduce electric lighting needs, researchers at the Lawrence Berkeley National Laboratory (Berkeley Lab) Environmental Energy Technologies Division (EETD) proposed, in 1984, a method to make daylight sensors more reliable. Now, this method, the sliding setpoint algorithm, has been incorporated in a commercial product, the LS-301 Dimming Photosensor recently released by The Watt Stopper Incorporated (see Figure 1).

Proposed by EETD researcher Francis Rubinstein, the sliding setpoint algorithm was first presented in *Energy and Buildings* and later refined in a paper published in the *Journal of the Illuminating Engineering Society* with co-authors Greg Ward and Rudy Verderber. The researchers, who were part of the Division's Lighting Group, were striving to correct the tendency of daylight sensors to over-dim electric lights in response to increasing daylight in a room. (Verderber is now retired, and Ward is no longer at Berkeley Lab.)

Figure 1. *The LS-301 dimming photosensor from The Watt Stopper uses an algorithm developed by EETD researchers.*

"We had determined that the standard control algorithm used by most manufacturers of daylight photosensors at the time did not work well, and we developed the sliding setpoint algorithm to solve these problems," says Rubinstein, who is still a scientist in the Lighting Group. "We spent quite a bit of time experimenting with different photocell configurations in a scale model located on the roof of a lab building."

Jerry Mix, president of The Watt Stopper, praises EETD's research: "The work of Francis Rubinstein and his colleagues at Berkeley Lab has provided us with great insight into the complex problem of dimming lights in response to daylight. We believe that their concepts, now implemented in real products, will go far to realize the dream of reducing energy use while providing highly desirable control."

Daylighting Saves Energy

Back in 1983, Rubinstein estimated in a published paper that daylighting with an effective lighting control system could save hundreds of millions of dollars per year in lighting energy costs. "That potential for energy savings still exists," he says today, "and it is still unrealized."

To use daylighting effectively as an energy-saving strategy, daylight photosensors need to be able to accurately track the daylight entering a room and to dim the electric lighting in proportion to the amount of daylight detected. As daylight increases, a control system receives input from the photosensor and automatically dims or turns off the overhead lights, saving lighting energy in the process.

The problem is that most daylight photosensors are easily fooled by the amount of daylight entering the room. When these photosensors use the standard "constant setpoint" control algorithm, they respond too strongly to the light coming in from the window and turn down the electric lights too much, so a constant total illumination level is not maintained at the desk surface. (Algorithms allow control systems to transform the signal from a sensor into a control signal to change the light level.)

The sliding setpoint algorithm "effectively reduced the sensitivity or gain of the control system," Rubinstein explains. The improved algorithm allows the lighting control system to keep illumination in a space roughly constant regardless of daylight level, so, as daylight levels increase during the day, building occupants do

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Improved Control Algorithm Appears in a Next-Generation Daylighting Product

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not experience annoying dips in total illumination. (see Figure 2).

With the sliding setpoint algorithm, the control system adjusts the electric light level so that the total light level detected by the photosensor is a linear function of the daylight component of the photosensor signal.

"In our research, we characterized the existing control algorithm and the improved sliding setpoint algorithm and showed how they both performed," says Rubinstein, who coined both terms. "We also built circuits to show how the sliding setpoint method would work and tested the system in a daylighted scale model at Berkeley Lab. The concept sat on a shelf for quite some time, probably because the sliding setpoint algorithm required two calibrations of the photocell —one that set the desired light level at night, when there's no daylight, and one during the day." This additional calibration required that manufacturers change their hardware and commissioning process. ("Commissioning" means setting up a system and making sure it works according to specifications.)

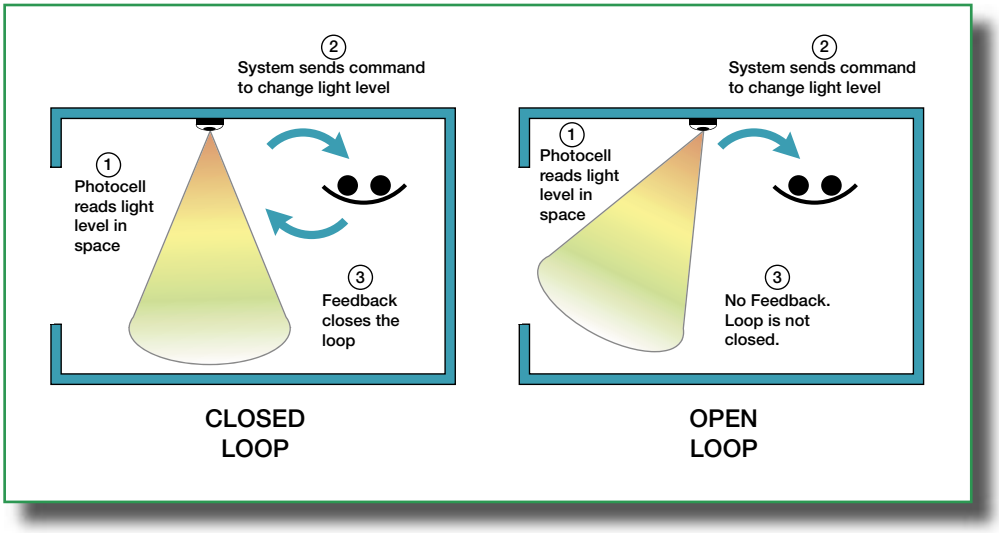

Figure 2. *Closed and Open Loop Control Systems for Daylighting*

The Wattstopper Inc. Develops Improved Technology

Searching for ways to improve on its existing daylighting controls, The Watt Stopper Inc. turned to the papers authored by Rubinstein and his colleagues. The Santa Clara, California-based company has worked with Berkeley Lab researchers in the past, for example, on an improved lighting control system for hotel bathrooms (http://www.lbl.gov/Science-Articles/Archive/EETD-lighting-demo.html).

Combining the sliding setpoint algorithm with wireless technology, engineers at the company have created a new dimming photosensor called the LS-301, which became available on the market in August 2004. "Until now, the setup and adjustment of a sliding setpoint device has been daunting. Now, we have combined technologies to create a device that is user friendly," says Mix.

The technology consists of the daylight sensor itself and a handheld commissioning control unit. The commissioning unit is used by the installer once per sensor to establish the setpoints, one during the day, and one at night. Previously, sensors, usually mounted in ceilings, were adjusted by installers on ladders. The commissioning remote helps them work more rapidly and safely. A second handheld remote allows the room's occupants to adjust lighting levels within the range of the setpoints they desire.

The Watt Stopper also designed their photosensor with an improved detector that responds to different wavelengths of light in the same way as the human eye. That is, the spectral response of the sensor matches the photopic response of the human eye.

"I'm pleased to see that Wattstopper has taken our ideas and added their own innovations to provide a practical solution to a real-world problem. Companies like Wattstopper, which invest in daylighting control technologies, are improving the quality of the lighted environment while helping consumers conserve energy and natural resources," says Rubinstein.

Mix adds, "We value our continuing work with Berkeley Lab to provide control solutions that are simple to install and adjust. We believe that the greatest deterrent to the success of the daylighting controls is whether or not the devices are initially set up and adjusted correctly by the installer. We now have the ability to build greater intelligence into the controls to automate the initial adjustment."

The Watt Stopper and Rubinstein are now working together to develop a next-generation version of this technology that will further simplify the commissioning process. The continuing work, funded by the California Energy Commission's Public Interest Energy Research program, aims at making a sliding setpoint device that can be adjusted in one visit.

—Allan Chen

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For more information about The Watt Stopper Inc., see http://www.wattstopper.com/

This research is funded by the U.S. Department of Energy, The Watt Stopper, Inc., and the California Energy Commission's Public Interest Energy Research program.

GAS-FILLED PANELS

The Lawrence Berkeley National Laboratory (Berkeley Lab) Technology Transfer Department licenses a wide range of cutting-edge technologies to companies that have the financial, R & D, manufacturing, marketing, and managerial capabilities to successfully commercialize Lab inventions. It develops and manages an array of partnerships with the private sector.

Figure 1. *The cellular structure of the gas-filled panel is called its baffle.*

Gas-filled panels

(GFPs) have a great deal of potential for use in building materials, appliances, vehicles, and insulation applications, where insulation is needed. GFPs are an innovative approach to ambient-temperature thermal insulation. They consist of infrared-reflecting (low-emissivity), multilayer baffles enveloped by a sealed barrier and filled with a low-conductivity gas or air (at atmospheric pressure). More descriptive information on the panels can be found at http://gfp.lbl.gov/.

Licensed uses include building insulation and insulated shipping containers. A potential application for gas-filled panels could be insulation for refrigeration equipment. Energy use of domestic refrigerators and freezers is directly influenced by the overall thermal performance of the cabinet and the doors.

Appliance insulation

Berkeley Lab researchers, in conjunction with Oak Ridge National Laboratory, performed experiments using prototype refrigerator doors and cabinets equipped with GFPs. Their use in door panels increased the overall energy efficiency of the refrigerator by 6.5%. Projected savings could reach as high as 25% when GFP insulation is used throughout the entire refrigeration cabinet as well as in the door panels.

Figure 2. *An assembled GFP from the side, and in profile*

Building insulation

Insulation materials are critical in buildings designed for low energy use and good thermal comfort. Fi-Foil Inc. has licensed GFPs for building construction. Increasing the overall level of thermal resistance, or R-value, of insulation is an effective strategy to lower heating. GFPs can be a boon to buildings because their insulating possibilities permit much higher R-values; the reflective nature of their outer skin and the air or gas barrier provides as much as if not more insulation than commonplace batt insulation.

The use of GFP insulation could contribute to lower building costs, because ceilings are often constructed with larger framing timbers (2 x 6s or 2 x 12s) to allow for maximum insulation. The GFP insulation, while providing equal or greater R-values, can easily fit into conventional 2 x 4 construction. An additional benefit is the flexibility of the panels, which can be manufactured in a variety of shapes to accommodate cavities in buildings walls, and roofs.

Vehicle insulation

Thermal insulation will be increasingly important in the future development of cars because significant improvements in gas mileage can be achieved by downsizing automobile heating, ventilation, and air conditioning equipment.

Here again, GFPs can contribute their light weight, and superior insulating qualities. A story about research using GFP insulation in cars is available at http://eetd.lbl.gov/newsletter/nl2/nl_2.html.

Packaging

GFPs are already used in packaging and shipping containers. Not only do they help eliminate some less-desirable packaging materials (Styrofoam "peanuts," for example), but they are also a better insulating material, especially for perishable goods. One technology using GFPs is Airliner®, developed by CargoTech (http://www.cargotech.com/company/).

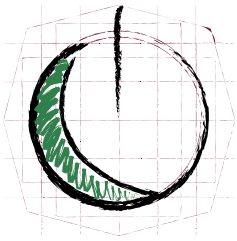
Figure 3. *GFPs insulating a car (above) and a refrigerator door (cut-away)*

—Ted Gartner

Contact Lawrence Berkeley National Laboratory's Technology Transfer Department at: http://www.lbl.gov/Tech-Transfer/.

Research Highlights

Better Power Interfaces for Computers and Consumer Electronics



A new standard, IEEE 1621, that addresses power control in PCs, other office equipment, and consumer electronics has just been approved by the Institute of Electrical and Electronics Engineers (IEEE) Standards Board. The standard should lead to greater use of low-power "sleep" modes, which will save large amounts of electricity.

Standard 1621 defines principles and design elements—mainly terms, symbols, and indicator lights—that should be consistent among all affected products. The effect of the standard could be compared to the effect of standardizing the placement of gas and brake pedals on cars so that drivers always know which pedal to press to accelerate or stop no matter which car they are driving.

Bruce Nordman, a Principal Research Associate at the Lawrence Berkeley National Laboratory Environmental Energy Technologies Division, worked with industry to draft the standard and shepherd it through the approval process.

"IEEE 1621 will be an important tool for the computer and consumer electronics industries because the days when everything was just 'on' or 'off' are gone," says Nordman.

Computers and other office equipment have multiple power modes, and many consumer electronics will soon have multiple modes as well. In each mode, devices behave differently. Because modes are marked inconsistently from product to product (e.g., "standby," "sleep," etc.) many users are confused and just leave devices on all the time. "The looming potential for great confusion can be averted by IEEE 1621," says Nordman, "which manufacturers can use in any electronic product."

Recognizing that this problem reduces consumers' effective use of electronic products and wastes energy, Nordman has worked since early 2000 with equipment manufacturers and other stakeholders to fashion a solution acceptable to industry that will ultimately change PCs, printers, copiers, TVs, CD and DVD players, and stereos, to name a few product classes, for the better.

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Also, see: "Simple Symbols that Save Energy." 2003. *Science Beat*. Lawrence Berkeley National Laboratory, June. http://www.lbl.gov/Science-Articles/Archive/EETD-simple-symbols.html

Fuzzy Logic and Public Health

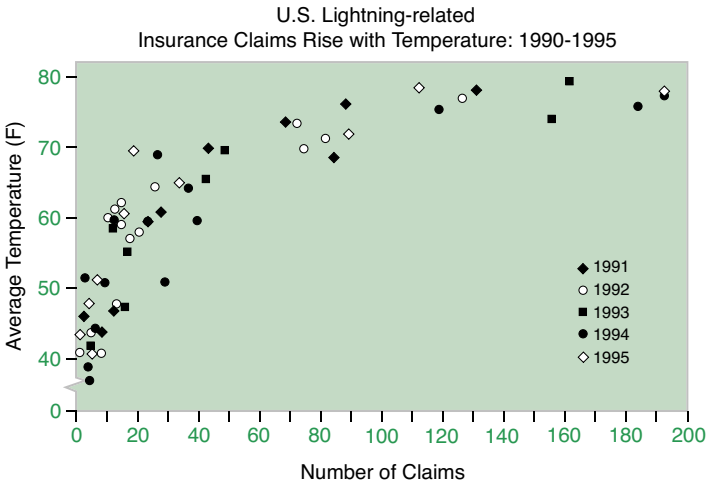
Thomas E. McKone is a senior scientist in the Environmental Energy Technologies Division, and adjunct professor in the School of Public Health at UC Berkeley, who has published, with a colleague at the National Environmental Engineering Research Institute in India, a paper examining the use of fuzzy logic in risk assessment and environmental modeling. The article, which appeared on the cover of the January 15 issue of *Environmental Science and Policy*, applies fuzzy logic to the problem of assessing the water quality of the Ganges River in India and judging whether two locations are "safe" for bathing. Bathing in the Ganges plays a significant role in Indian religious ritual but pollution in the river raises concerns for health participants in bathing rituals.

The Insurance Industry and Climate Change

At the 2005 annual meeting of the American Association for the Advancement of Science, EETD researcher Evan Mills outlined new findings on the vulnerability of the world's insurance industry to the impacts of climate change. The impacts of abrupt headline-catching catastrophes are well known, but Mills' talk focused on relatively small-scale, gradual, and indirect impacts such as increased lightning activity, subsidence-related damage to pipelines and power distribution systems by thawing permafrost or shrinking soils under drought conditions, and elevated political risk from trade or financial market disruptions. Taken collectively, the annual impacts of these types of events are equal in cost to those of mega-catastrophes.

Mills described the historical and financial impacts of extreme weather events on insurers. These include significantly eroded revenues and profitability, increased prices, and, in some cases, bankruptcies. Over the past five decades, insured losses from weather-related events have increased 15-fold, adjusting for inflation. Of key importance to insurers is the expected increase in volatility of losses resulting from climate change, and reduced predictability of the frequency, spatial distribution, and magnitude of losses.

The talk also covered preliminary findings from a major insurance-industry-funded study on the health impacts of climate change. Risk factors expected to be elevated under climate change include infectious diseases such as malaria and Nipah virus, urban heat catastrophes, aeroallergens (e.g. pollen), crop damage from agricultural pests, coral bleaching and consequent vulnerability of human settlements to tidal surges, super-infestations of forest pests, and wildfire. The study is led by the Harvard Medical School's Center for Health and the Global Environment, with a major role being played by Berkeley Lab.



Source: Hartford Steam Boiler Inspection and Insurance Co. claims data (2000).
Each symbol represents a lightning storm event.

A case in point is the European heat wave of summer 2003 in which temperatures were six standard deviations above the norm. Human consequences included 22,000 to 35,000 fatalities and uncounted hospitalizations, nuclear power plant shutdowns (due to elevated river cooling water temperatures), massive crop losses, and wildfires.

Constructive measures that can be taken by insurers to manage climate risks include strategic employment of sustainable energy technologies that have risk-management co-benefits such as reducing risk of heat mortality. Mills' presentation highlighted the particularly significant risks (as well as opportunities) in the developing world—where hazards are often greater and preparedness vastly poorer—described in a recent study completed by Mills for the U.S. Agency for International Development, titled "Insurance as an Adaptation Strategy for Extreme Weather Events in Developing Countries and Economies in Transition" (LBNL-52220).

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An EETD Blog: bleer.lbl.gov

The Berkeley Lab Energy and Environmental Research blog (http://bleer.lbl.gov) is now public.

The blog covers research in the fields of energy efficiency, the environmental sciences, and related areas conducted at Lawrence Berkeley National Laboratory, primarily in the Environmental Energy Technologies Division. It describes reports, publications, books, software releases, field demonstrations, conferences, and miscellanea that are not necessarily covered by Berkeley Lab's press releases or other web news resources.

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Environmental Energy Technologies Division

The mission of the Environmental Energy Technologies Division is to perform research and development leading to better energy technologies and the reduction of adverse energy-related environmental impacts.

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