Lawrence Berkeley National Laboratory

Vol. 2 No. 4

Environmental Energy Technologies Division News

Air Quality Advanced Technologies Building Technologies Energy Analysis Indoor Environment

# The California Energy Crisis: A Brief Summary of Events

*Editor's Note: This special issue of EETD News examines the California energy crisis of 2001, and research and development underway at the Environmental Energy Technologies Division of Lawrence Berkeley National Laboratory focused on helping to solve the crisis, both in the short and long term.*

The energy crisis in California has been in the news since 2000, when rapidly rising energy prices in the San Diego area first hit the headlines. Described as the consequences of the failure of the state's experiment in utility restructuring, the crisis, characterized by high wholesale prices of electricity, increasing frequency of Stage I, II, and III power alerts, and rolling blackouts, spread to the rest of the state in 2001.

Forced to buy expensive wholesale power on the spot market, California's investor-owned utilities rapidly acquired unsustainable levels of debt, while being forbidden by law from passing along the high costs of electricity to their retail customers. During the winter months of 2001, natural gas prices also spiked, sending retail gas bills through the roof. It was during the winter months that the state began experiencing power alerts, and rolling blackouts, or the frequent threat of them.

In April 2001, Pacific Gas and Electric (PG&E), northern California's investor-owned power utility and one of the largest utilities in the United States, now billions of dollars in debt, declared bankruptcy. Meanwhile, Southern California Edison (SCE) teetered on the edge of the same, forcing the state government's authorities to wrestle with complex solutions. The state's Power Exchange, which had been set up under restructuring legislation as the spot market for utilities and power generators to buy and sell power, closed down. The California Independent System Operator (CalISO) bought increasing amounts of power to keep the state supplied, and the electrical grid balanced.

However, a combination of short-term problems kept sufficient power from being available: they included larger than anticipated plant shut-downs, and a record dry year in the Pacific Northwest, which has traditionally sold summertime hydropower into the California market. By this time, a number of state and federal authorities, including the California Energy Commission (CEC), the State legislature, and the State Attorney general's Office, were investigating whether the causes of plant shutdowns, which were running at higher levels than at the same time in previous years, were in fact for legitimate maintenance—although questions about plant shutdowns were being asked as early as the fall of 2000.

With the failure of the Power Exchanges, and the CalISO buying more than half of the electricity used in the state, the state moved to secure as much power through long-term contracts as possible, with the California Department of Water Resources acting as buyer. The CalISO was originally intended to oversee and balance the electrical grid. To help provide revenue for the state's indebted utilities, the California Public Utilities Commission (CPUC) approved a substantial retail electricity rate increase, which would become visible in most customers' June bills, ranging from 20 to 30%, even as the state legislature worked on bailout plans for PG&E and SCE.

The state also moved to speed the approval of new power plants—which will not impact the energy problem substantially this year because of the length of time it takes to build them—and implement a cornucopia of programs to encourage energy conservation and efficiency to avoid rolling blackouts. One in particular, the Governor's 20/20 Rebate Program, provides a 20% rebate on electricity bills to customers who reduce their energy use by 20% during their June through September billing months.

At this writing, the programs encouraging conservation and efficiency were having a substantive effect in reducing the magnitude of the crisis. According to CEC statistics, in May 2001, Californians reduced monthly peak demand by 10%, 14% in June, 11% in July, and 9% in August, compared to the previous year.

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## In this Issue



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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Energy use declined by 11% in May, more than 12% in June, 5% in July, and 7% in August. More than 30% of utility customers in California have qualified for rebates under the 20/20 program. As the core summer months pass, the state is getting an assist from cooler than normal temperatures, which are reducing air conditioning loads; a declining economy has also reduced peak and energy demand. State authorities have been thanking Californians for their conservation efforts, to which they attribute in part the sharp drop in wholesale electricity prices since June.

Although California's power situation is unique in certain ways, the possibility of energy shortages elsewhere in the U.S. is not. The U.S. Department of Energy has warned that other regions are facing tight energy supply situations and possible blackouts. Solutions applied successfully in California should interest energy managers in other parts of the country.

Berkeley Lab's Environmental Energy Technologies Division has been developing energy-efficient technologies and practices and studying end-use energy consumption in the United States since the mid-1970s. Indeed, the Division was created in part as a response to the first energy crisis brought on by the oil shocks of the 1970s. For more than 25 years, Division researchers have been developing, demonstrating, and helping commercialize energy-efficient solutions that help reduce energy bills, emissions of air pollutants and greenhouse gases, and the nation's dependence on energy imports.

This special issue of EETD News explores some of the work of the Division that is helping California deal with its energy crisis, from web sites developed as a short-term response to the crisis, to ongoing work that increases the efficiency of energy use in residences, commercial buildings and industry, and how that work also helps the rest of the nation.

*—Allan Chen*

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## California's Electricity Market

| | |
|---|---|
| **Generation (1999)** | **276,000 GWh** |
| Utility | 130,000 GWh |
| Non-utility | 96,000 GWh |
| Imports | 49,000 GWh |
| **Consumption (2000)** | |
| Peak load | 53 GW |
| Consumption | 264,000 GWh |
| Retail Electricity Market value | $20 billion |
| **Customers (2000) million** | |
| Residential | 11.4 |
| Consumer | 13.1 |

Source: California Energy Commission

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BERKELEY LAB

### *Lawrence Berkeley National Laboratory*

Ernest Orlando Lawrence Berkeley National Laboratory is a multiprogram national laboratory managed by the University of California for the U.S. Department of Energy. The oldest of the nine laboratories, Berkeley Lab is located in the hills above the campus of the University of California, Berkeley.

With more than 4,000 employees, LBNL's total annual budget of nearly $400 million supports a wide range of unclassified research activities in the biological, physical, computational, materials, chemical, energy, and environmental sciences. The Laboratory's role is to serve the nation and its scientific, educational, and business communities through research performed in its unique facilities, to train future scientists and engineers, and to create productive ties to industry. As a testimony to its success, LBNL has had nine Nobel laureates. EETD is one of 13 scientific divisions at Berkeley Lab, with a staff of more than 400 and a budget of $40 million.

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# The California Energy Crisis: Long- and Short-Term Solutions

Researchers at EETD have worked with agencies in California and its utilities since the Division's beginnings in 1974 to help the state use energy more efficiently, reduce its energy bills, and thereby improve its productivity. During the current electricity crisis in the state, Division researchers have provided technical consultation to the California Energy Commission (CEC), the California Public Utilities Commission, the state legislature, and other agencies of the state, as well as worked on a number of formal projects funded by the CEC through its Public Interest Energy Research (PIER) program.

Buildings account for 66% of California's annual electricity use and 72% of peak load, up from 62% and 70% respectively a decade ago. These increases represent 90% of the consumption load growth and 94% of peak load growth of all sectors in the State from 1990 to 2000. EETD's expertise in building technologies, the indoor environment, building codes and standards, and end-use energy efficiency issues is being brought to bear to help California address its energy challenges.

An active participant in the CEC's Public Interest Energy Research Program, EETD has also worked in the area of utility market transformation programs, which help migrate markets toward the purchase of more efficient technologies, and supported California's electricity reliability and peak load demand programs targeted to the summer of 2001. Laboratory researchers are also developing new tools targeted to help the State and its ratepayers achieve substantial electricity savings from this summer through 2004.

## Contributions to California's 2001 Energy Programs

**Technical Assistance for Peak Load Demand Reduction Programs:** EETD has been supporting the CEC in its implementation of building energy standards updates, appliance efficiency regulations updates, and peak load demand reduction activities under the provisions of Assembly Bill 970. As part of our Department of Energy Federal Energy Management Program responsibilities, we have worked with federal agencies in the State to advise them of opportunities to participate in the AB970 peak load reduction program and have served as a linking pin to the Commission on their behalf.

**Contributions to Summer 2001 Electricity Reliability:** Through the Consortium for Electric Reliability Technology Solutions (CERTS), EETD is involved in several activities addressing the State's 2001 reliability challenges, including:

- Installing and demonstrating CERTS reliability-enhancing software tools at California Independent System Operator (CAISO);
- developing load participation programs planned by CAISO; and
- reviewing congestion management by CAISO.

**Energy Efficiency and Peak Load Savings Programs for California:** Lawrence Berkeley National Laboratory's Director, through targeted funding from the University of California, is providing support to develop new, innovative energy-efficiency programs that can help the state reduce average and peak electricity load.

**20% Savings Website:** In March, 2001, Governor Davis issued an Executive Order to implement a rate reward program for conservation efforts by all electricity customers in the State to reduce consumption by at least 20% from June through September 2001, compared with the same four months in 2000. To assist ratepayers in achieving the 20% target in residences, EETD developed a website that identifies a large range of savings opportunities and measures that take into account both the climate zone and house type in which the user resides (savepower.lbl.gov).

**Energy Supply and Demand Website:** EETD has developed a web-based management tool for California's energy users: a site that shows the total demand for electricity in California and the supply available to meet that demand in real time (energycrisis.lbl.gov). See a related story on page 12.

## Public Interest Energy R&D Development Contracts

EETD is one of the largest contractors to the California Energy Commission under its PIER program. These partnership projects with the State are structured as collaborations among labs, universities and industry for energy technologies R&D.

## End-use energy efficiency projects

**Instrumented Home Energy Rating and Commissioning:** This project's purpose is to develop better tools and techniques to verify energy performance of residential buildings and building components, including insulation, envelope, and duct sealing.

**Energy-Efficient Down-lights for California Kitchens:** With lighting industry partners, EETD is working to develop a single, dimming, electronic ballast that controls multiple compact fluorescent down-lights to reduce the number of ballasts required for a typical kitchen layout by 75% to 80%, and to develop thermoplastic fixtures with high efficiency coatings to reduce production costs, increase system performance, and result in light output effi-

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*continued from page 3*

ciency increases of 15% to 25% over existing CFL reflectors.

**HVAC Distribution Systems in Commercial Buildings:** Researchers are working to determine how leaky or poorly designed air-distribution systems waste energy used to condition air, and to develop methods to correct these problem systems. (See the article on the following page.)

**Next-Generation Power Management User Interface for Office Equipment:** This project's goal is to design a new, standard interface for office equipment power management that will provide for power-saving features to be used more effectively, reducing energy use and cost for users of commercial office equipment and appliances.

**Energy-Efficient Labs and Cleanrooms for High-Technology Industries:** A recent project is targeted to high-technology industries to develop resources and tools to help cleanroom and laboratory facility designers and operators achieve a 50% reduction in energy.

**Technical Analysis in Support of California Climate Action Registry:** EETD is supporting the Commission in carrying out its statutory responsibility to provide defensible greenhouse gas emission metrics and methodologies under Senate Bill 1771, which established the California Climate Action Registry. This information will also be used to help the CEC better develop a long-term research plan in support of the implementation of SB 1771.

## Advanced Energy Efficiency Technology for Commercial Buildings

Commercial buildings account for about one-third of all electricity consumption in California. This three-year research initiative, undertaken in coordination with 15 academic, industrial, and utility partners, will develop and deploy a set of energy-savings technologies, strategies and techniques, and improve processes for designing, commissioning, and operating commercial buildings, while improving health, comfort, and performance of occupants. The goal is to reduce electricity use in the California commercial sector by 22% (24,000 GWh) by 2015, while assuring that these savings are affordable and promote high-quality indoor environments. Five program elements include:

Life-Cycle Tools
Lighting, Envelope, and Daylighting
Low-Energy Cooling
Integrated Commissioning and Diagnostics
Indoor Environmental Quality

(See the following article, for more explanation of these programs.)

## Electricity reliability research

With the help of the Electric Power Research Institute and the National Consortium for Electricity Reliability Technology Solutions (CERTS), of which Berkeley Lab is a member, EETD is undertaking an integrated set of research and technology development efforts to maintain reliability, enhance access to the electric infrastructure, and improve overall system efficiency. The technical goals of the program are to maintain system reliability at a loss-of-load probability of one-day-in-ten years, improve access to the system for multiple generator and load types, improve the ancillary services market, and improve overall system efficiency. The specific technical objectives of this effort are to:

- develop consensus on research needs and approach, through an ongoing roadmapping effort;
- develop real-time system management tools, including wide area monitoring systems;
- evaluate the ability of distributed technologies in widespread use to improve system reliability;
- develop advanced hydro-generation simulation tools; and
- improve market rules for ancillary services.

EETD is undertaking three programs to assist the State and its ratepayers to realize substantial energy savings between 2001 and 2004.

This article summarizes major programs funded by California state agencies that are intended to improve the state's energy efficiency through technology R&D. Many other research programs carried out over the years by EETD, and currently in progress, will also have a substantial effect on the state's energy use. For example, EETD provides technical consultation to the Department of Energy on appliance standards, and to the DOE/EPA's ENERGYSTAR program on a variety of energy-efficient technologies and designs. The Division works with the Federal Energy Management Program to improve the efficiency of federal facilities, including those in California, and to help develop guidelines for the federal procurement energy-efficient products like office machines. Its work with other DOE programs such as Rebuild America, Building America, and EnergySmart Schools, and the Department of Housing and Urban Development's PATH program helps communities in California and the rest of the nation build and rebuild energy-efficiently.

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# High-Performance Commercial Building Systems

The California Energy commission's Public Interest Energy Research (PIER) program has funded a three-year, $9 million research initiative to reduce the energy use of commercial buildings (see *EETD News,* vol. 2, no. 3, p. 1 for announcement.)

Commercial buildings use one-third of all electricity consumed in California. EETD research suggests that the energy use of these buildings can be reduced by 30 to 50%, but capturing these savings requires an integrated program of research, development, demonstration, and market transformation to bring the necessary technologies and practices into common use. Having a roadmap for the program is particularly important in view of the fact that in the buildings sector, with its complex relationships among builders, vendors, designers, and contractors, new innovations can take 10 to 20 years to diffuse into the market.

Berkeley Lab's EET Division is the prime contractor for the PIER-funded High-Performance Commercial Buildings Program (HPCBS), leading the work of about a dozen public and private sector partners. The program's goals are to reduce electricity use in the California commercial sector by 22% by 2015, while assuring that these savings are affordable, and to promote high-quality indoor environments. These energy savings would amount to approximately 24,000 GWh (gigawatt-hours) per year and would save ratepayers $2.4 billion per year. Additionally, the energy savings would benefit the global environment by reducing carbon emissions by 2,260,000 tons per year.

The project is divided into five technical elements (life-cycle tools; lighting, envelope and daylighting; low-energy cooling; integrated commissioning and diagnostics; and indoor environmental quality.)

These articles summarize the goals of the five elements of the research and some recent milestones.

## Life-Cycle Tools

The element's goal is to develop integrated information management technologies to assist in improving commercial building performance. The problem it seeks to solve is the fragmentation of information flow among the designers, builders, and operational managers of buildings, who generally don't communicate information such as design intent and expected performance of building systems with one another. The resulting loss of information from design to construction and then to the operational phases of a building's life increases its energy bills, reduces occupant comfort, and can shorten the useful life of the building.

Technologies that are missing from the design-build-operate life cycle of buildings, and that we are developing, include standard performance metrics and benchmarking tools, methods for retrofit performance analysis, and protocols for exchanging data among building software programs.

Team members in this element (EETD, MIT, Silicon Energy, and Honeywell) are developing and expanding a number of tools or protocols: for performance metrics and benchmarking (Cal-ARCH); for improved analysis of retrofitting buildings (Metracker and RESEM), and for interoperable building simulation software (activities of the International Alliance for Interoperability (IAI) and its Industry Foundation Classes (IFCs) standard).

The Cal-ARCH, Metracker, and RESEM programs are all in development; software specifications for each tool have been completed. Team members have been working with the IAI to develop IFC protocols for HVAC systems simulation—with this tool, software programs from different manufacturers will be able to exchange data easily with each other.

A benchmarking project is underway, in which energy data collected from school buildings and a college campus are providing the basis for a common set of benchmarks to measure and rate the energy performance of commercial buildings. As the project continues next year, data will be collected from a larger sample of school buildings. The U.S. Environmental Protection Agency has used this data to modify its energy benchmarking methodology, and the state of California has found it useful in the planning of the Governor's Energy Challenge.

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## Lighting, Building Envelope, and Daylighting

High cost and poor performance have limited market penetration of controllable lighting and building envelope systems. Lighting and envelope systems, often manufactured by different vendors, cannot communicate with one another, preventing their optimization for energy efficiency and occupant comfort.

The goal of this element is to develop an integrated building equipment communications system (IBECS) that will provide Internet-based control of lighting, daylighting, and envelope systems. The project team (EETD, Vistron, and MB Associates) is developing lighting controls: a networking system combining lighting controls and envelope systems, such as motor-controlled blinds or electrochromic windows; and network software to commission, maintain, and diagnose problems within these building subsystems.

Prototypes for a number of the deliverable products of this element have been completed. They include an IBECS ballast network interface switch for controlling fluorescent lighting, and an IBECS-controllable, Title 24-compliant wall switch (see drawing on next page). The IBECS ballast network interface has been successfully tested in an office at Berkeley Lab. We are beginning the development of an IBECS-ready occupancy sensor, that will also be able to measure other variables such as lighting level and temperature, and transmit this information over the network.

A test-bed demonstration of a sensor-controlled electrochromic window installation in an office (see *EETD News,* vol. 2, no. 1, p. 1) has shown that this technology can be used to improve energy efficiency and occupant comfort, although additional testing and refinement of the technology will be necessary. Earlier tests of an actively-controlled Venetian blind daylighting system for office windows also showed great promise.

We are now developing plans to launch a multi-year engineering field test of electrochromic window systems in commercial buildings, and to develop the control technology needed for

whole-building, active load management. We are also developing an IBECS-ready control system for the Venetian blind daylighting technology.

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## Low-Energy Cooling

Conventional cooling systems are energy-intensive, contributing substantially (14%) to peak electricity demand in California. That demand is increasing as population grows in California's hotter inland areas. A number of compressorless cooling-system technologies can increase cooling efficiency, and methods are available to reduce cooling losses in the distribution system. The goal of this element is to significantly reduce cooling energy use and peak demand in commercial buildings. Other goals include improving health and productivity through systems that improve indoor air quality and comfort.

The project team partners (EETD, UC San Diego, Ove Arup and Partners, and Flack + Kurtz) are identifying and evaluating combinations of low-energy cooling technologies, and developing computer simulation models for the design of these systems. Other components of the work include evaluating the energy losses present in commercial cooling distribution systems (e.g., duct leakage), and developing new design tools and guides. Ultimately the goal is to incorporate widespread use of innovative cooling designs into the Title 24 building standard.

There has been a significant and growing interest in natural ventilation for commercial buildings. We have used the EnergyPlus simulation program to provide input to the design of a new, naturally ventilated Federal office building for San Francisco. The team members of this element have also been reviewing synergistic combinations of compressorless cooling technologies, energy-efficient space-cooling methods and distribution systems, and assessing the energy-savings potential of these technologies for the 16 climate zones of California, and various building types. More than 10,000 computer simulations of these combinations have been run.

Work is continuing to measure the leakage of energy from the duct systems of commercial buildings, and to develop metrics and diagnostics for these systems. We are also working to improve the simulation of ventilation and its effect on cooling. This work will result in a substantial improvement of EnergyPlus' ability to accurately model both mechanical and natural ventilation.

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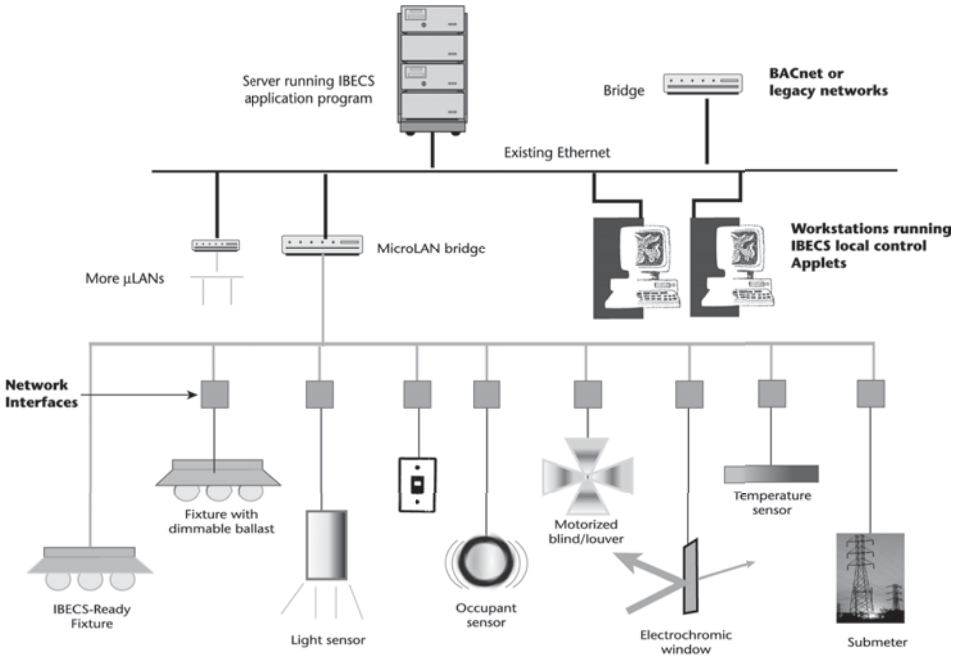
## Integrated Commissioning and Diagnostics

Once built, many commercial buildings do not perform as well as expected—using more energy, and causing occupant discomfort. An EETD study found that in a sample of 60 buildings, half had control problems and 40 percent had HVAC equipment problems. Other research has demonstrated that the proper commissioning of buildings (checking that all systems are working before a new building is occupied) can avoid these problems.

*An integrated building equipment communications system (IBECS) will provide Internet-based control of lighting, daylighting and envelope systems.*




The goal of this element is to make commissioning of new commercial buildings a standard practice, and to make "continuous commissioning" (the tuning of existing buildings) into a widely used practice. The element's project team consists of Texas A&M, EETD, PECI, MIT, UC Berkeley, University of Nebraska, Ove Arup, Flack + Kurtz, Silicon Energy, and AEC. A large variety of projects is underway to improve the commissioning and monitoring of new and existing buildings. Team members are building a library of functional test procedures, together with manual tools and guides, that building operators and contractors can use to commission lighting, HVAC and other building systems.

Another result of the work will be a guide to commissioning for building designers—many designers currently do not document their design intent or

provide the owner with performance specifications. The guide will provide information on integrating commissioning into the design and construction process.

Software tools to improve the diagnosis of problems in building systems are also under development as part of this element. These will include fault-detection procedures, using energy management and control systems to monitor performance, and systems to get Internet-based feedback from building occupants on problems they report.

Other tasks under this element include studying the persistence of energy savings in new buildings that have been commissioned, developing technology to monitor major electrical loads within buildings, and developing tune-up procedures for use in commissioning existing buildings.

Among some of the early results of this element:

Texas A&M completed an analysis of the multi-year energy savings from "retro-commissioning" 10 buildings, finding that savings persisted well, degrading by only a few percent per year. This demonstrates that commissioning a building and tuning its energy use, even after it has been occupied and used, is a viable energy-saving strategy.

EETD and UC Berkeley worked with the General Services Administration and the City of Oakland to test and evaluate diagnostic techniques and demand-shedding strategies in several large buildings. EETD received funds from GSA for the Web-based remote-monitoring GEMnet (GSA Energy and Maintenance Network), a significant deployment opportunity for this program's research results. UC Berkeley continues to work with GSA to examine maintenance and complaint logs, and test a web-based occupant feedback system.

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## Indoor Environmental Quality

In this element, we are investigating and demonstrating how the application of building science and ventilation engineering can lead to simultaneous building energy savings and indoor environmental quality performance improvements. This project focuses on developing and testing a concept for high-performance relocatable classrooms (RCs). RCs, otherwise known as "School Portables," or "Modular Classrooms," are very common in California. They provide school districts with quick and convenient means of adding or replacing classrooms, and can be moved around, reducing unnecessary classroom construction. An estimated 75,000 to 95,000 are currently in use in California school. The state of California mandates that at least 20% of new classrooms be RCs, and 6,000 to 8,000 single units are being placed annually.

We are in the process of evaluating the benefits of a novel RC ventilation system, and also of selecting construction materials that emit fewer indoor pollutants. We will construct and study four RCs; a pair sited and operated as classrooms in each of two California school districts with different climatic conditions. The basic specifications for the classrooms will include energy-efficient lighting, building envelope, and window enhancements. One task is to test a high-performance ventilation and air-conditioning system, the Indirect-Direct Evaporative Cooler (IDEC), suitable for warm dry climate zones of California. In these climates, IDEC offers potential cooling energy savings of about 70% compared to the standard (10 SEER) air conditioner used in RCs.

In addition to energy savings, the IDEC provides a continuous flow of outside air that will improve the indoor air quality of the RCs. For heating, an energy-efficient, natural gas-powered hydronic loop will be integrated into the IDEC ducting system. For test purposes, each RC will be equipped with both a standard HVAC and an IDEC/hydronic heat system. The HVAC system being operated will be alternated on a weekly basis with the unused system sealed and turned off. Indoor air quality (carbon dioxide, volatile organic compounds (VOCs), size-resolved airborne particle counts), thermal comfort, noise, and energy use will be monitored continuously and the ensuing data will analyzed to compare indoor environmental quality and energy use under the two HVAC system regimes.

A second task focuses on identifying the RC materials that are the major VOC sources through chamber measurements. Two of the field test RCs, one at each school, will be constructed using alternative materials selected for lower VOC emissions. The project also includes an effort to develop, test, and refine computer models of RC energy performance in California. Data from the field study will be used to validate the computer simulations and upgrade inputs to the model. Energy and cost-benefit projections will be made for different California climate zones.

We have received the enthusiastic cooperation of school districts and a manufacturer of RCs, and we are exchanging data with a number of groups on indoor air quality in schools.

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For more information on each of the commercial building projects, see http://buildings.lbl.gov/cec/

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# Supporting the Cool Roofs Standard

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) approved Standard 90.1 at its annual meeting in June of this year. Included in the Standard are norms for reflective roofs, proposed by EETD's Hashem Akbari, staff scientist in the Energy Analysis Department.

Akbari was responding to reflective roofs' characteristic of reducing the roof surface temperature, which, in turn (1) reduces the air-conditioning requirements of the building and (2) lowers the ambient air temperature of the building in a large urban area. A lower urban air temperature reduces the formation of smog.

Akbari proposed the inclusion of reflective roofs in the standard and he supported the inclusion with simulation results for roofs for residential and nonresidential buildings. Residential models are intended to apply to hotel guest rooms, patient rooms in hospitals, and high-rise residential apartments. Simulations were performed for 19 of the total 26 different climates used by ASHRAE.

Research shows that the temperature of highly absorptive dark roofs (low-solar reflectance) can be 50°C (90°F) higher than the ambient temperature. "Cool" roofs, i.e., those painted white or of light-colored materials, are only about 10°C (18°F) warmer, and, consequently, are effective in reducing a building's cooling energy use. Coupled with the reflectance of the roof, the emissivity of the materials is also an important factor. The cool roof materials must emit much of the heat energy they receive to help achieve the cooling. When taken into account with the amount of insulation under the roof and the building's thermal integrity, the cool roof can result in air-conditioning energy use savings of between 10 and 50%.

## California Standard Now in Place

Revised Title 24 standards (AB 970 Energy Efficiency Standard for Residential and Nonresidential Buildings) now give energy-performance credits for residences and commercial buildings that include cool roofs. The standards required various solar reflectances and thermal emittances for different types of roofing materials. For example, clay tiles must have a minimum total reflectance of 0.40 (when tested with ASTM standards) and a minimum thermal emittance of 0.75. Other materials must have initial higher reflectances and emittances. Liquid roofing products (coatings that reflect light) are measured in tensile strength, elongation and permeance, and weathering strength.

## Cool Savings Program

In California the Cool Savings Program (formerly Cool Roof Program) is funding and installing more than 1 million square feet of cool roofs. With an averaged estimate savings of about 0.35 W/sq ft, the Cool Savings Program has saved 523 kW on roofs already "cooled," and will save another 500 kW on the number of projects in the future. One major retailer has replaced its roof in a large store with a cool roof and is planning to test other materials on three of its California stores. When completed, a total of 10 million square feet of commercial space will be kept cooler with this program, saving a total of 3.5 MW of energy and also saving the retailer a considerable amount of money in energy costs.

## Heat Island Mitigation Studies

In other California efforts, many institutes and government agencies are looking at efforts to stem the heat island phenomenon. Heat islands are urban areas whose temperatures exceed the surrounding suburban and rural temperatures because the increased amount of buildings and asphalt retain heat.

In both Los Angeles and Sacramento, EETD researchers have participated in studies to assess the meteorological and air-quality benefits of mitigating urban heat islands. In Sacramento the utility district, the California Air Resources Board, the regional air quality district, and the energy commission have teamed up to provide demonstration projects advertising the benefits of local heat island mitigation.

In Chicago, Illinois, the Department of Environment has embarked on an Urban Heat Island Initiative in an effort to save energy and also to lessen pollution. The City of Chicago has begun demonstration projects in neighborhoods in the downtown areas to mitigate urban heat islands. These include rooftop gardens (one has been placed on the roof of City Hall), enhanced median plantings, and greening in parking lots, all of which reflect heat and even clean the air. Research will be carried out that will measure the air quality benefits of these strategies. Chicago has included standards in its energy code that mandate light-colored roofs to mitigate the urban heat island effect.

Supported with funding from NASA, EETD's heat island group also performed studies in Atlanta, Georgia, to determine heat island impacts on local air temperature and energy use. Because Atlanta has significant air quality problems, the Georgia Environmental Protection Agency will focus more attention on how heat islands and air quality are related.

In Houston, Texas, extensive air quality modeling is ongoing in order to submit heat island mitigation strategies to the Texas Natural Resource Conservation Commission for its mid-course review in 2004. Other U.S. cities that have put studies into place include Salt Lake City, Utah, and Baton Rouge, Louisiana. Funded by the U.S. EPA, these meteorological and air quality modeling studies assess the benefits of increased surface albedo and urban reforestation.

*—Ted Gartner*

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http://eetd.lbl.gov/Heatisland/

# Meteorology, Energy, and Air Quality

In theory the energy and air quality implications of climate and meteorological changes are relatively well established. Climate fluctuations on spatial and temporal scales have significant impacts on energy use, emission of pollutants, atmospheric chemical reactions, and other parameters such as diffusion, transport, and deposition of airborne pollutants.

The Heat Island Group's objective is to understand the relationship between energy and air quality with a focus on the role of urban meteorology. Urban areas are known to generate their own weather patterns, urban heat islands, convective clouds, and precipitation. Urban heat islands also induce increased emission of pollutants. The Heat Island Group performs meteorological and air quality modeling to understand and quantify these relationships from the perspective of developing mitigation strategies, such as urban heat island control.

Producing better meteorological forecasts and modeling capabilities is useful for improving the prediction of energy needs and the related distribution of electricity and gas. The energy crisis in California serves as a reminder that such forecast models and quantification tools may become even more important in the future.

During the past 15 years, Heat Island Group modeling has assessed the implications of local, short-term meteorological effects (e.g., urban heat islands) and long-term climatic fluctuations (e.g., some aspects of climate change). Several U.S. areas and airsheds were examined—those in non-attainment status for ozone or in climate types that require significant energy use (cooling or heating). The modeling served as a basis for formal or informal inclusion of heat island control strategies in State Implementation Plans (SIPs) or related air quality regulations. Atlanta, GA, Los Angeles, CA, San Francisco, CA, Salt Lake City, UT, Houston, TX, Chicago, IL, and Baton Rouge, LA, are considering including heat island control in some aspects of their air quality-improvement strategies. The South Coast Air Quality Management District and the City of Los Angeles have formally encouraged urban heat island control as an air quality-improvement strategy. The City of Houston and the Texas Natural Resources Conservation Commission are eager to include these strategies in their SIP and mid-course adjustment to the SIP, if modeling shows air quality benefits from heat island control in that region.

The heightened attention to heat island reduction and the modeling work for Houston are a result of the air quality situation in that region.

Southern Texas was recently examined for inclusion in the modeling work by the Heat Island Group. Using the PSU/NCAR MM5 (meteorological) and the UAM-V/CAMx (photochemical) models, We have simulated the greater Houston region's baseline meteorological and air quality conditions, as well as those in cases with "implemented" heat island reduction strategies. The simulations of a 7-day summer episode in Texas suggest that the daytime urban heat island in Houston can grow up to 3° Kelvin (K). Heat island reduction via increased urban albedo and forest can have a potential offset effect of 5K in air temperature near the surface. Higher above ground, for example at 20m, the offset is smaller (up to 3K) but still significant. Of course there are also negative effects from heat island reduction: downwind of modified areas there is a potential increase in air temperature of 2 to 3K near the surface and up to 2K at 20m above ground.

In terms of ozone air quality, in some areas ozone concentrations decrease and in others, they increase as a result of heat island reduction. Just like the response in meteorological parameters, the signal in ozone concentrations (increases or decreases) also varies from one day to another during the modeled episode. The range of changes in ozone at the peak time of the day (e.g., 1600 local time) is on the order of 10 to 20% reduction or increases, amounting to anywhere between 5 to 25 parts per billion (ppb).

Modeling work to date suggests that the impacts of heat island reduction in the Houston region are relatively larger than in other regions we have previously simulated, such as Salt Lake City, Sacramento, or Baton Rouge. In these other regions, the impacts on air temperature were smaller than 2K and the impacts on ozone air quality were smaller than 8 ppb in general.

We are also working on preliminary assessments of the possible air quality implications of meteorological and emissions changes in California that could be brought on by long-term climate change. Although this work is relatively more recent than the urban heat island effort, the preliminary results show significant potential impacts on ozone air quality, should climate change (global warming) occur. Using future-year controlled emission scenarios for the Sacramento Valley and the Los Angeles Basin, we used output from the Canadian and Hadley (UK) GCMs to prepare meteorological and emission data and used them in a photochemical model (Urban Airshed Model). The simulations of specific episodes in the Sacramento Valley and the Los Angeles Basin show that both regions will be in non-attainment status by 2050 and after. In the Los Angeles basin, the overall sensitivity to temperature is about 4.6 ppb/K whereas in the Sacramento valley, it is up to 2 ppb/K. Of course, the dependence is larger if non-controlled (present-day) emissions are used in the simulations.

*—Haider Taha*

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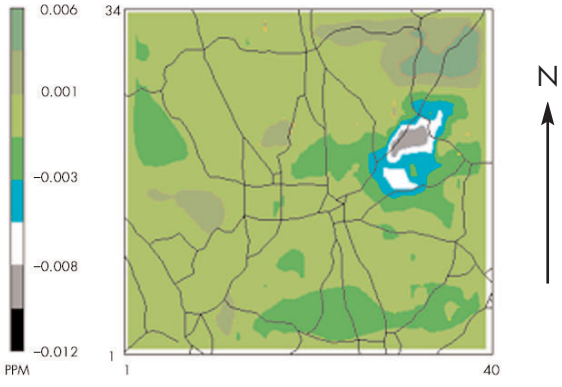
Haider Taha leads the meteorological and air quality-modeling activities in the Heat Island Group (HIG) of EETD.

*Impacts of increased urban surface albedo in Sacramento, CA, on ozone air quality at 5 P.M. on July 13, 1990. Downtown Sacramento is slightly to the southeast of the figure's center.*



# High-Performance Fume Hood Reduces Energy Use 50%

Fume hoods, devices that are widely used by high-tech industries, hospitals, and universities, help keep workers safe, but can use a lot of energy—a single fume hood running 24 hours a day uses as much energy as an entire house. New fume hood technology developed by researchers at Berkeley Lab's Environmental Energy Technologies Division reduces energy use by 50% or more. This technology has been demonstrated successfully in testing at Berkeley Lab and at the University of California, San Francisco's Department of Pathology.

With an estimated 85,000 fume hoods in California, and more than 500,000 in the United States. EETD researchers estimate that the new technology could save 360 gigawatt-hours (GWh or billion watt-hours) of electricity in California, and 2,100 GWh in the United States. At $0.08 per kWh, the annual electricity savings per hood is about $1,000 (close to 8,500 kWh saved per hood).

"This invention improves user safety while reducing both energy use and the size of mechanical systems required to provide adequate heating, ventilation, and cooling," said Dale Sartor, one of the fume hood's developers and Leader of EETD's Applications Team.

The prototype high-performance fume hood installation at UCSF's Scanning Electron Microscopy & Cardiovascular Structure Lab is the first in a working lab in California and one of two prototypes currently being tested in the U.S.

"We are thrilled with the success of this field test," Sartor said. "We are working with industry partners to continue the development and refinement of the technology." He added that, before the new hoods can be applied commercially, institutional and regulatory barriers also need to be overcome.

Fume hoods are ubiquitous in industrial, medical, and university research facilities. They are box-like structures often mounted at tabletop level with a movable window-like front called a sash. Fume hoods capture, contain, and exhaust hazardous fumes created during industrial processes or laboratory experiments.

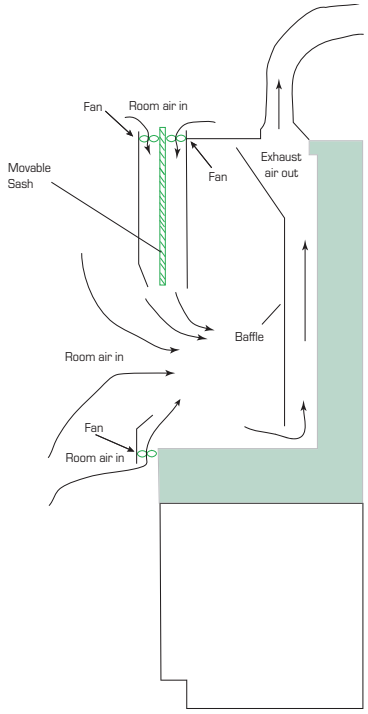
Generally, fumes are drawn out of a hood by fans through a port at the top of the hood. Pharmaceutical and biotechnology facilities have hoods, as do facilities ranging from industrial shops, to medical testing labs, university research labs, and high school chemistry labs.

"Fume hoods typically require large exhaust flows and are usually never turned off, so they use a tremendous amount of energy both in fan power and in heated and cooled room air," said co-developer Geoffrey Bell. "The hood could save typical industrial facilities hundreds of thousands of dollars a year in energy costs."

Hood use is growing rapidly in California. Besides biotech and high tech, universities and colleges are building labs to keep up with the demand for science education. Hoods contribute to the high energy cost of these buildings—often four to five times more expensive than offices.

## How It Works

A typical fume hood, with a sash opening six feet wide and two to three feet high, circulates air through this sash at 100 feet per minute. The energy to filter, move, cool or heat, and in some cases scrub (clean) this air is one of the largest loads in most lab facilities.




The Berkeley Lab design uses small supply fans located at the top and bottom of the hood's face, to push air into the hood and into the user's breathing zone, setting up a "divider" of air at the sash. The air divider helps prevent fumes from reaching a user standing in front of the hood. Consequently, the exhaust fan can be operated at a much lower flow. Current research has reduced the flow to 30% of a typical hood installation. Because less air is flowing through the hood, the building's environmental conditioning system can be downsized, saving both energy and initial costs of construction.

The high-performance technology was developed by Helmut Feustel and Bell. Additional members of the team are Sartor, Chris Buchanan, Darryl Dickerhoff, William Fisk, and Doug Sullivan.

*—Allan Chen*

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The demonstration and field-testing of the high-performance fume was funded by Pacific Gas & Electric. Research and development of the technology was supported by the U.S. Department of Energy, the California Energy Commission, and the California Institute for Energy Efficiency. Labconco Inc. of Kansas City, Missouri, provided the fume hood, Siemens Building Technology, Buffalo Grove, Illinois, the control and monitoring system, and Marina Mechanical, the installation. UCSF provided significant cost-sharing and in-kind support.

The Berkeley fume hood has a patent pending. For more information, contact Berkeley Lab's Technology Transfer Department, TTD@lbl.gov, (510) 486-6467.

For more information on the hood, see:
http://ateam.lbl.gov/hightech/fumehood/fhood.html

# The New Berkeley Lamp Lights the Way to Energy Savings

EETD researchers have developed a new high-performance, energy-efficient table lamp that is designed to save energy in homes and offices while increasing lighting quality and visibility. The lamp provides both a task light and an "uplight" for room illumination.

"Widespread use of this lighting system in offices and homes could greatly reduce the current power problems we have in California while increasing the quality of the lighting environment," says EETD scientist Michael Siminovitch. "To our knowledge, nothing currently available in the office, hospitality, or residential marketplace has both the high-performance lighting quality characteristics and energy efficiency of this new lamp."

At full power, this two-lamp fluorescent system matches the combined luminous output of a 300-watt halogen lamp and a 150-watt, incandescent table lamp while using only a quarter of the energy.

## California tests

The lamp was developed with funding from the Department of Energy, and additional support from the California Energy Commission. EETD is working with three California utilities, the Sacramento Municipal Utility District (SMUD), Southern California Edison (SCE), and Pacific Gas and Electric (PG&E), to field-test the first production lamps based on the new high-performance design in commercial buildings and residences throughout the state. The utilities will place these lamps in offices, residences, and hotels, monitoring energy use and customer satisfaction in an upcoming demonstration program.

## Specially designed optics

The new lamp uses two independently controllable and fully dimmable compact fluorescent lamps (CFLs). One lamp's light is directed downward, illuminating the table or desk. The other directs light up toward the ceiling, providing high-quality indirect lighting. An optical "septum" separates the two lamps, allowing three modes of lighting: downward lighting only, upward only, or up and down together. The relationships between the lamps, the septum, and the lamp shade have been designed to maximize the efficient distribution of light as well as to provide soft and even shade brightness.

Staff Research Associate Erik Page says, "This lamp is clearly an energy saver in homes, but it is also a great energy-efficient alternative in office spaces. Substantial savings can be had by turning off overhead room lighting altogether and using this lamp. The "down" light gives the user more than enough flux (light output) for most tasks, while the "up" light provides a low-glare ambient light that is ideal for computer environments."

The lamp was designed by the same Berkeley Lab research group that developed the compact fluorescent lamp-based alternative to the dangerous and inefficient halogen torchiere, that has been proven to be a fire hazard.

Lamp features were designed to enhance lighting quality and user visibility particularly in office applications with computer tasks. These features include providing task-illumination levels that are significantly greater than traditional task lights. "As people age, they need more light to comfortably perform visual tasks. This lamp caters to that need," Page adds.

The fully dimmable and controllable lights allow for maximum flexibility by enabling the user to adjust the lighting system to a changing environment. The dimming option increases energy savings by allowing users to reduce power when they need less light. The lamp also produces a more uniform light, reducing the harsh "hot spot" effect produced by halogen lights and some CFL designs. Early results of large area studies show that users are turning off overhead lights where the Berkeley Lamp is in use, opening the door to large energy savings.

*—Allan Chen*

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This research and development project was funded by the U.S. Department of Energy's Office of Building Technologies, State and Community Programs, with additional support from the California Energy Commission.

Berkeley Lab has a patent pending on the new design. For more information contact Berkeley Lab's Technology Transfer Department: TTD@lbl.gov or (510) 486-6467. Light Corporation of Grand Haven, Michigan has an exclusive license to manufacture the Berkeley lamp.

More information is available at http://lighting.lbl.gov/projects/table/table.html. The manufacturer's web site is www.lightcorp.com

# Two Web Sites Help Californians Save Energy

To help Californians reduce their energy use and the danger of rolling blackouts in the state, EETD researchers developed two new web sites: The 20% Solution (savepower.lbl.gov), that can help Californians reduce energy use by 20% or more, and California Electricity System Status (energycrisis.lbl.gov), which shows electrical demand in the state and the availability of generating resources to meet the demand.

The 20% Solution site identifies energy-efficiency measures and their predicted percentage savings. To use the site, residents simply identify their region of California, the size of their house or apartment, and whether they have air conditioning. The site then suggests 10 to 20 different ways to save energy this summer. The suggestions are in three parts: no-cost measures, low-cost measures, and more expensive measures.

"I am encouraged that the Department's national laboratories can play a substantial role in reducing the demand for energy in California, especially as the State faces severe energy supply challenges during the coming summer months," commented Secretary of Energy Spencer Abraham in May, when the site was made public. "I would urge consumers to look seriously at The 20% Solution web site and take advantage of its recommendations whenever possible."


## The 20/20 Rebate Program

California's 20/20 Rebate Program offered a 20% rebate on electricity bills from June through September 2001 for customers of Pacific Gas & Electric, San Diego Gas & Electric, and Southern California Edison who use at least 20% less electricity than they consumed in each of the four comparable months during 2000. The program is described in California Governor Grey Davis' Flex Your Power Campaign site.

"With the potential for weeks of rolling blackouts this summer," says EET Division Director Mark Levine, "we decided to focus the Lab's expertise on helping California residents identify simple, easy-to-implement ways to reduce energy use and avoid blackouts this summer."

"The suggestions in the web site are best-practice measures for dwellings in California, tailored to the diverse climate zones in the state," says Jon Koomey, head of the End-Use Energy Forecasting Group and leader of the site's development team. "Their effectiveness at reducing energy use has been demonstrated both by analytical models and by the real experiences of researchers and builders in real homes."

Following the site's advice cannot guarantee that a particular household or apartment will save 20% of its energy because every dwelling is different and similar buildings or appliances can vary in energy use. Savings measures, especially those that depend on human operators to implement daily, need to be applied consistently. Nonetheless, the measures described in the site have proven track records according to research at Berkeley Lab and other institutions.

Homeowners and apartment dwellers interested in customized suggestions on how to retrofit and remodel for energy efficiency can also consult two other web sites developed at Berkeley Lab, the Home Energy Saver (http://hes.lbl.gov) and the Home Improvement Tool (http://hit.lbl.gov). These sites are designed for simple use, but require users to input specific information about their homes.

## Real-time electricity web site

The California Electricity System Status web site at http://energycrisis.lbl.gov displays minute-to-minute changes in California's supply and demand balance.

"This site shows, in one place for the first time, California electricity demand, availability of power within the state, power imports and exports, and capacity out of service in real time," says EETD scientist Alan Meier, who headed the site's development team. "We expect that Californians will want to bookmark this site so that they can view the power situation this minute."

"Using this site," he adds, "consumers will be able to respond to the electricity crisis by reducing their power consumption when it's most important."

In addition to serving as a real-time management tool for energy users, the site will help consumers better understand the sources of the state's energy shortages—for example, how much capacity is offline at a given time, how much power needs to be imported from outside the state to make up for the shortfall, and how supply and demand change throughout the day.

The site builds on information provided by the California Independent System Operator, the California Energy Commission, and other sources. Meier says that the development team will add additional information and resources to the sites, including links to energy efficiency sites, and additional background information on the meaning of the data.

"This is one of a number of actions that Berkeley Lab is taking to inform Californians about energy shortages and what they can do to respond," says Mark Levine, Director of the Environmental Energy Technologies Division.

Berkeley Lab researchers Katie Coughlin and Robert van Buskirk also worked on the development of the power use site.

*—Allan Chen*

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savepower.lbl.gov
energycrisis.lbl.go

# Research Highlights

## EETD, Philips Relamping Berkeley's Telegraph Avenue

As America searches for a way out of the energy crisis, Telegraph Avenue just might light the way. In June, an entire city block along this avenue in Berkeley cut its projected lighting usage nearly in half—an astounding 45% (or 62,712 kWh/yr) annually—simply by switching to energy-efficient light bulbs.

Lamps of every kind, from common household light bulbs to industrial fluorescent tubes, were replaced with the most energy-efficient light bulbs throughout this city block, which is a mix of offices, restaurants, and residential apartment complexes.

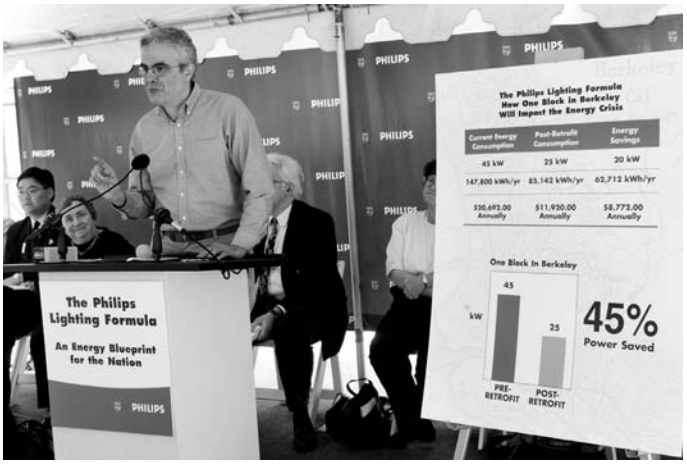
"Relamping" this Telegraph Avenue block was the work of Philips Lighting Company together with Lawrence Berkeley National Laboratory, the City of Berkeley, and local community organizations. Part of a national initiative, this grassroots effort is intended as a blueprint for energy conservation, illustrating how simple changes, such as switching to energy-efficient light bulbs, can result in dramatic savings.

If other cities across the country were to take these same steps, the collective savings would be astronomical. For example: New York's Times Square could save 23 million kWh and $5.8 million annually. Chicago's Miracle Mile could save 45 million kWh and $3.6 million annually. The Strip in Las Vegas could save 105 million kWh and $8.4 million annually.

Philips Lighting Company and Amtech Lighting conducted a lighting audit to determine the best energy-efficient lighting options available for each building. The two companies donated their products and installation services to conduct the actual lighting retrofit. They replaced all of the current lamps in the buildings on the city block with the most energy-efficient light bulbs available, from compact fluorescent lamps to T8 linear fluorescent lamps.

The city of Berkeley has invested in energy efficiency in its municipal facilities and throughout the community since the 1980s. The City offers energy assistance for residential and commercial buildings and is now in the process of developing a community-wide energy plan that will focus on alternatives to traditional generating plants, such as efficiency, conservation, and renewable energy.

*Officials from Philips Lighting replace bulbs in a Telegraph Avenue store as part of an energy-savings study.*




*EETD's Francis Rubinstein addressed visitors and officials during the Relamping event. To the left of Rubinstein is Berkeley Mayor Shirley Dean.*

## Max Sherman Made ASHRAE Director-at-Large

Max Sherman, group leader of the Energy Performance of Buildings Group, a part of the Indoor Environment Department, was installed as a director-at-large of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) at its 2001 annual meeting in Atlanta in late June. He will also be a trustee of ASHRAE's Learning Institute, which develops and guides the educational program.

Sherman has served on many ASHRAE committees over the years and has written books, papers, and articles—as well as holds patents—for methods and apparatus for measuring the tightness of enclosures.

## Aeroseal Corporation Acquired

Carrier Corporation has announced it is acquiring Aeroseal, Inc., a Texas-based firm that formed to commercialize aerosol-based duct-sealing technology. Aeroseal was co-founded by EETD scientist Mark Modera, developer of the technology. Aeroseal was the exclusive licensee of the Berkeley Lab patent covering the technology. The new company will be called Carrier Aeroseal, LLC.

The duct-sealing application developed by Modera at Berkeley Lab's Environmental Energy Technologies Division was originally funded by the U.S. Department of Energy, U.S. Environmental Protection Agency, California Institute for Energy Efficiency, and the Electric Power Research Institute.

The duct system in a typical U.S. home wastes 20 to 30% of the heating or cooling produced in residential furnaces and air conditioners, and current research indicates that the problem may be even worse in light commercial applications.

Independent test agencies and Carrier studies have concluded that the Aeroseal duct-sealing application effectively prevents excessive duct leakage. The Aeroseal process uses a sealing machine to inject small vinyl particles directly into the duct system. The technology will seal cracks and holes up to 3/8-inch without excess buildup.

A diagnostic evaluation, performed prior to the sealing application, measures duct leakage, airflow, and room temperature. This evaluation results in a printed computer-generated analysis of the home's duct performance. Should the homeowner decide to purchase a sealing application based on the findings of this summary, a sealing appointment is scheduled. After the sealing is applied the homeowner is provided with a certificate showing the exact amount of duct-leakage reduction.

The sealing process takes from four to six hours. The Aeroseal process, which applies to all types of duct systems, is patented in the United States and patent applications are also on file in Europe, Australia, Canada, Japan and Brazil.

For further information on Berkeley Lab research on ducts and energy use, see http://ducts.lbl.gov/

Research on aerosol-based sealing can be found at http://ducts.lbl.gov/aerosol/index.html. Other useful web sites include Aeroseal Inc.: http://www.aeroseal.com/ and the Carrier Corporation: www.carrier.com.

## EETD Displays New Technology at Lighting Event

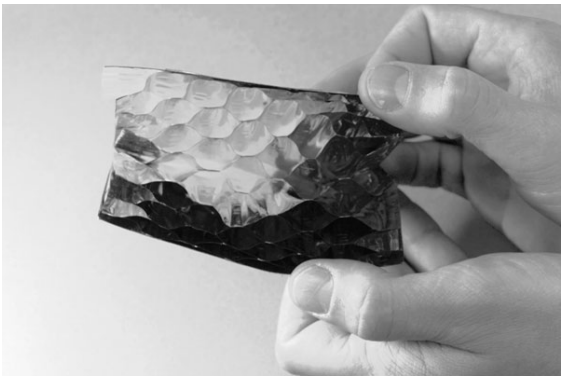

*(Left to right) Laura McLaughlin, Michael Siminovitch, and Erik Page of EETD's Building Technologies' Lighting Group pose in front of the Berkeley Lamp display at LightFair2001 held in Las Vegas, Nevada in June.*

*Energy-saving Berkeley Lamps are finding their way to facilities all over California. This one sits on the desk of Steve Larson, Executive Director of the California Energy Commission in Sacramento.*

## Gas-Filled Panels Win *R&D* 100 Award

One of *R&D Magazine's* prestigious R&D 100 awards has gone to the gas-filled panel technology developed by Berkeley Lab's Environmental Energy Technologies Division. Winners of this year's awards were notified June 29, with Department of Energy national laboratories taking at least 21 of the 100 awards. The magazine published the full list in September.

*Collapsible honeycombs of multiple layers can hold insulating air or gases.*

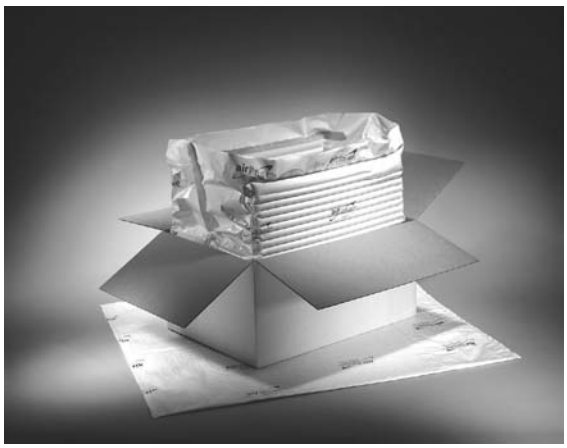


Gas-filled panels were developed as a spinoff of Berkeley Lab's research on multipaned superwindows in the 1980s. Since only products actually on the market are eligible for R&D 100 awards, the award came after the June 2000 debut of the AirLiner bag marketed by CargoTech of San Diego, California.

By replacing bulky, cumbersome, friable polystyrene foam containers with AirLiners, the company hopes to make inroads on the $500 million annual market for nonrefrigerated perishables. AirLiners are flexible, collapsible honeycombs of multiple layers of thin aluminized plastic, which can be filled with air or an inert gas. Their insulation value can be tailored by varying the gas and the number of layers; even plain air-filled panels insulate better than fiberglass.

Other uses for gas-filled panel technology include insulating appliances, buildings, and vehicles. See http://gfp.lbl.gov/ and http://www.cargotech.com/ for further details.

*CargoTech's Airliners can adapt to many shapes to replace bulkier packaging materials.*



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## Summer Student Has Rewarding Experience

Jordan Sand, a high school graduate from Ellendale, North Dakota, spent three weeks at Berkeley Lab at the beginning of summer working with EETD's Ashok Gadgil on a technology under development. Nicknamed "the tin box," Gadgil's research traces gas dispersions with infrared laser beams.

Sand came to LBNL via the Lemelson-MIT Invention Apprenticeship program. His idea of using grain wastes (flax, wheat, and corn straw ) in paper production earned him the opportunity to participate in the program (see http://web.mit.edu/invent/www/01apprentice.html) for the full story).

Although Sand did not see the laser working in the dispersion experiments with Gadgil ("The cutting edge is filled with problems," he quipped), he was nevertheless excited to be working at Berkeley Lab. He characterized the Lab as being full of smart and interesting people, and Berkeley as being "different and unusual."

Sand will attend North Dakota State University this fall, but hopes to pursue a career in chemistry at the University of Michigan, the University of Illinois, or UC Berkeley.

# Important Notice: *EETD News* Distribution Shifts to Web

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*—Editorial Staff*

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