Lawrence Berkeley National Laboratory

Winter 2000

Environmental Energy Technologies Division News

Air Quality Advanced Technologies Building Technologies Energy Analysis Indoor Environment

Lithium Batteries for Hybrid-Electric Vehicles

A long-standing focus of EETD electrochemical research has been to support the development of high-performance rechargeable batteries for electric vehicles. This has proved to be an extremely challenging task because of the need to simultaneously meet multiple battery performance requirements: high energy (watt-hours per unit battery mass or volume), high power (watts per unit battery mass or volume), long life (10 years and hundreds of deep charge-discharge cycles), low cost (measured in dollars per unit battery capacity), resistance to abuse and operating temperature extremes, perfect safety, and minimal environmental impact. Despite years of intensive worldwide R&D, no battery can meet all of these goals.

A compromise of sorts is the hybrid-electric vehicle (HEV). The HEV is a centerpiece of the Partnership for a New Generation of Vehicles (PNGV), a multi-agency government program aimed at introducing automobiles with three times the fuel economy of our present-day fleet. In a hybrid vehicle, a battery, a combustion engine (or a fuel cell), or both are used to drive an electric motor. The advantages of this configuration include the use of a smaller battery (compared to an all-electric vehicle) and a smaller combustion engine (compared to a conventional vehicle). The system can be designed so the combustion engine operates at a nearly constant speed, which greatly reduces its exhaust emissions and increases the overall vehicle fuel economy. The battery provides power for vehicle acceleration and absorbs the energy released during vehicle deceleration (regenerative braking). Prototype HEVs not only achieve more than 60 miles per gallon of gasoline, but also meet ultra-low vehicle emission requirements. The battery, however, must be designed to deliver very high power and undergo hundreds of thousands of shallow charge-discharge cycles. This is basically a new type of battery, and little is known about how it behaves under such use conditions.

The PNGV has contracts with three battery companies to develop high-power batteries for HEVs, and the U.S. Department of Energy has recently formed a new R&D program to support the PNGV contractor efforts. The basic chemistry chosen by the PNGV and its contractors is the lithium-ion system. This system uses a lithium-carbon negative electrode, an organic electrolyte, and a mixed metal-oxide positive electrode (typically nickel and cobalt oxides). Lawrence Berkeley National Laboratory (Berkeley Lab), Argonne National Laboratory (ANL), Sandia National Laboratory (SNL), Idaho National Engineering Laboratory (INEEL), and Brookhaven National Laboratory (BNL) participate in this new cooperative effort, which is called the Advanced Technology Development (ATD) Program. A unique feature of the ATD Program is the design and manufacture of special high-power lithium-ion battery cells, which are tested under strict protocols at INEEL, SNL, and ANL and then sent to Berkeley Lab

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Steve Sloop is shown handling lithium battery components inside an inert-atmosphere glove box.

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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and BNL for detailed diagnostic examinations (some cells are retained at ANL and SNL for related diagnostic tests). The program participants meet on a regular basis to discuss testing and diagnostic results. This represents a significant advance in cooperative R&D among national laboratories, at least in the electrochemical area. It also exemplifies the role national labs can play in supporting technology innovation in the private sector.

The primary Berkeley Lab role is to carry out diagnostic studies to determine cell component chemical, structural, and morphological changes that lead to battery performance degradation and failure as the batteries are aged, cycled, or abused. Berkeley Lab's diagnostic results will guide the development of improved cell chemistries and complement the results obtained at the other national laboratories. Berkeley Lab is using Raman spectroscopy, infrared spectroscopy (performed at Berkeley Lab's Advanced Light Source), atomic force microscopy, impedance measurements, gas chromatography, and other analytic tools to characterize electrodes and electrolytes taken from cells that have been cycled at other national laboratories. Our data are being compiled with related information obtained at the other participating laboratories on an ATD Program web site and are being made available to the PNGV managers and contractors.

EETD researchers participating in this program are Thomas Adler, Elton Cairns, John Kerr, Fanping Kong, Robert Kostecki, Frank McLarnon, Steve Sloop, and Kathryn Striebel, as well as Materials Science Division researchers Phil Ross and Sherry Zhang.

—Frank McLarnon

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This research is supported by the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Transportation Technologies, Office of Advanced Automotive Technologies of the U.S. Department of Energy.

Robert Kostecki is shown preparing electrode samples for characterization using atomic force microscopy.

Erratum: Due to a printer's error the headline on page five of the Fall 1999 issue was cut off. It should read "EPICenter: Montana State University's Green Building Project."

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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, LBNL is located in the hills above the campus of the University of California, Berkeley.

With more than 3,800 employees, LBNL's total annual budget of nearly $330 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 300 and a budget of $36 million.

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New Fluorescent Lamp Ballast Energy-Efficiency Standards

Each year, about 80 million fluorescent lamp ballasts are sold for use in U.S. commercial and industrial buildings. They come in four basic types: magnetic and electronic ballasts for operating T12 (1.5 inch diameter tube) or T8 (1 inch diameter tube) lamps. In the present market, almost all of the T8 lamps are operated by electronic ballasts, and almost all of the four-foot T12 lamps are operated by magnetic ballasts. Since electronic ballasts are more efficient and the lamp/ballast systems are more efficacious, a large potential energy savings can be tapped by transforming the market for ballasts operating T12 lamps into one dominated by more efficient T8/electronic systems.

Generally, electronic ballasts cost more to purchase than the magnetic ballasts, but they use less electricity. In most situations, the life-cycle cost (LCC) of an electronic lamp/ballast system will be less than for a magnetic lamp/ballast system with equivalent light output. In most past LCC analyses for the U.S. Department of Energy, point estimates were used for the various inputs. In this analysis, where the change in LCC is calculated, we used a different approach—the four most important inputs are distributions. These distributions were developed to express the variability of electricity price, ballast price, operating hours, and ballast lifetime. We calculated the change in LCC for 10,000 combinations of these four variables. A Monte Carlo simulation is used to select from the distributions according to the frequency of occurrence of each possible value of each input. The two figures show the results of a probability-based LCC analysis in which commercial users replace energy-efficient magnetic T12 lamp/ballast combinations with electronic rapid start (ERS) T12 lamp/ballast combinations (Figure 1), or with ERS T8 lamp/ballast combinations (Figure 2).

In the first scenario, in which the T12 lamp is retained, LCC will be reduced about 80% of the time (represented by the delta LCC values in green, which are to the right of the $0 marker on the x-axis), with a mean savings of $6 over the ballast lifetime. For the second scenario (in which commercial concerns change from T12 to T8 lamps when they change from magnetic to electronic ballasts), LCC will be reduced about 98% of the time, with a mean savings of $18 over the ballast lifetime.

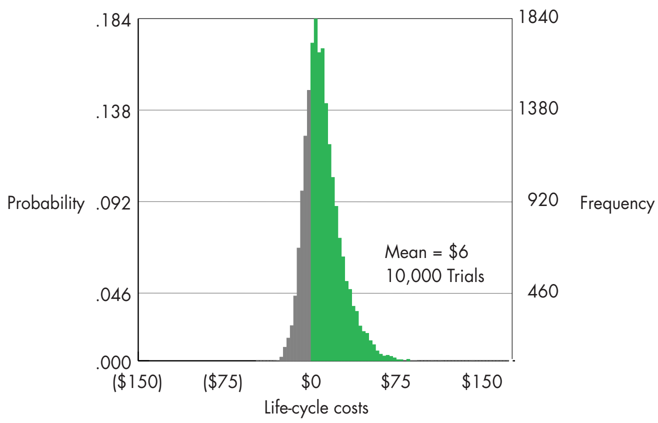

Figure 1. LCC will be reduced in about 80% of cases when an electronic ballast operating two T12 lamps (in commercial-sector buildings) replaces a magnetic ballast operating two T12 lamps.

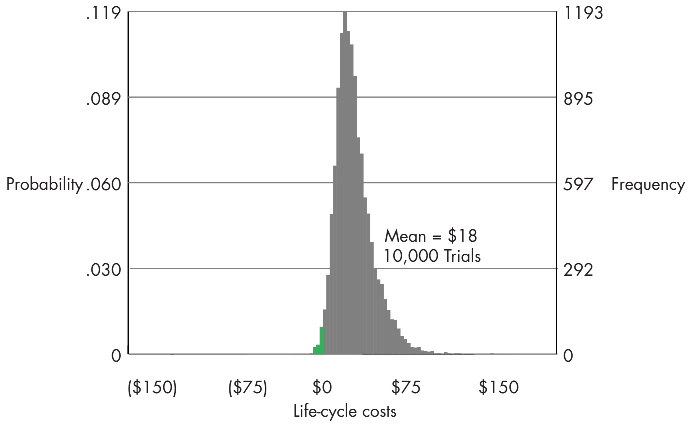

Figure 2. LCC will be reduced in about 98% of cases when an electronic ballast operating two T8 lamps (in commercial-sector buildings) replaces a magnetic ballast operating two T12 lamps.

In late 1999, U.S. manufacturers of lighting equipment and energy-efficiency advocates agreed to a set of energy-efficiency standards for fluorescent lamp/ballast systems found in commercial and industrial buildings. This occurred after years of discussion between ballast manufacturers and the DOE. EETD supplied the energy and economic analyses (such as the LCC analysis) to DOE that were used for the negotiations and to prepare a Notice of Proposed Rulemaking. We also wrote a Technical Support Document on ballast standards.

The commercial and industrial lighting sector will be subject to new energy-efficient lighting regulations beginning April 1, 2005. These regulations affect ballasts that operate T12 fluorescent lamps. That market is presently dominated by magnetic ballasts. The switch to electronic ballasts will result in cumulative energy savings of 2 to 5 quads (quadrillion Btus) of primary energy over the period 2005 to 2030. The range results from analyzing two different scenarios for the base-case shipments forecast without standards. That is equivalent to the annual electricity use of 19 to 42 million households in the United States. Businesses will reduce electricity costs by $3.4 to 7.2 billion (discounted to 1997 at 7% real), and carbon emissions will be reduced by 30 to 70 million metric tons over the same period. Since the cost of electronic ballasts will be higher than that of energy-efficient magnetic ballasts, we estimated that the net savings to businesses will range from $2.6 to 5.4 billion (discounted to 1997 at 7% real).

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For more information, refer to *Technical Support Document: Energy Efficiency Standards for Consumer Products: Fluorescent Lamp Ballast Proposed Rule, January 2000.*

This research is supported by the U.S. Department of Energy's Office of Building Research and Standards.

Leading by Example: In-House Energy Management at LBNL

The U.S. federal government is among the largest energy users in the nation. The Department of Energy's Federal Energy Management Program (see article in this issue, page 5) has been the focal point for helping all government agencies manage their in-house energy use. DOE's own energy bill ranks second after the Department of Defense. Energy management has naturally been a high priority within DOE's own facilities, and Berkeley Lab has long been an active participant in that effort.

Since the mid-1980s, Berkeley Lab's In-House Energy Management (IHEM) group has led the way in saving energy in our own facilities. IHEM staff review virtually every construction project from an energy-efficiency standpoint, enforce state and federal energy-efficiency requirements, carry out energy audits, analyze energy consumption and spending trends, and work to enhance employee energy awareness. Through a recent merger with the Lab's Engineering Division, the IHEM team is more involved than ever in integrating energy management and mechanical system engineering with conceptual design, study, construction, and day-to-day operations and maintenance.

Over the past 14 years, the IHEM program has reduced energy intensity per square foot at the Lab by almost 35%. This corresponds to an annual savings of over $1.7 million in energy costs.

While most of the projects involve relatively familiar buildings-related retrofits, the IHEM group's mandate also extends to sophisticated—and often energy-intensive—research facilities. One of the earliest projects involved enormous magnets on our Bevatron—a huge 6-billion-electron-volt particle accelerator. Electricity costs were extremely high, limiting the number of experiments that could be performed within available research budgets. Energy retrofits involving more efficient magnets and other measures reduced bills and made it possible to conduct additional research at the facility.

More conventional conservation measures include lighting, motor-driven systems, chiller plants, laboratory ventilation, and improved energy monitoring and control systems (EMCS). The EMCS now has over 10,000 sensor points in about 150 buildings. Commissioning of retrofit projects and new construction has become routine, with the help of outside specialists.

Two 1999 projects recently won awards from DOE. These projects successfully reduced the annual operating hours of over 30 exhaust fans and improved the energy efficiency of more than 2,000 light fixtures. The lighting project also involved the redesign of office furniture fixture layouts and lamp retrofits, saving $43,500 annually.

Also in the lighting arena, LED exit signs (which save approximately 90% compared to incandescent signs) have been installed virtually everywhere on the site.

On the horizon is more focus on environmental design. A new Operations Building will showcase "green" building design and a prototype for future construction at Berkeley Lab. The building will include an efficient building envelope, high-albedo roof coating (to control air-conditioning costs), natural lighting, high-efficiency windows optimized for each wall orientation, under-floor air supply, natural convection-assisted low-pressure ventilation, individual-preference and occupancy-based ventilation and temperature controls, and indirect-direct evaporative cooling. The building will also use a high proportion of recycled steel as well as recycled materials in the building panels, carpeting, fabric, tiles, and other elements.

The Lab is also addressing transportation energy issues. This year the Lab will add at least 12 new 90-hp electric pickup trucks to the 260-vehicle fleet now on the site. This is in keeping with Federal Executive Order 13031 (1996) which requires 75% of replacement "nonspecial-purpose" vehicles in federal fleets to use alternative fuels. The Lab promotes employee use of public transportation by offering pre-tax purchases of tickets and passes, and encourages use of bicycles by providing shuttle bus bike racks, bike parking, and a special Web site.

Berkeley Lab's energy managers continue to interact with EETD researchers, particularly through the Applications Team. One example is development of Federal Energy Management Performance Measurement and Verification Guidelines (http://ATeam.lbl.gov/CBS/femp/MVdoc.html), designed to facilitate third-party financing of energy retrofits and to help ensure that predicted energy savings are achieved in practice.

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http://www.lbl.gov/Workplace/Facilities/OpMaint/hvac/hvacr.htm

This work is supported by Berkeley Lab's internal operation budgets and by the U.S. Department of Energy Federal Energy Management Program.

Berkeley Lab Acts to Implement Presidential "Greening" Order

Last year, President Clinton signed Executive Order 13123, which establishes stringent new goals for energy management in federal facilities. In doing this, he recognized that the federal government can do a great deal to reduce its energy bill and greenhouse gas emissions, as well as its impact on the environment, simply by making energy efficiency a criterion in purchasing and retrofitting facilities with off-the-shelf, energy-efficient technologies.

In response, Deputy Lab Director Klaus Berkner issued a General Administrative Memo, titled "Greening the Government through Efficient Energy Management," directing all Berkeley Lab employees to comply with the Executive Order. The memo (see sidebar) asks Lab employees to pay special attention to energy efficiency when purchasing energy-using equipment and products, selecting models with an ENERGY STAR® label or those in the top 25% of energy efficiency, as designated by the U.S. Department of Energy's Federal Energy Management Program (FEMP).

Along with its energy-savings goals, the Order establishes specific measures to be undertaken by federal agencies (including National Lab facilities) and new provisions for annual reporting and accountability. These new federal guidelines replace an earlier Executive Order dating from 1994.

EETD staff in the Washington, D.C. Projects Office, including Jeff Harris, Phil Coleman, and Michelle Ware, have been heavily involved in the analysis supporting DOE/FEMP recommendations for energy-efficient government purchasing. Part 4 of the Executive Order calls on agencies to use life-cycle cost analysis in making investment and purchase decisions about facilities and energy-using equipment and directs DOE to work with the U.S. Environmental Protection Agency (EPA) in designating additional ENERGY STAR®-labeled products, consistent with the top 25% of efficient products on the market.

Lab staff are also helping DOE/FEMP to partner with the General Services Agency (GSA), the Defense Logistics Agency, and other federal organizations to educate buyers on requirements, designate efficient products in federal supply catalogs and on-line listings, and develop innovative ways of financing small purchases of energy-efficient equipment. Our staff helped DOE create the FEMP Web site on energy-efficient purchasing, located at http://www.eren.doe.gov/femp/procurement, with specific guidance on how to purchase more than 30 types of energy-efficient products. Finally, Division researchers are participating in a pilot project on using a "second price tag" to help buyers easily compare products in terms of future energy costs as well as initial purchase price.

We are also working with EPA and DOE to extend the federal leadership to energy-efficient purchasing practices for state and local governments, schools, and other corporate and institutional buyers. With U.S. Agency for International Development support, we are exploring opportunities for energy-efficient government purchasing in Mexico, building on the FEMP model. We have also evaluated federal energy management programs around the globe; see http://eetd.lbl.gov/CBS/pubs/energy.html.

In addition to promoting federal purchases of energy-efficient products, the Executive Order contains numerous provisions for auditing federal facilities, financing energy-saving measures through energy-saving performance contracts (ESPCs), measuring and verifying savings, and assisting in the design of new construction and retrofit projects. EETD staff are involved with FEMP and other agencies in each of these areas.

The EETD Design Assistance team, led by Rick Diamond, works on innovative design projects with several federal agencies. Examples include a high-profile collaboration with GSA on energy management controls at the San Francisco Federal Building, advanced lighting projects with the U.S. Postal Service and the Coast Guard, and ongoing efforts with the National Park Service on greening the Presidio of San Francisco. The Executive Order directs agencies to designate showcase facilities that "highlight energy or water efficiency and renewable energy improvements." Berkeley Lab staff are involved with several of these showcase projects, such as the Thoreau Center at the Presidio of San Francisco, which houses a group of nonprofit organizations in a building designed with energy-efficient features, photovoltaic panels, and electric vehicle charging stations. Bill Carroll coordinates EETD work, through a multi-Lab council, to evaluate new energy technologies for use in federal facilities as part of the FEMP New Technologies Development Program. Berkeley Lab is also working with Pacific Northwest National Laboratory (PNNL) on a pilot project to use federal buying power as a means of speeding commercialization of new energy-saving technologies, beginning with a "technology procurement" of an advanced, energy-saving rooftop "packaged" (unitary) air conditioner.

EETD's Applications Team under Dale Sartor and Charles Williams provides technical support to FEMP for ESPC projects at some 30 federal sites in the Western, Northeast, and Mid-Atlantic

continued on page 8

LBNL's effort to comply began with a general administrative memo from an associate director.

General Administrative Memo

July 19, 1999

Distribution: Level I—All Employees
Posted On Behalf Of: Klaus Berkner

Executive Order 13123, signed by President Clinton June, 1999 directs all Federal Agencies to "select, where life-cycle cost-effective, ENERGY STAR® and other energy-efficient products when acquiring energy-using products." For products where no ENERGY STAR® label is available, Federal Agencies are directed to purchase products that are rated in the upper 25 percent of the energy efficiency range for that class of products.

I would like to encourage all laboratory employees to include energy efficiency as one of the criteria when specifying equipment for procurement, wherever possible. Operating cost can be reduced substantially, and these products often have lower maintenance costs as well. Even if the initial purchase price is slightly higher, energy-efficient products typically cost less to own over their lifetime. Lower energy consumption also reduces the emission of greenhouse gases such as carbon dioxide and reduces water pollution.

The Federal Energy Management Program (FEMP) has developed a website to make the selection and purchase of energy-efficient products easier. It can be accessed at the following location:

http://www.eren.doe.gov/femp/procurement/challenge.html

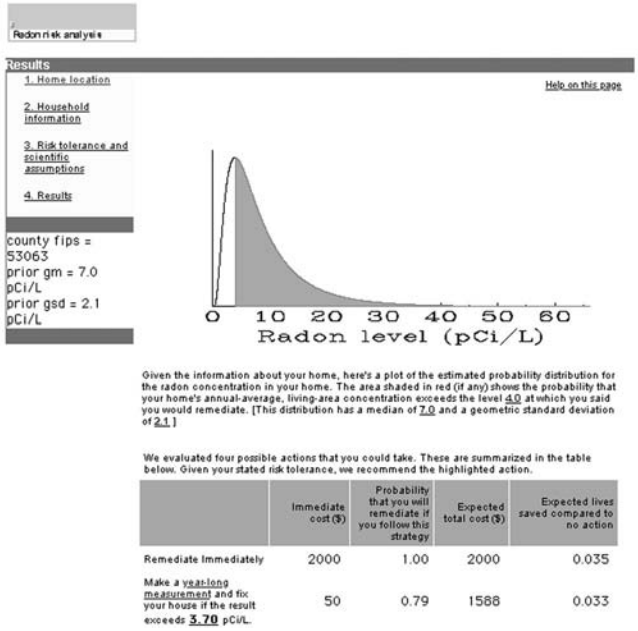
The Radon Project Web Site

Radioactive radon gas, seeping into houses from the soil below, poses a health risk to humans in certain parts of the United States. A new Web site, developed jointly by EETD and Columbia University's Department of Statistics, uses advanced mathematical methods, research on radon gas infiltration, and geologic data to help homeowners determine when and how to take action to reduce health risks from radon exposure.

Developed by EETD's Phil Price and Andrew Gelman, along with researchers at Columbia, the Radon Project Web site resides at <http://www.stat.columbia.edu/radon/>.

Radon is a naturally occurring radioactive gas, a product of radioactive decay of radium. Studies of uranium miners have shown that breathing high concentrations of radon can increase the risk of getting lung cancer. Long-term exposure of more than 20 picoCuries per liter (pCi/L) has been shown to cause lung cancer in people. Enough radon gas seeps out of soil into basements and crawlspaces in parts of the United States to pose a real health risk to people living in homes built on that soil.

The Web site can help homeowners determine what the chances are that they are breathing potentially dangerous levels of radon, and whether those risks are high enough to warrant measuring their actual exposure or having a contractor come in right away to install measures to reduce radon's infiltration in the house. Policymakers can also use the site as a tool to determine optimal policies for addressing radon health risks.



On the Radon Project's Web site users enter their location and data about their homes to calculate the estimated probability of radon penetration. This example is from an area with known high radon concentrations.

The site prompts the user to choose his or her home state and county from a U.S. map, then asks a few questions about the house's basement, whether any known measurements of radon were made in the area, and how many smokers and nonsmokers live in the house. Radon exposure increases the risk of lung cancer more for smokers than for nonsmokers.

The site then automatically inputs default values for acceptable risk levels and the estimated costs of reducing exposure to acceptable levels (assumed in this software to be 2 pCi/L or less). With this information, the software calculates the probable level of radon exposure in the home and provides the user with an exposure probability curve and a simple table showing the costs of various actions (doing nothing, short- or long-term testing to measure radon level accurately, or immediate remediation). It also recommends one of these four steps, based on the exposure level calculated.

The Environmental Protection Agency suggests that people with living-area concentrations over 4 pCi/L should remediate their homes to reduce this risk. Radon levels between 2 and 10 pCi/L probably pose some risk— the higher the level, the greater the risk—and levels above 10 pCi/L are considered definitely dangerous by experts in the field. Research suggests that in 50,000 to 100,000 homes, radon concentrations in living spaces exceed 20 pCi/L. This level is roughly equivalent to the lifetime exposure of a uranium miner and increases cancer risk among nonsmokers appreciably, among smokers by considerably more.

A unique scientific attribute of the software is its use of a method called hierarchical modeling to help decide what step to take (radon measurement or immediate remediation) given the uncertainty about how much radon is present. Radon varies tremendously throughout the United States, ranging from almost none in some areas to more than 30 pCi/L in others. Even within a single U.S. county, radon can vary within a similar broad range. Hierarchical modeling allows the software to take the spatial variability of radon into account when calculating the odds of radon exposure where the home is located.

Price and Columbia's Gelman co-developed the computational theory underlying the software. Berkeley Lab provided the data and model parameters for the Radon Project site. Maps of soil radon concentration in the United States used in the Berkeley Lab data were developed by the U.S. Geological Survey. Price wrote the computer code for using the data in the site's software, while Columbia researchers wrote the FORTRAN program to implement the computational theory.

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http://www.stat.columbia.edu/radon/

Lin, Chia-yu, Andrew Gelman, Philip Price and David Krantz, 1999. "Analysis of Local Decisions Using Hierarchical Modeling, Applied to Home Radon Measurement and Remediation," *Statistical Science,* v. 14, no.3, pp 305-337.

This work is sponsored by the U.S. Environmental Protection Agency, and at Columbia University by the National Science Foundation.

Research Highlights

Researchers Develop GHG-Mitigation Guidelines

Efforts by EETD researchers Ed Vine and Jayant Sathaye have been directed toward devising guidelines that will help nations verify that their actions to reduce greenhouse gas (GHG) emissions are working. In 1997, 176 nations pledged to reduce aggregate emissions of greenhouse gases by at least 5.2% below 1990 levels by 2008-2012. (These nations are parties to the U.N. Framework Convention of Climate Change.) To ascertain that these GHG-reducing efforts will be successful, agencies need protocols and guidelines to estimate energy savings or to standardize data collection and analysis.

Vine and Sathaye speculate that energy-efficiency projects will involve monitoring, evaluating, reporting, verifying, and certifying (MERVC). Guidelines are needed for implementation to accurately determine their impacts. Standard guidelines will also enable nations to increase the reliability of data, introduce consistency across projects, and reduce costs.

In a three-week training course in September 1999, EETD researchers Steve Kromer and Satish Kumar instructed 30 participants from 15 countries in MERVC methods. Kromer and Kumar used U.S. DOE International Performance Measurement and Verification Protocols, which they also helped develop.

New Tool for Measuring Gas Concentrations

Researchers Marc Fischer, Phil Price, Carrie Schwalbe, and Tracy Thatcher and team leaders Ashok Gadgil and Rich Sextro of EETD's Indoor Environment Department have demonstrated a powerful new technique for rapid mapping of tracer gas concentrations in ambient air. The technique combines rapid open-path optical remote sensing and computed tomography. The goal of the current work is to study turbulent transport in large indoor spaces and to provide the data needed to test a computational fluid dynamics (CFD) model being implemented by EETD researcher Elizabeth Finlayson. Once tested, the CFD model will be used to optimize the design and operation of ventilation systems for large spaces (such as auditoriums, factories, and transportation terminals) that minimize both the risk of exposure to gaseous contaminants and energy use.

EETD researchers celebrate "first light" of the gas monitoring instrument in the large air-dispersion chamber. Left to right, Melanie Thatcher, Marc Fischer, Tracy Thatcher, Phil Price, Carrie Schwalbe, and Ashok Gadgil. Gadgil holds an example of the launching and receiving optics, which are also seen hanging on the wall behind them.

The ingredients for the success of the measurement technique are high speed and spatial resolution. Speed is obtained by using an optically multiplexed tunable diode laser spectrometer to measure tracer gas concentrations—currently methane—over a set of 60 co-planar beam paths in a matter of seconds (conventional techniques require many minutes to collect the same information). Spatial resolution is obtained by using an tomographic algorithm that combines the measurements along a set of beam paths to reconstruct a "best fit" map as a sum of smooth analytic functions. Although the system was only commissioned in late 1999, the air-dispersion team has demonstrated the system's ability to accurately map time-evolving gas concentrations using a large chamber in LBNL's Building 71.

While the current goals of this work focus on indoor air, future projects are being planned to test models of air dispersion used in studies of CO_2 exchange between the atmosphere and terrestrial ecosystems. Currently, interpreting the ecological controls on CO_2 flux is complicated because the flux measured at a given location comprises contributions from different parts of an ecosystem (such as soils, understory plants, and trees). The three-dimensional weighting function or "footprint" for flux measurements must be determined using a combination of meteorological measurements and sophisticated models of air dispersion. The gas-mapping technique being developed by EETD is expected to play a uniquely powerful role in testing these models. An animation of reconstructed gas concentrations can be found at http://eetd.lbl.gov/env/mlf/air-dispersion.

LBNL Helps USPS Win Governor's Award

The Post Office just got a little greener. The 1999 California Governor's Environmental and Economic Leadership Award in the category of Environmental Management has been presented to the U.S. Postal Service (Pacific Area) for its efforts to reduce pollution and conserve energy. Ray Levinson, Environmental Compliance Coordinator for the Pacific Area, directed the overall efforts of the team in California, which included William Golove, an EETD Staff Research Associate. Golove provided technical assistance for nearly three years. USPS endeavors included lighting retrofits, high-intensity discharge dimmer controls, and modified air compressors at mail-processing facilities throughout the state. An investment of nearly $1.2 million on the Postal Service's part resulted in energy savings of more than 5.1 million kWh and earned $268,555 in utility rebates. This saved the USPS more than $350,000 in annual energy costs and helped reduce annual CO_2 and NO_x emissions by 1,900,000 and 2,600 pounds.

Additional work by Golove and the USPS is aimed at procuring direct-access green power for the more than 1,300 post

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regions. Steve Kromer and Satish Kumar are helping FEMP develop advanced information tools to streamline the management of ESPC-funded projects as well as those financed by utilities, Department of Defense shared-savings contracts, and federal agencies' own funds. This builds on earlier Berkeley Lab work on measurement and verification (M&V) guidelines to help federal customers, ESCOs, and DOE determine that the energy and cost savings are real (http://Ateam.lbl.gov/MVdoc.html). In a related area, Bill Carroll coordinates the FEMP Interlaboratory Coordinating Council, which oversees development of software to help federal agencies design and manage energy-efficiency projects.

Chuck Goldman and Bill Golove work through FEMP to help federal agencies use utility programs for energy efficiency and project financing, as well as negotiate successfully for lower-cost power in newly deregulated, competitive markets. Berkeley Lab is also developing a "how-to" guide for federal agencies interested in green power purchases along with guidelines for agencies to verify whether power sources are genuinely "green."

In the future, EETD staff will work with FEMP to develop new strategies to help federal agencies reduce their energy costs. For example, Berkeley Lab's leading-edge work on energy efficiency in "high-tech buildings" (such as laboratories and clean-rooms) is directly relevant to federal laboratory facilities and other buildings with energy-intensive "process" uses. Next-generation contracting mechanisms and M&V tools should help agencies to optimize both supply and demand-side cost savings from a single energy services supplier. Streamlined Web-based tools for managing project information, now under development by the Lab, can be applied to a wide range of federal and non-federal projects.

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offices in California. At present, that possibility is still being studied. Commenting on his efforts, Golove remarked, "It has been a pleasure to see a federal agency taking a leadership role in improving the energy-efficiency of its facilities." The award was presented December 8, 1999, at the state capitol.

EETD's Michael Siminovitch of the Lighting Group also provided technical assistance in the USPS energy-efficiency efforts. See an article in *EETD News,* Vol. 1, No. 1.

Bound paper copies of the entire set of the *Center for Building Science News*, the publication that preceded the *Environmental Energy Technologies Division News*, are now available free to anyone interested while supplies last. Quarterly issues from 1993 through summer 1998 cover energy-efficiency research.
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Sources

EREC: Energy Efficiency and Renewable Energy Clearinghouse
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Energy-efficiency resources on the Web:
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