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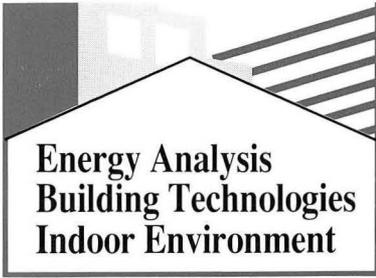
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Center *for* building science

News

LAWRENCE BERKELEY LABORATORY

ENERGY & ENVIRONMENT DIVISION • SUMMER 1994

Our Hand in Greening the White House

"For as long as I live in the White House, I want Americans to see it not only as a symbol of clean government, but also a clean environment. We're going to identify what it takes to make the White House a model for efficiency and waste reduction, and then we're going to get the job done... Before I can ask you to do the best you can in your house, I ought to make sure I'm doing the best I can in my house." —President Bill Clinton, Earth Day, 1994

In an effort to provide leadership by example, the Greening of the White House project is bringing new technology, enlightened operations and management practices, and revised procurement procedures to the First Residence. Modern information technologies (e.g., multimedia) will make information about the new technology and practices employed at the White House available to the public.

The Executive Residence, the East and West Wings, and the Victorian-era Old Executive Office Building (OEOB) will all receive the benefits of the greening. Audits of these buildings were conducted by an interagency team led by the Department of Energy and the Environmental Protection Agency. The American Institute of Architects coordinated 100 national experts, including the Center's Steve Selkowitz and Francis Rubinstein, who focused specifically on space conditioning, windows, and lighting. The result is that

White House operations staff will take more than 50 environmentally inspired actions, including practical and cost-effective landscaping, waste reduction, recycling, and water and energy-efficiency improvements.

Auditors also looked at some indoor air-quality issues. A ban on cigarette smoking in the White House, *continued on page 3*

Developing a Methodology for Identifying High-Radon Areas

The second and final part of this series describes the Indoor Environment Program's research on finding the homes with a high probability of radon exposure.

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Monitoring Buildings with Energy Management and Control Systems

Buildings that have an EMCS may already have an energy monitoring system as well—with a little adaptation.

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Is Demand-Side Management Economically Justified?

Recent work by the Energy Analysis Program examines the value of utility DSM efforts.

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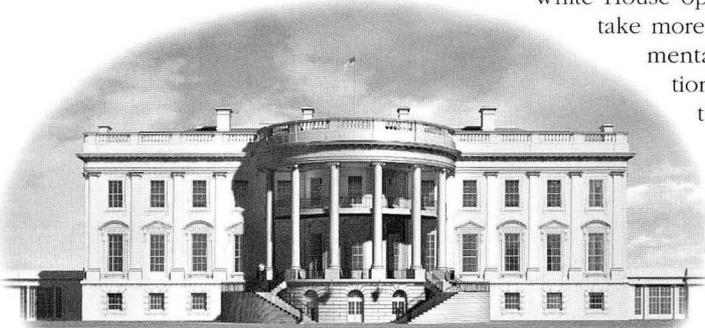
Computer-Based Design Tools

Easier-to-use features in the upcoming releases of PowerDOE and EDA will help architects proliferate energy-efficient buildings.

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GREENING OF THE WHITE HOUSE

About the Center

Addressing increasingly critical energy-related issues, the Center for Building Science has become an international leader in developing and commercializing energy-efficient technologies and analytical techniques and documenting ways of improving the energy efficiency and indoor environment of residential, commercial and industrial buildings.

The Center is the home of three Energy & Environment Division programs—Building Technologies, Energy Analysis, and Indoor Environment. It serves as a national and international voice for energy efficiency, provides technical support to energy and environmental policymakers, supports and creates institutions and demonstration programs, provides a training ground for students in the energy field, and facilitates transfer of technology and information to the private sector.

Researchers in the Center recognize that despite significant, steady progress since the energy crises of the 1970s, a large potential for energy savings remains to be realized. The Center's interdisciplinary staff studies a wide spectrum of environmental, economic, and technical aspects of energy-efficiency activities, recognizing that energy efficiency is a new and highly cost-effective energy resource.

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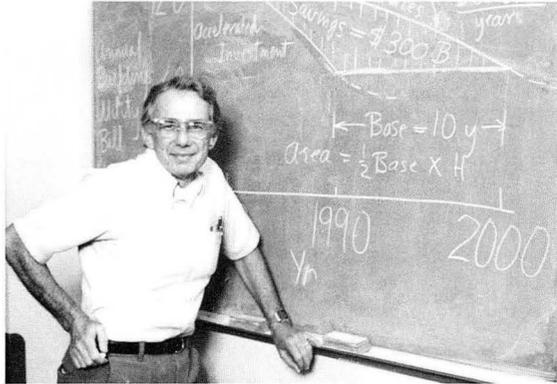
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This news letter may also be found on the World Wide Web at URL: <http://eande.lbl.gov/CBS/NEWSLETTER/CBSBNEWS.html>

A Viewgraph from the Director

Non-Energy Benefits Motivate Energy-Efficiency Improvements

Few benefits are provided by electric power plants, coal mines, oil pipelines, and other energy supply systems aside from the energy they produce. Technologies to improve energy end-use efficiency, however, offer numerous non-energy benefits. One class of such benefits accrues at the national level—improved competitiveness, energy security, net job creation, environmental protection—while another relates to consumer decision-making.

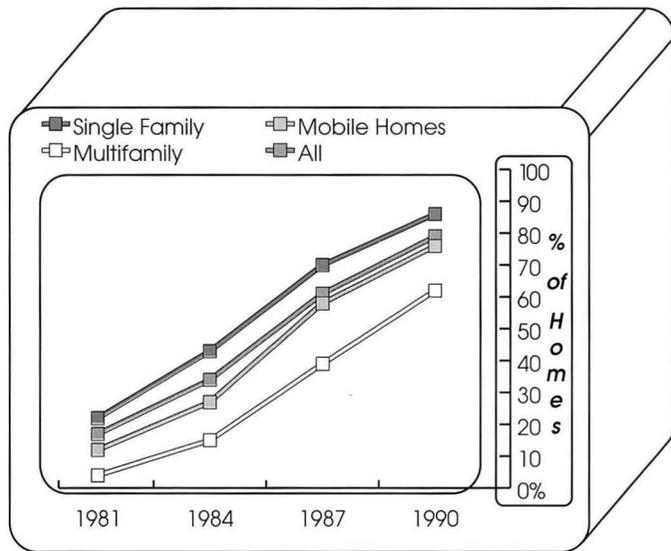


Art Rosenfeld

From a consumer perspective, it is often the non-energy benefits that motivate (or can be used to promote) decisions to adopt energy-efficient technologies. A striking example is the rapid penetration of microwave ovens into the housing stock. While energy savings from microwave ovens can be substantial, the non-energy amenity and convenience factors clearly have driven consumer adoption.

Consumer awareness of non-energy benefits is also important to utilities, energy service companies, and others seeking to sell efficiency. While energy-efficient technologies help provide equivalent services at lower costs, non-energy benefits can actually add value or enhance the energy services delivered by efficient technologies. In addition, where certain market segments are not sensitive to economic arguments (e.g., in the proverbial "landlord-tenant" split-incentive situation), some non-energy benefits can assume special importance:

- *Indoor environment, comfort, health, and safety*—applies to measures that reduce indoor air pollution, enhance thermal comfort, or improve factors associated with health or safety, such as the ability of exhaust heat recovery systems to decrease the likelihood of insufficient ventilation rates at certain times of day or in certain parts of a building.
- *Acoustical environment*—applies to measures that lead to reduced noise levels, such as the sound-insulating value of highly efficient windows.
- *Labor productivity*—applies to measures that have lower maintenance costs, improve productivity because workers have an improved environment, or that reduce the amount of time required to do a task (exemplified by the more rapid cooking time offered by microwave ovens).
- *Process control*—applies to measures that enhance the control of a process, such as the use of variable-speed motors to improve quality and uniformity of a manufacturing procedure or halogen-lamp cooktops to improve control over cooking.



U.S. Microwave Oven Penetration

- *Amenity or convenience*—applies to measures that augment the quality of energy services or the functionality of the end-use device. For example, electronic ballasts eliminate flicker and noise from lighting systems.
- *Water savings*—applies to measures that lead to less water use, such as horizontal-axis clothes washers.
- *Direct and indirect economic benefits from downsizing equipment*—applies to measures such as the HVAC equipment and distribution system downsizing made possible by reduced solar gain through windows, from lights and plug loads, etc.

For consumers, non-energy benefits can equal or exceed the importance of the energy cost avoided, thus meriting greater consideration in marketing strategies, design and evaluation of utility programs, and government policies designed to promote energy efficiency. 

—Art Rosenfeld

For a more detailed discussion, see our new publication entitled “Consumer Non-Energy Benefits as a Motivation for Making Energy-Efficiency Improvements,” by Evan Mills and Art Rosenfeld. LBL Report 35405 submitted to the 1994 ACEEE Summer Study on Buildings and available through the Center.

Note: Art has accepted the position of Senior Advisor to Christine Ervin, Assistant Secretary for Energy Efficiency and Renewable Energy at the U.S. Department of Energy, and plans to spend the next two years in Washington. He can be reached at (202) 586-6593 (phone), -9260 (fax), or via email at Arthur.Rosenfeld@hq.doe.gov.

Greening the White House (continued from page 1)

implemented early in the Clinton Administration, represents a significant improvement in this area.

Many of the energy-saving measures go well beyond the efficiency levels required by current standards. Each will be implemented cost-effectively, preserve the significant historical components of the structures, and maintain or improve comfort, productivity, and security. Among the energy-efficiency actions expected:

(1) *Lighting.* Lighting retrofits of lamps and fixtures will include placing CFLs in the President’s study and dining room and installing occupancy sensors in some areas. Other recommended improvements include replacing mercury vapor lamps with metal halide lamps, evaluating lighter interior paints, and modifying existing historic skylights to capture more daylight. In the OEOB, T8 lamps and electronic ballasts will become the standard for future lamp and ballast purchases. The installation of these lamps is currently 70% completed. The Center’s Lighting Systems Group was consulted on the lighting retrofits and used its RADIANCE software to explore various design options.

(2) *HVAC.* Heating, ventilating, and air-conditioning systems will be upgraded by adding an energy management and control system. Installing smaller, improved chillers will meet part-load requirements more efficiently. A new condensate heat recovery system will preheat domestic hot water. Hot-water coils will replace all-electric reheat functions. As they are replaced during routine maintenance, the 1,000 window air-conditioning units in the OEOB will exceed by up to 20% the efficiency of the units currently available through the federal supply schedule. Where appropriate, the units will be linked with time-clock or occupancy-sensor controls. Gradually, operations staff will retrofit all steam radiators in the OEOB with thermostatic control valves and rezone the steam-heating system for better control. Center researchers also looked at opportunities to improve insulation levels; at the Center, Vladimir Bazjanac performed simplified whole-building DOE-2 simulations to identify more efficient envelope, air-conditioning, and plug-load options.

(3) *Windows.* The Center’s Windows and Daylighting Group evaluated a variety of options. As a result, high-efficiency window retrofits are being evaluated for the third-floor solarium and greenhouse, and a new specification calls for dual-glazed (or better) windows for all future replacements.

(4) *Plug loads.* The White House procurement staff will buy office equipment (e.g., copiers and fax machines) with low standby losses. The President has signed an Executive Order mandating that all federal purchases of personal computers, monitors, and printers meet EPA’s Energy Star specifications. The Center’s Jeff Harris was a member of the “plug loads” team that recommended the use of Energy Star office equipment at pilot sites. That same report also recommended that monitored demonstrations be done at the OEOB and that Energy Star hardware purchases be accompanied by programs to train users in proper configuration and use of the hardware. Copiers purchased in the future should offer double-sided copying capability. The White House will also

continued on page 5

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Developing a Methodology for Identifying High-Radon Areas

The second of two parts

Average concentrations of radon in U.S. homes carry an increased risk of lung cancer estimated to be on the order of one in a thousand (about 13,000 cases/year), a level that is considered excessive by some and acceptable by others. But almost everyone agrees that concentrations ten or a hundred times higher than this exceed acceptable risk levels in the indoor environment, where estimated risks of premature death due to various types of pollutants (other than radon) and accidents are also typically one in a thousand.

About 50,000 to 100,000 homes are estimated to have annual average concentrations exceeding 20 pCi/L (picocuries/liter) in the living space. At this level (approximately 20 times the national average), inhabitants receive annual radiation doses that exceed the occupational standard for underground miners. Fortunately, these higher-than-average-exposure homes are not spread uniformly throughout the national housing stock; they occur most frequently in concentrated areas.

Having a method of determining the distribution of indoor radon concentrations by geographic area would be extremely useful. With it, authorities could focus their monitoring and control efforts in regions containing most of the high-radon houses, identifying and fixing these houses faster than is likely with the current unfocused approach of seeking to monitor every home in the country. The objective of a focused strategy is to target for mitigation the homes with the highest exposures—and therefore the highest added risk—rather than spend considerably more money and effort trying to reduce the national average exposure. This strategy would also permit development of building codes tailored to specific regions and other approaches to constructing radon-resistant buildings.

Even in a small area, indoor concentrations are not uniform, but distributed over a wide range of values. The difference between a typical area and a "high-radon" area is that in the latter, the entire distribution of radon concentrations is shifted higher than in more typical areas. Even areas with average concentrations have a small probability of containing houses with unusually high radon levels, but a high-radon area has a substantially higher chance of having such houses. The radon research group in the Center's Indoor Environment Program has estimated that approximately 90% of the U.S. homes with concentrations of 20 pCi/L or greater are likely to be located in 10% of the area of the United States. Therefore, the probability that a house in one of these parts of the United States will

have a concentration 20 pCi/L or greater is 80 times higher than the probability for a house in the rest of the country!

Identifying High-Radon Areas

The most straightforward way to identify high-radon areas is to monitor enough houses throughout the country to determine the local concentration distributions, even in small areas. This has not been done simply because of the high expense (although the cost is nonetheless small compared to the possible cost of today's unfocused radon measurement and control strategies, which could cost tens of billions of dollars). For example, monitoring 10 to 20 houses in each 4,000-person census tract in the U.S. would require a survey of one million homes, a daunting prospect if we are

to follow proper monitoring protocols in a representative sampling of homes.

Another approach is to understand enough about the process of indoor radon entry and removal to create a computer simulation model that can predict indoor concentrations from information about the controlling parameters, such as soil permeability and weather-induced air-pressure changes. In spite of the last decade's advances in transport modeling, it is still not possible to model radon concentration reliably this way, in part because many of the physical parameters needed as input are not known.

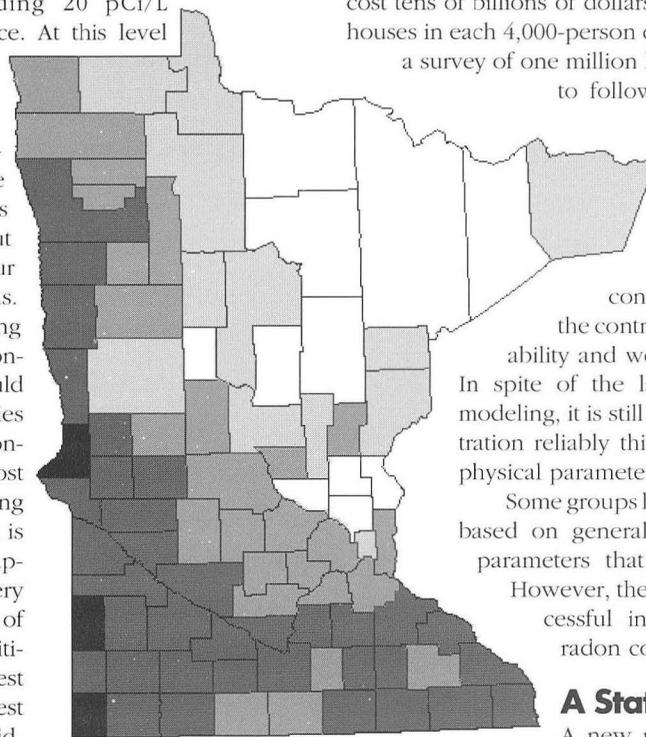
Some groups have tried to derive a radon "potential" based on general knowledge about soil and house parameters that affect radon transport and entry. However, these efforts have been generally unsuccessful in predicting actual absolute indoor radon concentrations.

A Statistical Model Approach

A new method, under development by the Center scientists and collaborators at the U.S. Geological Survey, is to use available monitoring data *jointly* with data on physical parameters, not in a physical model, but in a statistical one. This is an extension of ordinary multiple regression analysis, where the result,

in this case the indoor radon concentration, is determined by an array of parameters.

Developers of this methodology initially used data from Minnesota, a state with higher-than-average indoor radon concentrations. The average concentrations vary substantially from one county to another, as shown by a sampling of homes in that state. A simple correlation analysis demonstrated that the variation in the county-average radium content of topsoil accounted for most of the difference in the county-average radon concentration, with lesser contributions from other soil characteristics. Although this is the type of behavior that might be expected in principle (since radon is produced by the decay of radium), this correlation emerged with



Estimated geometric mean radon concentration by county for Minnesota. Darker shades indicate higher indoor radon levels. Homes in white counties have estimated concentrations below 2.5 pCi/L; black counties are greater than 5.5 pCi/L.

surprising ease. Extensions of this approach to two other states, New York and Washington, also indicate a significant dependence on soil radium content, although the behavior is more complex. There appear to be other parameters that affect county-average radon concentrations in these states.

Work is in progress on extending the statistical approach—applying a geographic information system—to use the data more comprehensively. Also, the radon group is advancing the statistical method to take proper account of the varying (and often small) number of monitoring data that determine the county mean concentrations used in the analysis. For the relatively well-developed case of Minnesota, the group has found that radium content of the soil accounts for more than 70% of the variance in county mean concentrations. The correlation model yields an estimate of the county mean that is as accurate as an estimate based on the monitoring of 20 to 30 homes in the county. Thus, good estimates can be obtained even for the Minnesota counties in which there are only a few (or no) monitored homes.

The challenge now is to extend this approach to areas much smaller than counties, (e.g., to the census tract level). To accomplish this, the radon group is cooperating with the Minnesota Department of Health, which is conducting a new survey according to a Center/USGS design. Careful choice of the location of participating homes will provide a more robust test of the Center's statistical methodology. The radon group, including faculty from the statistics department of the University of California at Berkeley, believes that further investigation of this approach will provide better local concentration estimates. It hopes to develop techniques that can be applied across the nation to derive reliable estimates of local concentrations so that the high-radon homes can be identified efficiently and rapidly. 🌐

—Anthony Nero



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Greening the White House (continued from page 3)

increase electronic mail and “paperless” faxing capabilities. A CFC-free Golden Carrot refrigerator (which beats the 1993 DOE standard by 30%) has been installed.

In addition to these hardware solutions, an in-house Energy and Environmental Management Council will play a continuing role in educating and training personnel. For example, “green” messages reminding employees to turn out the lights are regularly sent over the email system. The Council will also review and revise operations

and maintenance procedures to ensure that the new technologies realize maximum savings and to identify new opportunities.

The Center hopes that the high-visibility “greening” movement will continue. It is evaluating local opportunities such as the San Francisco Presidio, a potentially important example of integrating energy efficiency with ongoing efforts in military base conversion and historical building preservation. 🌐

—Evan Mills

The Greening of Our House

The White House isn't the only building in the U.S. working toward a greener future. LBL's in-house energy management group has been implementing energy-efficiency retrofits—ranging from motor drives to energy management and control systems to lighting—for years.

In our four-story building, what was once five and a half miles of fluorescent fixtures and 11 miles of lamps has just been retrofitted. Throughout most of the building, 1960s-style “luminous ceilings” have been replaced with reflective ceilings, below which hang new direct-indirect pendant luminaires equipped with T8 lamps and electronic ballasts. Where appropriate, occupancy sensors, local switching, and daylight sensors have been installed. Prototype thermal management strategies to improve light output and efficacy are being demonstrated in some offices (see *CBS News*, Winter 1993, page 4).

According to the original design, the lighting load was about 7 watts per square foot. Delamping in the 1970s cut this roughly in half. The new retrofit reduces the load to 1.3 watts per square foot (over 90% savings as compared to the original system design). Adjusting for additional savings achieved by the controls, the effective power density will measure about 0.5 watts per square foot. In keeping with California law, the nearly **10,000** old lamps have been sent to mercury recovery facilities; the metal fixtures will also be recycled. 🌐



Project manager Chuck Taberski (left), engineer Tai Voong and IHEM section chief Doug Lockhart pose in front of the replaced light fixtures.

Monitoring Buildings with Energy Management and Control Systems

Monitoring and evaluation are important parts of all energy-efficiency programs. With the increasing regulatory requirements for verification of demand-side management program savings and continued development of more innovative financing mechanisms, the ability to substantiate claims of energy savings using measured data takes on added importance.

Although expensive, the accurate monitoring of energy consumption and building operations is a necessary part of conservation savings analysis. Energy management and control systems (EMCSs), intended for building operations and control functions, already contain most of the same equipment usually installed for energy monitoring and can often be used for this application as well. Since building owners and managers are installing EMCSs in an increasing number of commercial buildings, with proper planning, conventional energy-monitoring equipment might be unnecessary.

However, EMCSs are not designed with end-use monitoring in mind. The features of an EMCS are determined by building rather than monitoring needs, so EMCS-based monitoring faces complications. Differences between the EMCS models, the installed options at sites with the same model, or the degree of system use at a site mean the difference between a system that can be put into service for monitoring energy right away and one that cannot be used at all. Assessing which systems will work is often difficult.

There are several methods for connecting to an EMCS to collect data. One can tap into the EMCS at a fairly low level and use a data logger, taking advantage of the existing EMCS sensors. Or one can make use of the EMCS's data collection, computation, and reporting capabilities by connecting at a higher level and collecting summary reports. In the latest generation EMCSs, the complex network architecture, multitasking capabilities, and standardized operating systems permit quick and simple data transfer. The best method to use will depend on the characteristics of the EMCS and the needs and resources of the monitoring program.

Some time ago, we evaluated the use of EMCSs as energy monitors in five buildings in Texas and California and developed guidelines based on these evaluations. The guidelines address how to determine whether the elements necessary for energy monitoring are present and what to do if they are not. Recently, we tested these

guidelines in several buildings and evaluated their usefulness to the assessment process.

Our evaluation discovered that confounding human factors can override the technical aspects of EMCS monitoring covered by the guidelines. Included in this category are such nontechnical issues as the sharing of system resources and the availability of system maintenance staff when an external party uses equipment owned by building management and designed for control rather than monitoring. We interviewed energy management and EMCS operations staff at several sites to explore these issues. Using an in-place EMCS for monitoring requires assistance from on-site personnel for assessing capabilities, reconfiguring the system, and other consulting during monitoring. In all projects, and especially in EMCS monitoring, it is important to identify organizational contacts with the information, resources, and incentive to help.

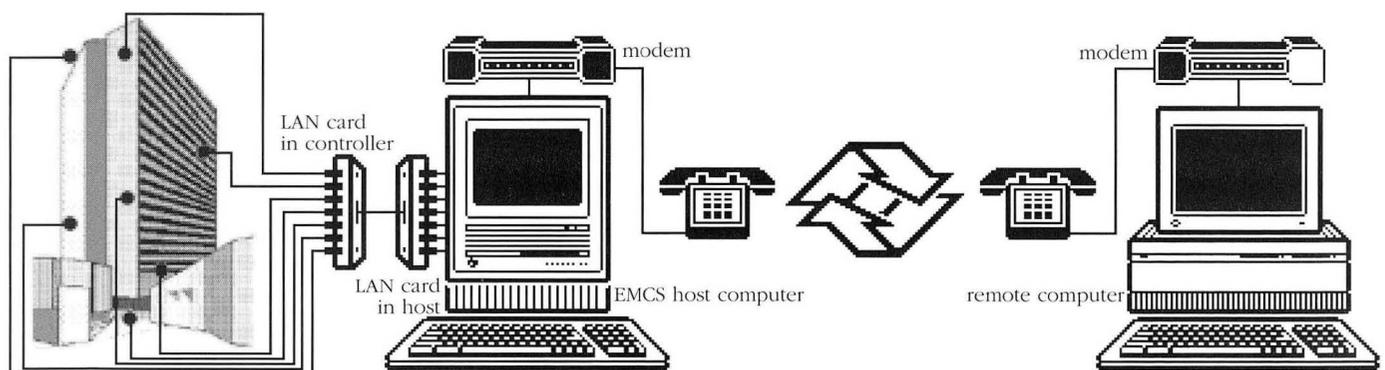
We have begun an in-depth case study of EMCS monitoring involving a laboratory building at LBL that was also the subject of a pilot study of shared savings. An outside contractor installed retrofits, and a fraction of the savings realized by the owner will be paid to the contractor, who is responsible for monitoring the building and estimating the savings. The method for determining savings from the retrofits was clearly specified in the contract and will include the use of the EMCS for monitoring. To verify these savings estimates, LBL's in-house energy management group has installed its own submetering.

The next phase of this research will compare the savings estimates resulting from the EMCS-based monitoring and those of the more conventional submetering. Also, we expect to make more detailed engineering estimates of savings with the operational and consumption data collected by the EMCS. A comparison of the resulting savings estimates and the different processes for collecting and analyzing data should reveal a lot about how well the EMCS does its new job. 

—Kristin Heinemeier



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Although there is a wide range in EMCS characteristics, most current- and next-generation EMCSs contain sensors, sophisticated networking hardware, data-storage algorithms, and communications hardware and software, all of which make the EMCS an ideal platform for commercial building performance monitoring.

Is Demand-Side Management Economically Justified?

With billions of dollars being spent on demand-side management programs in the U.S. every year, the rationale for and performance of these programs are coming under increasing scrutiny. Three projects in the Energy Analysis Program are making significant contributions to the DSM debate.

In May, Joe Eto, Ed Vine, Leslie Shown, Chris Payne, and I released the first in a series of reports we authored from the Database on Energy Efficiency Programs (DEEP) project. The objective of DEEP is to document the measured cost and performance of utility-sponsored energy-efficiency DSM programs. This objective is elusive because problems with data consistency, evaluation methodology, and data-reporting formats continue to inhibit the usefulness and comparability of individual program results. The first report investigates the results from 20 recent commercial lighting DSM programs. Unlike previous reports of its kind, the DEEP team's compared each utility's DSM definitions and methodologies for computing costs and savings and made adjustments to standardize reported program results. All 20 programs were judged cost-effective when compared to avoided costs in their local areas. At an average cost of 3.9 cents/kWh, however, utility-sponsored energy-efficiency programs are not "too cheap to meter." It seems obvious that utilities must take active measures to minimize program costs and rate impacts. However, it is less apparent to the utilities that the industry's adoption of standard definitions and reporting formats will encourage identification of the best program designs.

Following several economists' misapplication of willingness-to-pay theory to the realm of DSM, Mark Levine and I investigated customer decisions to participate in DSM programs and sought out hidden costs associated with program participation. Using survey data collected by Massachusetts Electric Company's Energy Initiative and Design 2000 programs, we found empirical evidence that consumers systematically underestimate the value of energy-efficient equipment, suggesting an important role for DSM as a means of alleviating market imperfections. We also conclude that there is little evidence that extensive hidden costs are incurred by program participants. Finally, our work suggests that the industry give additional consideration to the potential for DSM programs to transform markets; this can cause the Total Resource Cost test (traditionally used by utilities to calculate DSM program net benefits) to underestimate the benefits of the utility DSM program, possibly by a considerable margin.

A more general treatment of market failures re-

lated to energy efficiency can be found in a new report by researchers at LBL and Oak Ridge National Laboratory. Eric Hirst of ORNL and LBL's Mark Levine, Jon Koomey, Jim McMahon, and Alan Sanstad provide a comprehensive discussion of this important area. They present a rigorous empirical framework for identifying such market failures and give examples of energy-efficient technologies whose adoption has been impeded by market failures. They discuss the economic theory of market failures, showing how this applies to energy efficiency. Finally, they discuss the rationale for utility DSM in promoting energy efficiency and review the success of appliance standards in overcoming market failures affecting energy efficiency in consumer products. This report, which is drawing wide attention, may be the most complete statement to date of the technologically oriented perspective on the performance of markets and policies related to energy efficiency.

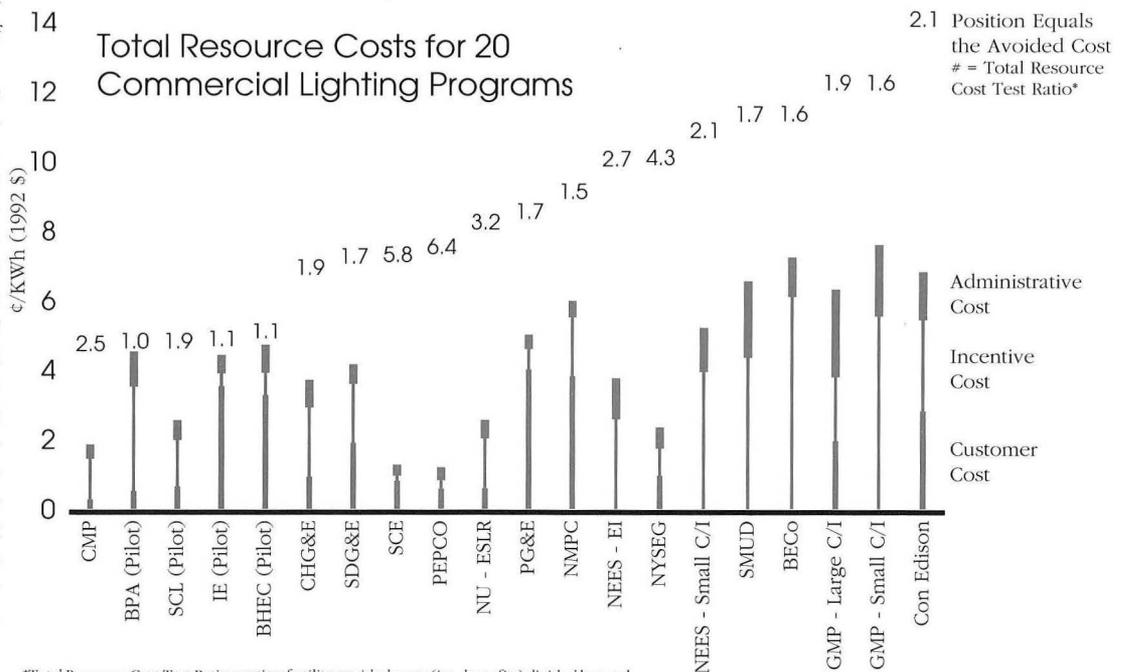
—Richard Sonnenblick



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*Total Resource Cost Test Ratio = ratio of utility avoided costs (i.e., benefits) divided by total cost of program (i.e., Administrative Cost + Incentive Cost + Customer Cost)

Computer-Based Design Tools

Reaching decisionmakers during the building design process

Concerns about energy production's environmental effects, which gained their first wide public exposure during the 1970s, and the high capital cost of new power plants continue to occupy the attention of scientists and policymakers. Twenty years of research efforts have produced a comprehensive understanding of the implications of building energy use as well as an increasing number of energy-efficient strategies and technologies with significant potential for energy savings.

ing (CAD) software packages. The widespread availability of personal computers in most building design firms offers a unique opportunity to make powerful energy simulation tools like DOE-2 available to building designers.

PowerDOE

PowerDOE is a new version of the DOE-2 building energy simulation program. Its primary developers are the Building Technologies

Program, Hirsch & Associates, and Regional Economic Research, Inc. PowerDOE has a graphical user interface running under Microsoft Windows, making it easier to use than DOE-2 while retaining DOE-2's calculating power and accuracy. Interface features include menu-driven input, on-line help, graphical results display, building component libraries, links to CAD packages, and the option to generate a building description automatically from type and vintage. PowerDOE has an open architecture to encourage third-party development of specialized performance analysis modules that can be attached to the core program. For example, a planned link to the object-oriented SPARK program will allow users to simulate new HVAC technologies of arbitrary complexity.

PowerDOE, however, is still an analytical rather than a design tool, and its primary audience is engineers, energy consultants, and utility staff. It accepts as input the detailed physical description of a building, occupancy patterns, climate data, etc., and provides as output the building's energy performance. A design tool would go beyond calculating the energy performance to address other building design considerations like comfort, economics, and

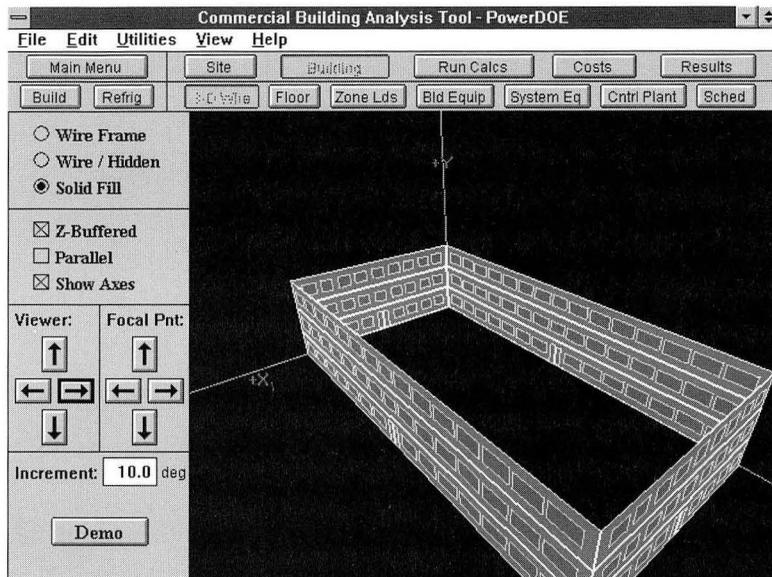


Figure 1. PowerDOE includes a user-controlled, three-dimensional perspective and axonometric display of the whole building configuration.

However, these strategies and technologies have not been transferred effectively to the building design community. The majority of new and retrofit buildings are still designed without any energy-related considerations beyond those enforced by energy codes. One reason this knowledge gap exists is because building designers do not have the means to assess the impact of new strategies and technologies efficiently and reliably *during* the building design process.

A reliable energy performance assessment requires the use of complicated algorithms that take into account specific attributes of the building and its context. The algorithms and the large computing power required to calculate year-round energy behavior has necessitated the development of building energy simulation computer programs such as DOE-2, produced by the Center's Building Technologies Program. Such programs were originally written for mainframe computers, but they are now under continuous development for today's powerful workstation and personal desktop computers. Thanks to the dramatic decrease in the cost of computing power, an increasing number of building design firms use such computers to create and maintain electronic versions of drawings and specifications through computer-aided draft-

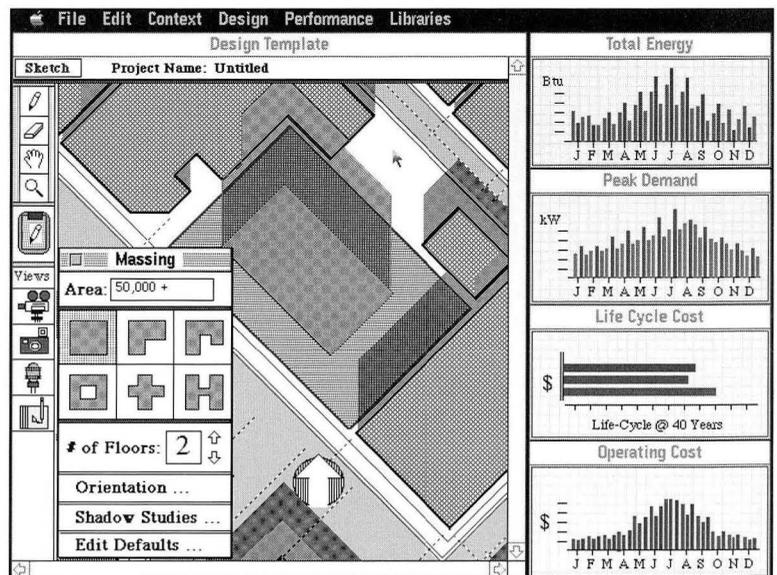


Figure 2. Through a Schematic Design Tool that incorporates shadow-casting visualization, EDA will assist building designers with initial building massing and orientation decisions, providing feedback on multiple performance considerations.

aesthetics. Also, a design tool would help its users formulate appropriate design criteria and improve building performance as the design evolves.

EDA

EDA is the code name for a building design tool that the Building Technologies Program is developing. EDA will give building designers an integrated view of how well different solutions meet design criteria throughout the building design process, from the initial, schematic phase to the detailed specification of building components and systems. Based on a comprehensive design theory, EDA will be linked to simulation algorithms for energy and other performance considerations, such as cost and environmental impacts, and to databases, such as electronic product catalogs, and utility programs. EDA will also provide context-dependent advice on performance improvement.

The first version of EDA will be linked to PowerDOE and will incorporate a Schematic Design Tool and a multimedia-based Case Studies Database (CSD) to help building designers understand the energy and cost impacts of changing the values of building parameters (such as shape, orientation, and number of floors) using the PowerDOE simulation engine. This database will be the equivalent of an electronic magazine for existing buildings, providing a realistic set of benchmarks for evaluating the performance of proposed buildings. In addition to presenting conventional alphanumeric data for displaying descriptive and performance characteristics of buildings, CSD will allow the

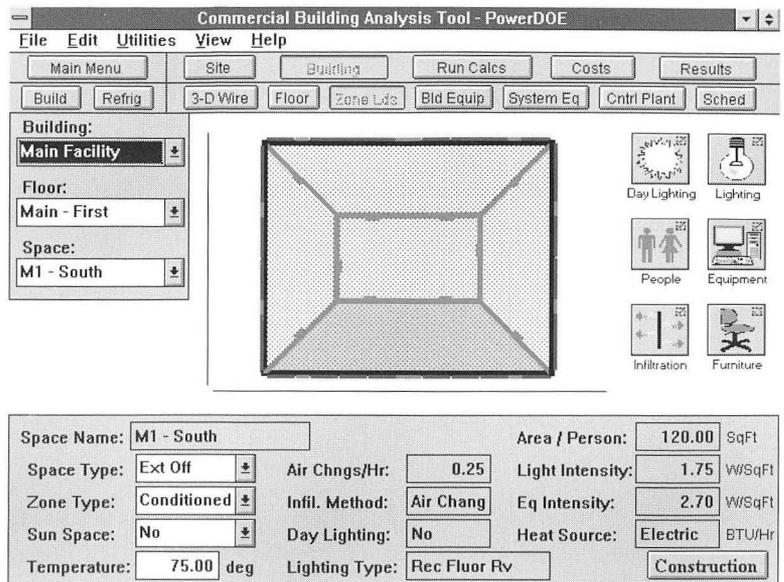


Figure 3. The interactive user interface of PowerDOE allows a designer to specify the various building components and systems easily while providing visual feedback on the placement of building envelope elements in plan and elevation views.

user to explore a building through the use of images, sound, and video.

The initial versions of PowerDOE and EDA are scheduled for combined release in the spring of 1995.

—Konstantinos Papamichael



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Visitors from Far and Wide

Dr. Fu Min Guan of Qing Dao Ocean University in China recently visited the Center to discuss the status of efficient lighting manufacturing and market penetration in China with members of the Energy Analysis Program and the Lighting Systems Group. Dr. Guan is also the director of marketing and engineering for Pacific Resource, Inc.'s China Lighting Division.

During a seminar on lighting in China, Dr. Guan noted that there is a large potential for growth in energy-efficient lighting. Of the three billion lamps manufactured in China last year, less than 2% are CFLs, and 90% are incandescents. He also discussed U.S.-China joint ventures and ways of promoting energy-efficient lighting in China through improved product quality and better consumer education.

Two recent visitors to the Simulation Research Group expressed an interest in establishing DOE-2 "resource centers." Prof. **Roberto Lamberts** in Brazil and Dr. **Deo Prasad** in Australia have agreed to be primary contacts for program users in their respective parts of the world. SRG has sent each resource center the new DOE-2.1E documentation and all back issues of *DOE-2 User News*. They will also receive new program documentation and LBL reports pertaining to DOE-2 when published. Program users can then arrange to get photocopies of the new material for a nominal cost. Dr. Prasad is also the distributor of the WINDOW 4.1 and FRAME

programs. The SRG hopes to establish more resource centers in other countries. Interested readers can fax them at (510) 486-4089 or send email to Kathy Ellington, KLEllington@lbl.gov.

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Center Research Facilities

The Energy-Efficient Fixtures Laboratory

Replacing the incandescent bulb with a more efficient light source is only the first step in developing an energy-efficient lighting system. Improved fixtures can raise the system's efficiency even further. At LBL's Energy-Efficient Fixtures Laboratory, researchers in the Lighting Systems Group study the optical and thermal efficiency of luminaires, and work closely with fixture manufacturers to develop more efficient products. "Fifty to seventy percent efficiencies are now typical of fixtures," says senior research associate Chin Zhang, "and we're trying to improve them to eighty to ninety percent."

A visitor to the Lab will see test devices that mimic the ceiling plenum space, found in most commercial buildings, into which the lighting fixtures are recessed. These chambers are designed for studying the thermal characteristics and performance of different types of fixtures such as CFL recessed downlights, T12 recessed, and pendant-mounted fixtures. The simulated plenum chambers are ideal for measuring light, input power, and temperatures of these fixtures and light distribution systems. For example, researchers can use these chambers to study the performance of a typical T12 fixture with or without "spot coolers," a thermally conductive device developed at LBL to optimize light output of the fixture. The long, narrow T12 fluorescent fixture has been a traditional staple of office lighting systems.

The air-handling test facility, a specialized version of the plenum chamber, simulates the flow of air through open luminaires, measuring the performance of air-handling and static fixtures. As air flows from below into the plenum, a photocell measures the relative light output as a function of lamp wall temperature and air flow rate. Venting cools fixtures and has been found to increase performance by up to 20 percent (*CBS News*, Winter 1993, p. 4).

The Lab's dirt depreciation chamber provides a dust-filled facility to study the effect of dirt deposits on the light output and temperature of vented versus unvented CFL fixtures. The chamber's air injection and heating system produces simulated convection currents that propel fine dust into the fixtures as photocells measure their behavior.

A new testing device is under construction that will help design and measure the efficiency of advanced centralized lighting distribution systems. An example of such a system is a single light source attached to one to four hollow light guides that distribute the light to four task planes at the same time (*see photo*). Researchers will measure the system efficacy and optical efficiency, as well as the quality of light cast by such advanced lighting technology.

"Fifty to seventy percent efficiencies are now typical of fixtures," says senior research associate Chin Zhang, "and we're trying to improve them to eighty to ninety percent."

Looking to the future, researchers are constructing a goniophotometer to measure the optical distribution of light from various luminaire systems. With this device, they will produce industry-standard photometric reports on new lighting systems.

The Lighting Systems Group works closely with the U.S. lighting industry to transfer its efficient fixture technology. Over the years they have established joint research and training programs with manufacturers such as Osram, GE Lighting, Lithonia and Cooper Lighting. It is also cooperating with Southern California Edison and other California utilities, lamp and fixture manufacturers, LBL's in-house energy management group and the National Institute for Standards and Technology on efficient lighting demonstration projects. 

—Allan Chen



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Oliver Morse adjusts a centralized light guide system consisting of a 250-watt metal halide lamp, a high-efficiency beam splitter and four hollow light guides. This results in a lighting load of only 60 watts per work station with light levels even higher than those provided by typical fluorescent systems and superior light quality.

Energy Currents

China Information Service Offered

The Energy Analysis Program is proposing to launch a multiclient service, tentatively called the China Energy Information Service, that would draw upon EAP's extensive research on China's energy sector and its strong working relationships with Chinese policymakers and researchers.

The service would provide private U.S. firms with the information they need to market their energy-related products, technologies, and services in China. For an annual fee of less than \$15,000, participants would be entitled to:

- Annual updates of EAP's *China Databook* covering China's energy supply, use, investment, and other related statistics.
- Bimonthly topical reports on subjects to be chosen in consultation with advisory committees composed of the service's subscribers.

- Annual workshops in Berkeley for subscribers to discuss topics of interest and meet with representatives from Chinese enterprises, government offices, and research institutions.
- Information consulting services entitling each subscriber to a fixed amount of consulting time annually (e.g., up to 20 hours).

Using the network, subscribers would be able to expand their access to potential business opportunities in China. EAP would like to begin offering the service later this year. Further details, as well as information on EAP's other China-related activities, are available. 



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A World Wide Web Update

The Center for Building Science now has a World Wide Web homepage accessible from the general LBL homepage. Through WWW and the Mosaic browser, Internet users can access LBL's hypertext documents, gopher databases, library catalog, publications list, and Quicktime movies. All that's required is a networked computer (Mac, PC, or UNIX) running Mosaic. To access the general LBL server from the Mosaic application, use the "Open URL" command in the "File" menu. Enter "http://www.lbl.gov/LBL.html" in the dialog box.

Follow the page's Web "links" by clicking on them. First click on the "Scientific Programs at LBL" link to bring up a list of divisions and programs at LBL, including the "Energy & Environment Division." Clicking on "E&E" will bring up its page, which includes the "Center for Building Science" link. From the Center's homepage, users can view, save, and print text and graphics describing ongoing

projects at the Center, browse all the issues of this newsletter, as well as view and perform keyword searches on the Center's publication list. All information is linked through hypertext, making it easy to find related topics or follow two-part news articles.

We invite Internet users to browse the Center's homepage. The Web group is also eager to have new information to add to the server, either as text or graphic documents provided by Center and program staff or as links to locations running other Web servers that would like to be accessible from the Center for Building Science page. Contact John Sadlier or Sam Webster for more information. 



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NEWSLETTER/CBSBNEWS.html

News from the D.C. Office

U.S. Green Building Council Priorities

The U.S. Green Building Council was recently formed as a nonprofit, Washington-based organization to promote environmentally sound building design, construction, and operation. The Council's concept of "green building" includes energy efficiency, indoor environmental quality, occupant comfort and productivity, and "sustainable" choices of materials, location, and site design.

LBL is one of the few research organizations to have joined the Green Building Council thus far. Steve Selkowitz is LBL's primary contact, and Jeff Harris covers many of the meetings in Washington. Other Council members include industry organizations, manufacturing firms, utilities, environmental groups, and several Federal agencies.

At the Council's general meeting in Washington D.C., 18-19 April, members selected three priority program areas for work this year:

- *Green Building Resource Center.* This would be a national center for disseminating information and educational tools on energy efficiency, indoor air quality, and sustainable buildings.
- *Green Building Benefits Study.* The Council wants to work with real estate industry, lenders, and insurance underwriters to help establish a consensus on how to calculate tenant and owner benefits—and thus create a marketable dollar value—for a "green" building.
- *Building Rating Systems.* The Council wants to explore options for a national system of rating and labeling green buildings, modeled on similar programs in the UK and British Columbia. The target is mainly commercial buildings, but there is also interest in rating homes.

continued on page 12



D.C. News... *continued from page 11*

Some of the Council's other interests include:

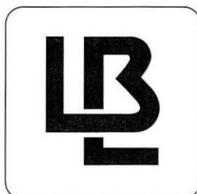
- A proposed program for product certification and environmental labeling.
- Life-cycle assessment for building products, including energy-using equipment and lighting.
- Environmental (pollutant) fees, full-cost accounting, and "green" utilities. The Council would encourage both new accounting methods and supportive public policies in these areas.
- Demonstrations of Green Buildings. The demonstration project efforts to date have been led by the National Institute for Standards and Testing as part of a new program mandated by Congress in 1993. Five demonstration sites have been funded.

LBL shares with many Council members a whole-buildings perspective on performance—one that seeks to integrate technologies and systems, hardware and people issues, design and operation, and attention to end-of-life issues for structural components, equipment, and furnishings. Participation in the Council offers LBL an opportunity to apply its tools and expertise on energy efficiency to a broader spectrum of building performance issues and to link its concerns with indoor air quality and energy. LBL's expertise on energy efficiency is a valuable resource for the Council, since energy cost savings, the one benefit relatively easy to document, represents a solid foundation for the claims of added market value being pursued by Green Buildings advocates. ♻️

—Jeff Harris



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About Lawrence Berkeley Laboratory

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

With more than 3,000 employees, LBL's total annual budget of about \$250 million supports a wide range of unclassified research activities in major areas covering the biological, physical, 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 of its success, LBL has had nine Nobel laureates, more than all of the other U.S. national laboratories combined. The Center for Building Science is one of 12 Centers located at LBL.



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