Reducing the Federal Energy Bill Berkeley Lab's Work with the Federal Energy Management Program

It costs billions of dollars and uses more energy than any other entity in the United States. What is it? Answer: the Federal government. In fiscal year 1995, the Federal government spent $8 billion on a net energy consumption of 1.15 quadrillion BTUs. While that may be a lot of energy in absolute terms, the numbers have been improving for years. Compared with fiscal year 1985, the 1995 energy-use figure is down by 22.5%, and the costs are down $2.5 billion.

The decline is explained in part by the activities of FEMP (the Federal Energy Management Program) and the efforts of energy-efficiency experts at national laboratories, such as those at Berkeley Lab's Environmental Energy Technologies Division and its Applications Team. Berkeley Lab researchers have worked extensively with FEMP and other government agencies for a number of years to find ways of applying advanced energy-efficiency technology and facilities-management practices to reduce the Federal energy bill [Spring 1995, p.1].

One reason for this improvement is that Congress directed the Federal government to become more energy-efficient. Section 543 of the National Energy Conservation Policy Act, as amended by the Energy Policy Act of 1992, requires each Federal agency to reduce energy consumption by 10% in its Federal buildings by FY 1995 (measured against a FY 1985 baseline on a BTU/gross-square-foot basis) and by 20% by FY 2000. Executive Order 12902 aims at continued progress by requiring a 30% reduction by FY 2005.

Among the work that has helped advance these goals is the participation of Berkeley Lab Applications Team staff in such projects as the "greening" of the White House [Summer 1994, p.1], and the Presidio of San Francisco [Winter 1998, p.8]; design assistance for other Federal facilities; advanced technology demonstration projects such as the San Francisco Federal Building at 450 Golden Gate [Winter 1997, p.4]; purchasing guidelines for the Federal procurement of efficient technologies [Summer 1996, p.3]; and the

development of measurement and verification protocols for energy efficiency in Federal buildings [Winter 1996, p.8]. FEMP is also supporting the Energy-Efficient Fixtures Laboratory work on a lighting project for the U.S. military [see next article].

Two Applications Team projects funded by the Federal Energy Management Program a energy-efficient retrofit of the Presidio of San Francisco facilities (left), and the lightin trols testbed at the San Francisco Federal Building.

The Super ESPC

A recent focus of the EET Division and its Applications Team is participation in FEMP's development of the Super Energy Savings Performance Contract (ESPC). Team members Steve Kromer, Brad Gustafson, and Mike Holda participate in FEMP's Alternative Finance activities, along with many others at FEMP, DOE, and the national laboratories.

A Federal agency looking to meet its energy-consumption goal can contract with an energy service company (ESCO) using the ESPC to acquire investments from the private sector for energy-efficiency and renewable-energy projects. The ESCO incurs the costs of designing, installing, financing, and maintaining energy systems; in return, it receives compensation based on a share of the cost savings from reduced utility and other operations and maintenance expenditures. FEMP provides standard ESPCs that agencies can use to quickly get a contract in place with an ESCO.

FEMP, with the participation of Berkeley Lab staff, has been developing a major improvement to the ESPC called the Super ESPC. The Super ESPC uses the same general contract terms and provisions as the conventional ESPC; but has several advantages over the standard ESPC. The Super ESPC blankets a much larger geographic area, and all Federal agencies can use it as a procurement vehicle. The conventional ESPC is designed to fund work at a specific site.

Also, the Super ESPC substantially reduces the time required to contract with an ESCO for its services-this is what should make Super ESPCs a highly effective application for Federal agencies. The contracting, the issuance of the request for proposals, establishment of terms and conditions, and the choosing of the contractors-in other words, the boilerplate terms and conditions for contracting-are done so the agencies don't have to deal with them. They can focus their energy more on site conditions-deciding what they want to improve-and less on the procurement process.

This new type of contract is modeled on the Federal government's indefinite-delivery, indefinite-quantity contracting process. As a result, agencies can get energy-efficiency retrofits started sooner, accelerating their energy and cost savings. In the past, facility personnel had to do their own contracting for energy-efficiency retrofit projects; the process could take 18 months, compared with three to six months under the Super ESPC. Agencies also have access to Department of Energy experts to help evaluate and award proposals and supervise design and technical construction.

Six Regions

FEMP is in the process of releasing six regional Super ESPCs: for the northern, mid-Atlantic, southern, midwest, central, and western regions. The agency has announced Super ESPC awards for two of the six, the western and southeastern regions, with others expected this year. The western-region contract will allow agencies to issue $750 million in ESPC delivery orders to improve energy efficiency at Federal facilities. For the future, FEMP is exploring possible ways to allow state and local governments to use Super ESPCs.

Berkeley Lab staff have been involved in the Super ESPC development process since the beginning and will help develop all six regional contracts. The work has included advising DOE on the technical aspects of the request for proposals, identifying and developing pilot sites for evaluating the contracts, and sitting on the technical evaluation committees. Gustafson, Holda, and Kromer are now working with Federal agencies to develop delivery orders and

identify facilities that can use the energy-saving contractors available under the Super ESPC.

The Berkeley Lab staffers are also on the FEMP team that's developing delivery-order guidelines. This how-to manual will help agencies use the Super ESPC effectively. These guidelines, as well as other information on Super ESPCs, are available on the project finance page of the FEMP Web site <www.eren.doe.gov/FEMP/>.

The FEMP service network (FSN) is being developed to support agencies involved in ESPC projects from both the procurement and technical sides. Berkeley Lab staff are involved in setting up the FSN and will be participants when it is operating. Berkeley Lab and the other national labs, regional support offices and the contracting personnel will offer a team consisting of field, technical and contracting resource people.

—Allan Chen

William Carroll
Environmental Energy Technologies Division
(510) 486-4890; (510) 486-6940 fax

Dale Sartor
The Applications Team
(510) 486-4988; (510) 486-5394 fax

More information is available at the Federal Energy Management Program Web site and the Applications Team Web site.

This work is supported by the U.S. Department of Energy's Federal Energy Management Program.

FEMP Supports Energy-Efficient Lighting

The Energy-Efficient Fixtures Laboratory at Berkeley Lab is receiving support from FEMP for two efficient lighting-related projects, one involving military bases, and one for the U.S. Post Office.

At the Bolling Air Force Base in Washington D.C., Michael Siminovitch, Steve Johnson and Erik Page of the Fixtures Laboratory in cooperation with Gene Foley, Alliance to Save Energy, recently supervised an exchange of energy-efficient compact fluorescent-based torchiere floor lamps for hot-burning, inefficient, halogen torchieres. Siminovitch and his staff developed and tested a prototype model of the CFL-based torchiere that is now in commercial production by Emess Lighting, among other manufacturers [See Fall 1996, p.6]. Halogen torchieres, in addition to being 300-Watt energy guzzlers, are thought to have caused at least 200 fires in the U.S. Popular on university campuses, halogen torchieres have caused dormitory fires, as well as substantial increases in energy consumption. As a result, a number of universities such as Stanford and Yale have now banned their use and subsidized CFL-for-halogen torchiere exchanges to reduce fire hazard.

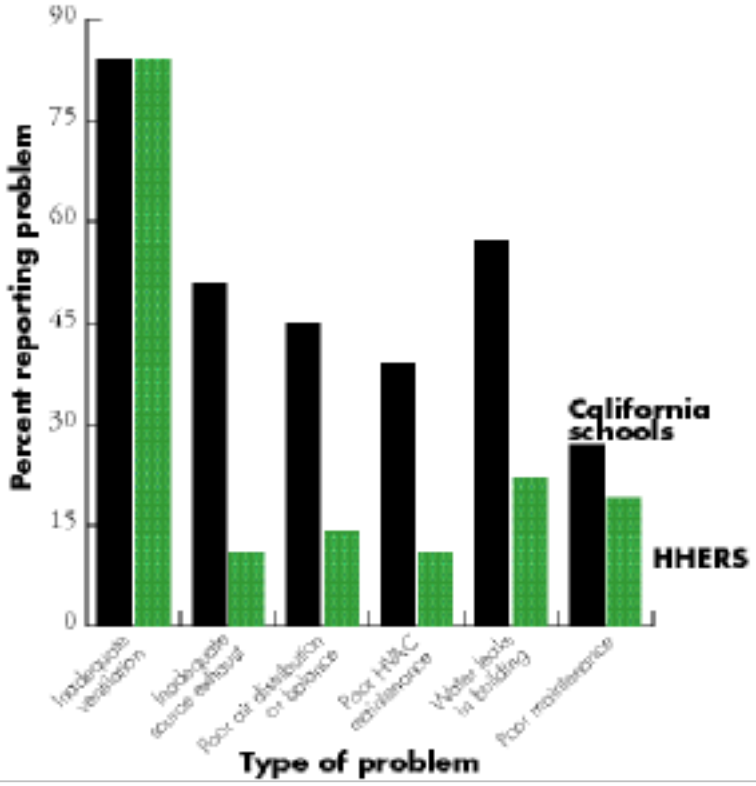
The halogen units are also popular in military housing, where they pose the same fire hazard-just weeks before the Bolling exchange, one caused a residential fire at the base. At a ceremony in January marking the start of the exchange program, the base's commandant expressed his satisfaction at the prospect of removing a safety hazard from his facility. Siminovitch and his staff are now conducting a follow-up study at Bolling to determine the number of use hours of the CFL torchiere. The data will help them estimate the energy-savings potential of CFL torchieres in the U.S. residential sector. They are also working with FEMP and the U.S. military to expand the CFL-for halogen torchiere exchange to other military bases.

A second project underway with initial seed money from FEMP is to develop energy-efficient lighting design for U.S. postal facilities. The staff of the Energy-Efficient Fixtures Lab will re-light a post office in the San Francisco Bay area town of Rodeo, and then test, measure and study the results. Efficient lighting demonstration projects at several more post offices will follow in the second phase of the project.

—Allan Chen

CBS Newsletter
Summer 1998
pg. 3

A Survey: Indoor Air Quality in Schools



Comparison of the percent of California schools and HHERs reporting problems by type.

We recently undertook a survey and critical review of the published literature on indoor air quality (IAQ), ventilation, and IAQ- and building-related health problems in schools, particularly those in the state of California. The survey's objectives included identifying the most commonly reported building-related health symptoms involving schools, and assembling and evaluating existing measurement data on key indoor air pollutants most likely to be related to these symptoms. The review also summarizes existing measurements of ventilation rates in schools and information on the causes of IAQ and health problems in schools.

Most of the literature we reviewed (more than 450 articles and reports) dealt with complaint or problem schools. Among the papers were peer-reviewed

scientific literature, conference proceedings, 77 Health Hazard Evaluation Reports (HHERs) from the National Institute of Occupational Health and Safety, and 70 reports of investigations of problem schools in California. The HHERs provided a national perspective; they are from a sampling of schools in 31 states not including California.

The types of health symptoms reported in schools were very similar to those defined as "sick building syndrome" symptoms, although this may be due at least in part to the type of questionnaires used in these studies. Some of the symptoms, such as wheezing, are indicative of asthma.

Formaldehyde, total volatile organic compounds (VOCs), CO, CO_2, and microbiological pollutants were the most commonly measured air pollutants in schools. CO_2 is often used as a surrogate for occupant-generated pollutants and an indicator of the adequacy of ventilation rates. It was the most commonly measured species in the papers reviewed, appearing in 46 of the HHERs. In one-third of these HHERs schools, 40% or more of the CO_2 measurements were greater than 1,000 ppm, a level generally regarded as indicative of inadequate ventilation for pollutant removal.

The majority of the formaldehyde measurements in the U.S. were taken in complaint schools but were generally below 0.05 ppm. Measurements of other pollutants were too limited to draw any conclusions about the prevalence of indoor concentrations above levels of concern, even in problem schools. However, there is some evidence that microbiological pollutants, also called bioaerosols, may be a particular concern. These include bacteria, allergens, and fungal spores. Although sampling and analysis methods do not make it possible to characterize exposures to these agents accurately, some recent measurements taken in California problem schools suggest that airborne bacterial levels are high enough to indicate inadequate ventilation. A significant fraction of these schools may not have ventilation rates high enough to dilute the concentration of bioaerosols that cause infectious diseases such as influenza, colds, and tuberculosis.

The few scientific studies on causes of symptoms in complaint schools indicate that exposures to molds and allergens in schools contribute to asthma, sick building syndrome, and other respiratory symptoms. Other indoor air pollutants such as VOCs and aldehydes have not been investigated closely, but we suspect they may also contribute to health symptom prevalences in schools.

The major building-related problem identified in this literature was "inadequate ventilation with outside air" (see Figure). Several lines of evidence indicate that

inadequate ventilation with outside air is a fairly common problem in schools in general, including those in California. However, inadequate ventilation can only be considered an indicator, not the causal agent for health symptoms reported in problem schools. Water damage to the building shells of schools, leading to mold contamination and growth, was the second most frequently reported building-related problem.

The cause of many of the ventilation and water-damage problems in schools was inadequate or deferred maintenance, or both, in these buildings and their HVAC systems. However, in most studies, neither the building and ventilation-system problems nor the specific pollutants have been clearly and unambiguously demonstrated to be related causally to the symptoms.

Although there is considerable qualitative information on health complaints and ventilation and IAQ problems in schools, we do not know what fraction of schools is experiencing these problems and their related health symptoms. We also do not know whether mitigation measures intended to solve these IAQ problems have worked, or how effectively they have worked.

—Joan Daisey and William Angell

Joan Daisey
Indoor Environment Department
(510) 486-7491; (510) 486-6658 fax

William Angell
Indoor Air Quality Project
Minnesota Extension Service
University of Minnesota.

The full text of this report, LBNL-41517, is available from the Indoor Environment Department Office, (510) 486-6591.

This research is supported by the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, and the U.S. Department of Energy.

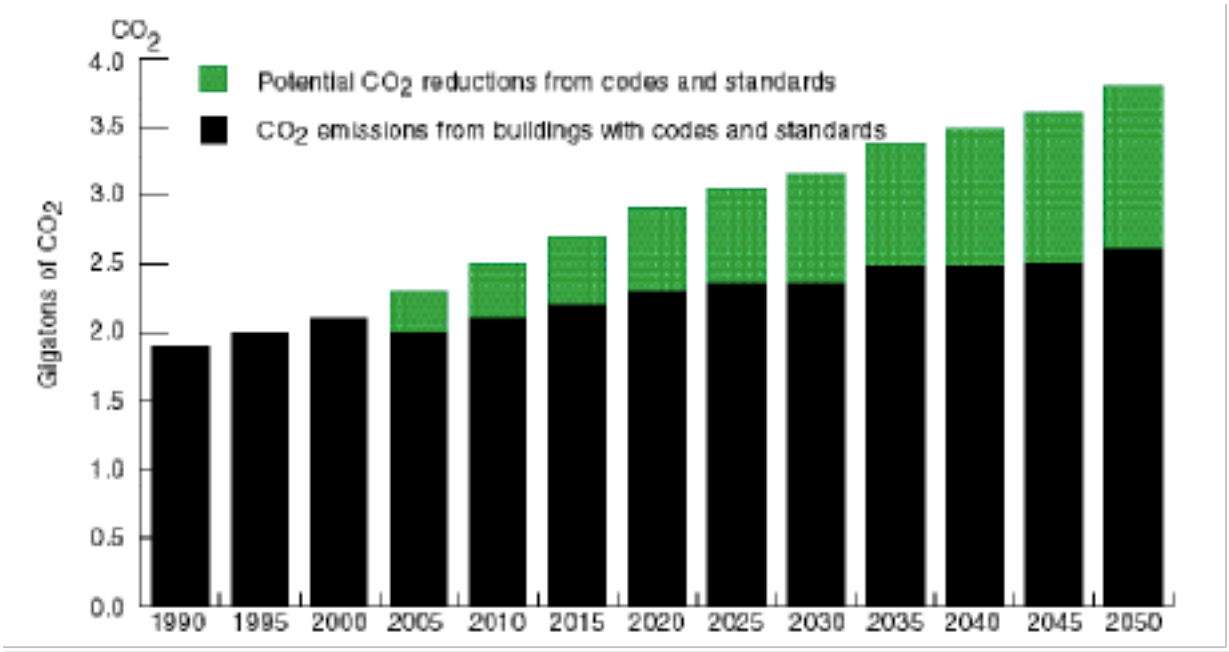
CBS Newsletter
Summer 1998
pg. 5

International Energy-Efficiency Standards

Two cost-effective approaches to reducing energy use in buildings are minimum energy standards for appliances and incorporating energy-efficiency principles in building codes. More than two dozen nations already have adopted, will soon adopt, or are considering the adoption of energy-efficiency standards and codes. The Environmental Energy Technologies Division has pooled its resources in the field of energy-efficiency standards with its international activities to create the International Building and Appliance Standards team. The IBAS team convenes regularly to discuss progress in existing international standards activities as well as to identify possible new Berkeley Lab opportunities to support efficiency standards the world over.

The current status of appliance efficiency standards worldwide indicates that by next year, 22 countries will have mandatory standards, three will have voluntary standards, and many others will have proposed or be considering standards. The state of international standards offers many opportunities for Berkeley Lab to work with a range of countries in the areas of standards development, implementation, and monitoring. Over the years, Berkeley Lab has supported development of energy performance standards in 18 countries and currently has projects in four.

For example, in the Philippines, Berkeley Lab is working with the Philippine Department of Energy and its Fuels and Appliance Testing Laboratory, as well as the U.S. Agency for International Development (USAID), to conduct a market characterization study for motors. A similar study of the design/permit/build process for commercial buildings in the Philippines is also underway. These studies will lay a foundation for electrical-motor efficiency standards and address issues of compliance with a recently adopted commercial building code.



Potential global carbon savings in all buildings from energy efficiency codes and standards, estimated by Berkeley Lab researchers for the Intergovernmental Panel on Climate Change.

Berkeley Lab is also beginning work on a market survey and workplan for the Ghanaian Ministry of Mines and Energy to support Ghana's interest in developing and implementing energy performance standards for refrigerators, room air conditioners, and lighting systems. The goal of this activity, supported by USAID, will be to transfer to our Ghanaian counterparts the skills necessary to develop, administer, and periodically review and update energy-efficiency standards for several technologies.

Other countries and areas where IBAS is tracking activities (current and future) include Mexico, China, Thailand, India, the European Union, and Latin America.

Interest in this activity continues to increase. For example, the Ceylon Electricity Board recently inquired about support for their upcoming Energy-Efficient Commercial Building Code project. The Lab also responded to a request from the United Nations for support in their effort to compile data on the state of standards in six Arab countries.

The IBAS experts, in addition to supporting, tracking, and marketing international project activities, are busy with research that complements the project work. This research relies on transaction-cost economics and actual

experience with appliance standards in the U.S. to suggest that energy performance standards can enhance economic efficiency, countering some economists' claims to the contrary. An article titled "Standards Stand Up to Competition: Performance Standards and Economic Efficiency" is currently in draft form for review and will be published in the near future. In the past, IBAS has analyzed the economics of standards for the World Bank. Specifically, IBAS has reported on the per-unit cost of operating a standards and labels program in the U.S. and is tracking data from other key countries that would allow it to conduct similar analyses.

For countries or organizations interested in better understanding the IBAS program, materials are available that provide a more in-depth explanation of this topic, including:

- a general brochure
- a brief handout highlighting its various international activities
- a step-by-step description of the process-from conception to implementation-of developing consumer product energy-efficiency standards and labels, and of the services industrialized nations can provide to developing countries to help achieve those goals.

These materials and others are also available on the IBAS Web page.

—Mirka della Cava

Mirka della Cava
(512) 916-9663

This research is supported by the U.S. Agency for International Development, the U.S. Department of Energy, U.S. Environmental Protection Agency, the United Nations, and governments of Mexico, Ghana, and the Philippines.

The IBAS team members are Chris Busch, John Busch, Sachu Constantine, Mirka della Cava, Steve Greenberg, Sajid Hakim, Jeffrey Harris, Joe Huang, Mark Levine, Jiang Lin, Aimee McKane, Jim McMahon, Alan Meier, Steve Pickle, Greg Rosenquist, Jayant Sathaye, Isaac Turiel, and Steve Wiel.

CBS Newsletter
Summer 1998
pg. 6

EnergyPlus: The Merger of BLAST and DOE-2

EnergyPlus is a new Department of Energy-supported project that will merge two major building energy simulation programs, DOE-2 and Building Loads Analysis and System Thermodynamics (BLAST). Development of both software tools began in the 1970s, when the U.S. Department of Defense began funding the software that became BLAST and the Department of Energy began funding the DOE-2 program. At the time, it was not clear which effort, if either, would produce a usable building energy analysis program. Each has hundreds of subroutines designed to solve specific building-design problems, and each has been used successfully by building designers. The goal of EnergyPlus is to take the best features of DOE-2 and BLAST and unite them in a single program. EnergyPlus will also offer new analysis tools for building technologies that are too new to have been incorporated in the older software. The table below shows which elements of BLAST and DOE-2 will be present in EnergyPlus.

Program Structure

EnergyPlus will be structured using an input file containing the complete object-based description of the building and its HVAC system. The input file will be in a form that can be produced from the DOE-2 Building Description Language (BDL) file, the BLAST file, or user interfaces that may be developed in the future.

The building simulation will be based on the heat balance engine from IBLAST, a research version of BLAST with HVAC systems integrated into the building loads simulation. For maximum flexibility, the development team will write an HVAC simulation manager to handle communication between the heat-balance engine and the various HVAC modules, including DOE-2 and BLAST template systems, and, for custom systems simulation, the SPARK and HVACSIM+ programs. The HVAC manager will handle data communications between the HVAC modules and the input and output data structures.

The calculation engine will write results into an output data structure accessible to output postprocessing agents. The output data structures are designed to allow users access to the results of the simulation without the need for the software's developers to modify the calculation engine.

Integrated Simulation

The design community has told EnergyPlus developers that the new software will need additional modeling capabilities beyond those available in DOE-2 and BLAST. One of the improvements will be an integrated loads/HVAC technique that corrects a deficiency of both precursor programs: inaccurate prediction of indoor temperatures for undersized HVAC systems.

Integrated simulation will allow users to evaluate a number of energy-saving measures that DOE-2 and BLAST do not currently simulate accurately enough, including free cooling using outside air, realistic system controls, moisture adsorption and desorption in building elements and radiant heating and cooling systems.

To facilitate continuity with existing programs, the development teams at LBNL, the University of Illinois, the U.S. Army Construction Engineering Research Laboratories have combined efforts. The team will emphasize an input structure and format that eases the user transition to the new software. EnergyPlus computational techniques and program structures will represent a significant step toward a new generation of building simulation programs. The program's development process is structured to encourage broad participation (such as writing new modules and development of interfaces) by third parties. A beta version for interface developers will be available in December 1999; a version for testing will be available in Spring 1999. The program will be released in late 1999 or early 2000.

Source of EnergyPlus program elements.

From IBLAST:	From DOE-2:	New features:
Simultaneous solution technique	Daylighting	HVAC water and air loops
Combined heat and mass transfer	Advanced fenestration	SPARK** connection
Internal mass	Switchable glazing	Input function capability
Radiant heating and cooling	Anisotropic sky model	Interzonal airflow (COMIS*** link)
MODSIM* connection	Window blind model	Sub-hour time steps
Thermal comfort	System and plant models	Foundations heat transfer
System and plant models	Atmospheric pollution calculation	
Heat balance engine		
Coil models		

*MODSIM is an object-oriented programmi language based on Modula-2.
**SPARK—Simulation Problem Analysis an Research Kernel, an object-oriented progra for complex physical processes.
***COMIS—Conjunction of Multizone Infilt Specialists, an airflow-distribution model fo multizone structures.

—Dru Crawley

[Excerpted from an article in the Building Energy Simulation User News, Vol. 18 No. 4 by C. Pedersen, D. Fisher, R. Liesen, R. Strand, and R. Taylor of the University of Illinois; W. Buhl and F. Winkelmann, LBNL; L. Lawrie, U.S. Army Construction Engineering Research Laboratories; and D. Crawley, U.S. Department of Energy.]

BLAST Support Office, University of Illinois
(217) 333-3977; (217) 244-6534 fax

Visit the BLAST Support Office web site.

Kathy Ellington
Building Technologies Department
(510) 486-5711; (510) 486-4089 fax

Visit the Simulation Research Group web site.

This research is supported by the Department of Energy's Office of Building Technology, State and Community Programs, Office of Building Systems.

CBS Newsletter
Summer 1998
pg. 8

News From the D.C. Office

Regional Builder Option Packages: A Simplified Guide for Constructing

Energy Star® Homes

ENERGY STAR Homes is part of a family of voluntary market-transformation programs sponsored by the U.S. Environmental Protection Agency and Department of Energy. The goal of the various Energy Star programs is to help energy users save money and reduce the emission of greenhouse gases by increasing the efficiency of various energy end uses, such as appliances and office equipment. Residential energy use accounts for approximately 20% of the carbon dioxide gas emissions in the U.S., from direct fuel combustion (natural gas, oil, wood) and emissions from electricity generation. The EPA estimates that the average house is responsible for emitting twice as much carbon dioxide as the average car. Energy Star Homes will reduce emissions from new housing.

Through the Energy Star Homes Program, EPA has formed partnerships with builders and developers and alliances with mortgage lenders, product manufacturers, utilities, and other industry stakeholders, to encourage the

construction of new homes that consume at least 30% less energy than those built to 1993 Model Energy Code standards. Energy Star Homes use the 100-point scale of the draft Home Energy Rating System (HERS) as the performance standard. To participate in the program, builders must have an independent party rate their homes in accordance with the Guidelines. For homes that rate 86 or higher, the builders submit documentation to EPA and receive Energy Star labels that they can display on these homes. Builders who have signed Memoranda of Understanding with EPA also receive permission to use the program logo in advertisements, technical and marketing assistance, and access to preferred mortgage products.

EET Division Provides Program Support

Since April 1995, the End-Use Forecasting Group of Berkeley Lab's Environmental Energy Technologies Division has performed technical analyses on ventilation, air conditioning heat recovery units, cool roofing materials, and duct sealing for EPA in support of the Energy Star Homes Program. In July 1995, the role of the EET Division was expanded to provide on-site program support through the Washington, D.C. Project Office. Part of the program support is account management, which involves the EET's D.C. Office staff working directly with partners and allies to foster market penetration of the program and the construction of Energy Star Homes.

Although the labeling process is simple, many builders are uncertain what home improvements are necessary to meet the Energy Star guidelines. This uncertainty has prevented some builders from joining the program. EPA recommends that builders contact a HERS rater in their area to analyze house plans and recommend improvements specific to their needs and location. Some builders are willing to do this; for many others, a simpler approach is needed.

Regional Builder Option Packages for 14 Cities

In response to its partners' needs, EPA asked Berkeley Lab's End-Use Forecasting Group to develop Regional Builder Option Packages (ReBOPs). Using computer simulations and cost data, we developed lists of cost-effective improvements builders can make to their homes to meet the Energy Star guidelines. ReBOPs have been prepared for several housing prototypes in 14 cities across the United States.

In addition to developing ReBOPs, the EET Division staff is disseminating them to program partners and allies. Drawing on our account management

experience, the EET staff is preparing a ReBOP User Guide, a list of anticipated Frequently Asked Questions, and a builder comment form. By both developing and implementing the ReBOPs, Berkeley Lab has a unique opportunity to get feedback from the intended users. Direct contact with program partners and allies will also be beneficial in the development of additional ReBOPs. We hope this direct link will improve Berkeley Lab's understanding of the home-building industry so that future technical analysis and program support efforts can better serve EPA and its program partners and allies.

—Donald Mauritz

Donald Mauritz
Lawrence Berkeley National Laboratory
1250 Maryland Avenue, SW, Suite 500
Washington, D.C. 20024
(202) 484-0884, x118; (202) 484-0888 fax

For questions concerning the development of ReBOPs, contact Richard Brown in the End-Use Forecasting Group at (510) 486-5896. For questions concerning the implementation of ReBOPs, contact Donald Mauritz in the Washington, D.C. Project Office at (202) 484-0884, x118.

This research is supported by the U.S. Environmental Protection Agency.