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The Home Energy Saver: Interactive Energy Information and Calculations on the Web

The Internet is an important new resource for information about energy efficiency. While many applications amount to little more than reformatting static text into Web pages, the Internet shows its true potential when it lets users interactively obtain customized information [CBS News, Summer 1996, p. 1]. An example is the Center's Home Energy Saver, which was the first Internet-based tool for calculating energy use in residential buildings.

The Home Energy Saver quickly computes a home's energy use on-line, based on methods developed by Center researchers. By changing one or more features of the modeled home to improve energy-efficiency, users can estimate how much energy and money they can save. Users benefit from a constantly evolving information base that is more timely than resources published in static electronic media. Hypertext links lead the user to hundreds of other Web sites that provide detailed information on energy-efficient products, home builders, residential utility programs, government programs, practical newsletters, energy software, and other useful topics. [http://hes.lbl.gov/]

ACTION INFORMATION

How much can homes in your area save?

Analyze your home for energy savings

A host of web resources on home energy savings

Frequently Asked Questions

The Site's Four Elements

The Home Energy Saver Web site consists of four main elements. With a single mouse click, the Quicklook module instantly compares energy use for typical and energy-efficient homes in different parts of the country. The Home Energy Saver's Virtual Home Energy Advisor goes a step further by calculating energy use in a particular city, based on a detailed description of the home provided by the user. In addition to calculating energy use on-line, the Home Energy Saver's Librarian connects users to an expanding array of related information resources on the Internet; the Answer Desk provides answers to a variety of frequently asked questions.

The Virtual Home Energy Advisor uses the DOE-2 building simulation program to estimate heating and cooling energy consumption. DOE-2 performs a very sophisticated series of calculations, but the user interface is relatively simple. A full annual simulation for a typical weather year (involving 8760

hourly calculations) takes about 10 to 20 seconds, once the user has entered information describing the home. Users can choose from more than 250 weather locations around the United States. Default energy prices for each fuel and state are available, or users can enter a specific price.

The Virtual Home Energy Advisor also calculates domestic water-heating energy consumption, using a model developed by Center researchers. Users can see how the number and age of occupants, equipment efficiencies, and water-heater thermostat settings affect bottom-line energy costs. And by entering the number and approximate age of their major domestic appliances, users can estimate the appliance's energy consumption, based on historic sales-weighted efficiency data. Two very detailed modules estimate energy consumption for lighting and dozens of miscellaneous gas and electric appliances, and lighting, using default values based on data collected over the years by Center researchers.

Advantages of Web-Based Tools

A Web-based approach has several distinct advantages over the traditional software production and distribution process. First, given the sophistication of Web development tools, the user interface can be designed (and subsequently modified) with considerably less effort-and thus lower cost-than with traditional methods. Second, the cost to distribute the product is minimal. Furthermore, future refinements or additions to the program do not require physical redistribution or reinstallation of the software or documentation; changes need only be made to the master version (located on the home server) for all users to have the benefit of those changes. Any user with a forms-enabled Web browser, regardless of platform, sees a seamless interface free of most hardware and software compatibility and installation problems. Regardless of the computing resources they have available, users have access to powerful computational engines residing on the host server. Lastly, the Web provides immediate access to all the other relevant energy-efficiency information that is constantly evolving on the Web.

The first phase of Home Energy Saver development is now complete. The next phase will focus on further developing the site into a one-stop shop for homeowners seeking to improve energy efficiency. The site will suggest the most cost-effective changes to make to the house, link to information about products available for these upgrades, and offer information on selecting a contractor and participating in utility programs.

—Evan Mills

Evan Mills
Center for Building Science

Visit the Home Energy Saver.

This work is sponsored by the U.S. Environmental Protection Agency, Atmospheric Pollution Prevention Division.

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News From the D.C. Office

Energy-Saving Office Equipment Part 2: Making the "Virtual Office" Real

More on the DC Office efficiency up-grade: Lighting, Office Equipment: Part 1

Regular readers of the Center for Building Science News know that energy-efficient lighting and office equipment can have significant environmental and economic benefits. Previous articles ("Monitored Savings from Energy-Efficient Lighting in D.C. Office" [Spring 1997, p. 3] and "Energy-Saving Office equipment" [Summer 1997, p. 3]) discussed these features of Berkeley Lab's Washington, D.C. office. The D.C. office also serves as a demonstration site for telecommunications technologies, which have energy and environmental benefits of their own.

For example, in avoided travel and commute costs alone, our teleconferencing, communications, and remote-computing systems currently save us an estimated 405 GJ (385 MBtu) of energy and $37,500 per year in travel costs and staff time. These savings are bound to increase in the future, as the technology improves and people learn to make even more effective use of it. In addition, an

intangible benefit accrues to Berkeley Lab employees and clients: these communications technologies bring people closer by making information distribution easier and meetings-at-a-distance more frequent.

Phone and Video Conferencing

Conference phone calls are now commonplace for group conferencing at a distance. In the D.C. office, two phones are available for conference calls. These phones have special circuitry that compensates for different voice levels throughout a large room. They require a dedicated power supply, which uses 5 to 10 W whether actively in use or "off." While we make an effort to physically unplug the phones when not in use, a better design would have the off switch on the primary (110 V) side of the power supply, preventing it from "leaking electricity." (This is true for many power supplies, a major source of "leaking electricity" consumption in homes and offices.)

When audio conferencing isn't enough, researchers can turn to video-conferencing equipment. The D.C. office provides a monitor and camera for conventional two-way visual transmission, plus a separate overhead-projector-type camera for transmiting of presentation graphics. At each site, the video camera, monitor, and associated routing equipment draw 390 W in operation and 23 W when "off."

We are increasingly using video conferencing for simultaneous seminar presentations in Berkeley and Washington (originated at either site). The phone and/or video-conference systems are used 3 to 4 times per week, and we estimate that at least one cross-country trip is avoided for every 10 phone or video conferences. Each avoided round-trip saves about 21 GJ (20 MBtu) and 0.4 metric tons of carbon. In energy terms, this is the equivalent of more than 7000 hours of video-conferencing equipment use! Dollar savings are also significant-a two-hour conference call costs only 1/20 as much as travel costs and staff time for one round-trip from Washington to Berkeley.

Computer Remote Access

Quick and easy access to data and electronic documents can be just as important as person-to-person communication. Electronic documents are easily exchanged, viewed, or interactively edited using the Lab's local and wide-area networks. Staff in the D.C. office can remotely access e-mail, files, and the Internet through dial-up connections while working at home, or on business travel anywhere in the U.S. or overseas. Extending these services allows us to

benefit from flexible workplaces and schedules while maintaining close contact with our colleagues and clients. Electronic document-sharing saves a substantial amount of printing, copying and mailing of paper documents, conservatively estimated at 500 sheets per week.

In keeping with the Berkeley Lab policy of "one Lab, two sites," network services like printing and file sharing promote collaboration between Berkeley- and D.C.-based researchers. For example, documents can be printed from Berkeley directly to the D.C. office's laser printer, allowing us to deliver them to DOE headquarters within minutes. Files can also be posted on the Lab's intranet for review by research collaborators anywhere in the world.

Science-at-a-Distance

While the systems described here are now relatively common in business and government, the D.C. office is also a showcase for future technologies designed to support remote science through "virtual co-Laboratories" and Internet-based "distance learning."

Current video-conferencing facilities usually require special retransmission facilities to allow more than two locations to share in the exchange. Berkeley Lab is developing a new method of video-conferencing on the Internet-the Multicast Backbone, or M-Bone. One day in the near future, anyone with a PC and an Internet connection may be able to participate in real-time audio-visual presentations. More information on the M-Bone is available at http://www.mbone.com/ and at http://www.lbl.gov/Science-Articles/Archive/MBONE-van-jacobson.html.

The LBNL Data Visualization Laboratory, recently installed at both the Berkeley and D.C. sites, extends the concept of virtual research collaboration by creating a powerful visual environment for analyzing complex data sets-ranging from oil field extraction rates to photometrically accurate rendering of work surfaces in an office with complex daylighting design. Use of 3-D virtual reality simulations allows combustion modelers or building designers to gain a whole new perspective-literally-on complex data sets.

—Christopher Payne

More on the DC Office efficiency up-grade: Lighting, Office Equipment: Part 1

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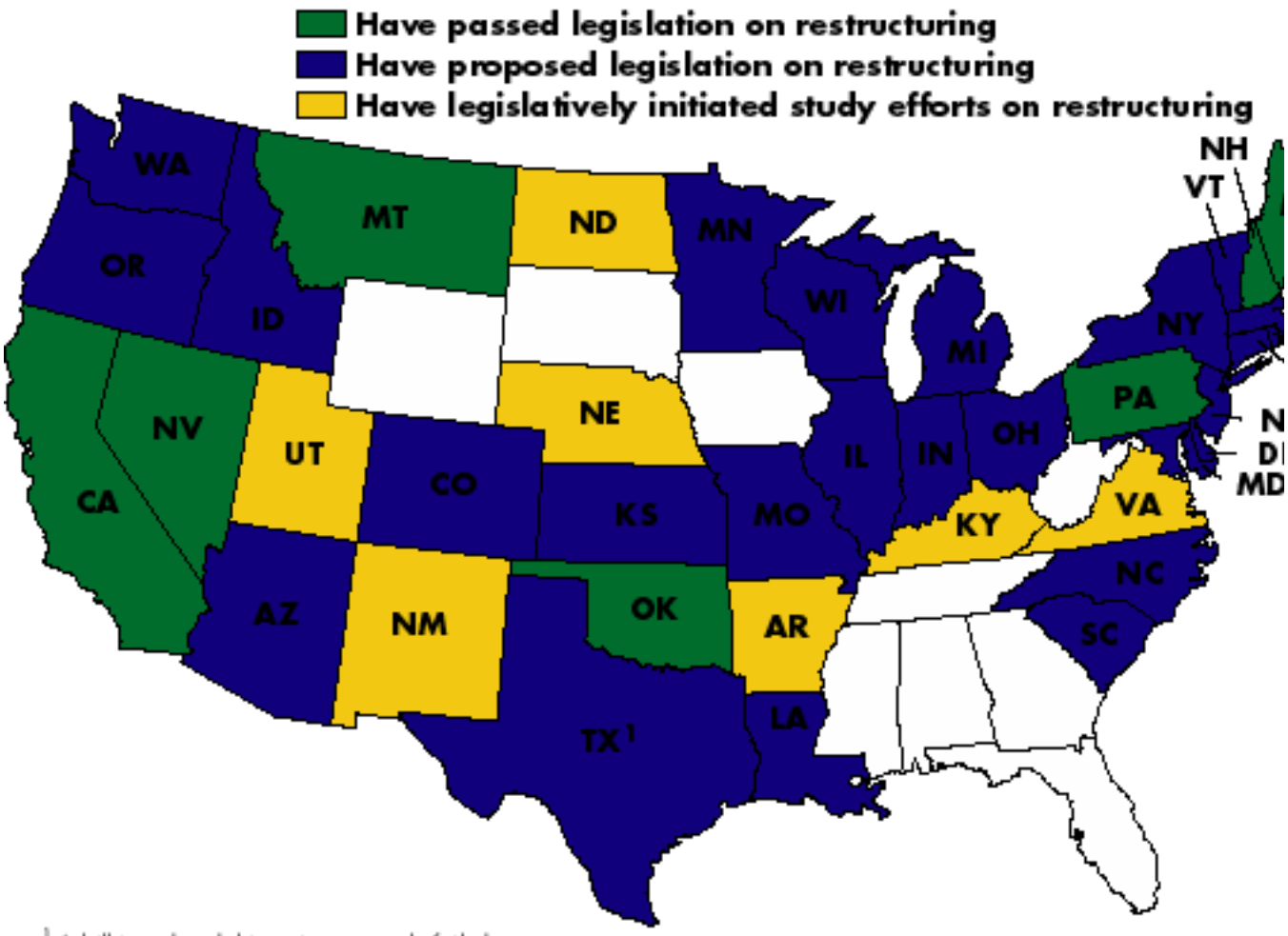
Utilities Group Aids in Restructuring Process

Researchers at the Energy Analysis Program's (EAP) Utility Planning and Policy (UPP) Group are helping ensure that energy efficiency, renewable energy, and a host of other important issues are not overlooked as California and the nation restructure the electric power industry. The UPP staff is analyzing the potential impact of restructuring on efficiency and renewables, modeling a variety of potential restructuring policies, and assisting federal customers seeking to better understand emerging electricity markets. UPP Group Leader Chuck Goldman is participating in discussions on how to distribute surcharge funds set aside for energy efficiency in California, and Acting EAP Head Stephen Wiel is assisting state lawmakers and regulators by overseeing the National Council on Competition and the Electric Industry.



[1] A bill introduced this spring narrowly failed to pass.
[2] The bill is broadly supported by regulators, the governor, and the local utilities and appears likely to pass.

Dramatic Changes in Progress

All these activities have been spurred by the dramatic changes currently shaping the U.S. electricity industry. Sometimes erroneously referred to as deregulation, electricity industry restructuring involves the de-integration of what was long considered utilities' natural monopoly over the generation, transmission and distribution of electricity. Key legislation in the 1970s introduced competition into electricity generation, and today the general consensus is that bulk-power markets are in fact competitive. In recent years, economists and others have argued that the retail segment of the electricity market could be restructured to be similarly competitive. That is, restructuring advocates have argued that there are no economic reasons why retail customers, large and small, should not be able to choose an electricity supplier in much the same way they can choose a telephone company. At least eight states have enacted legislation that will allow customers to choose their own electricity

supplier, and others are following suit (see map). In addition, several bills on restructuring have been introduced at the federal level. In most of these restructuring plans, regulated utilities would retain only certain transmission and distribution functions.

A key question arises from the restructuring process: what will become of public support for energy efficiency, renewable energy, and other important public-purpose programs mandated in a regulated system but that may not be supported in emerging electricity markets?

New policies will likely be required, and the UPP staff is involved in assessing a range of proposed policies. Researchers Chris Marnay, Robert Markel and Cooper Richey are using computer models to explore potential impacts of new policies. "We run the NEMS and Elfin models to see what we can learn about new policies designed to promote renewable energy," says Marnay, adding, "Our forecasts show that, in the near term, policy will remain an important ingredient in continued renewables development." NEMS simulates energy flows throughout the entire U.S. economy, and Elfin models production costs in the electric power sector. Both tools offer insights into the complex interactions among energy policy, energy markets and environmental impacts.

In other work, Ryan Wiser and Steve Pickle have reported on the role of green marketing for renewables and on financing issues policymakers should consider when crafting new renewables policies. Joe Eto and Evan Jones have explored options for deploying photovoltaic systems under restructuring, and Steven Stoft has found that proposed transmission-pricing formulas could actually hamper use of renewable and other intermittent energy sources.

California Considers Efficiency Policy

In some areas, however, new policies have already been adopted. In California, a small surcharge (~0.2¢/kWh) will help fund programs than support energy efficiency, renewables, low-income energy assistance and research and development. Advisory panels will oversee the distribution of these funds, and UPP Group Leader Chuck Goldman has been appointed by the California Public Utilities Commission to serve as one of nine members of the California Board for Energy Efficiency. The CBEE will direct $225 million per year in funding for energy-efficiency programs over a four-year period. It is charged with overseeing the independent administration of energy-efficiency programs designed to transform markets by providing cost-effective energy-efficient services to customers not normally served by markets, furnishing customers

with information on the costs and benefits of efficiency measures, reducing market barriers to investments in efficient products and services, and creating a sustainable and competitive energy-efficiency services market.

The UPP staff has the luxury of focusing on a few key issues related to restructuring, but for state legislators and regulators trying to keep up with the full array of issues surrounding restructuring, staying informed can be daunting. To meet this challenge, the National Association of State Legislatures and the National Association of Regulatory Utility Commissioners jointly chartered the new National Council on Competition and the Electric Industry. Acting EAP Head Stephen Wiel was named Executive Director for the National Council in March 1997. "The National Council is a partnership between NARUC and NASL to deliver high-quality and timely information on the electric industry into the hands of decisionmakers," says Wiel. Stuart Chaitkin of the California Public Utilities Commission has joined Berkeley Lab part-time to assist Wiel with National Council affairs.

—Steve Pickle

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For more information and a list of available and downloadable publications, visit the UPP Web site.

This work is supported by DOE's Office of Utility Planning and Policy.

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THERM: Two-Dimensional Building Heat-Transfer Modeling

For more information and to download THERM, please visit our website: http://windows.lbl.gov/software/therm

The Windows and Daylighting Group's two-year-old computer program THERM 1.0 is a state-of-the-art tool for modeling two-dimensional heat-transfer effects in building components. The thermal property information THERM provides is important for the design and application of building components such as windows, walls, foundations, roofs and doors. This Microsoft Windows-based program has great potential to users such as building component manufacturers, educators, students, architects, engineers and others who are interested in assessing the heat-transfer properties of single products, product interactions, or integrated systems. THERM identifies thermal short circuits in components, allowing designers to make more effective insulation technologies and insulating designs.

THERM 1.0 uses a two-dimensional conduction heat-transfer analysis methodology based on the finite-element method, which can model the complicated geometries of building products. A graphic interface allows the user to draw the cross section to be analyzed. The user can trace imported files in DXF or bitmap format or input the product's geometry from known dimensions. The cross section is represented by a combination of polygons, with material properties defined for each polygon. The user introduces the environmental conditions to which the component is exposed by defining the boundary conditions surrounding the cross section. Once the model is created, the remaining analysis is user-transparent. Results from THERM can be viewed in terms of U-factors, isotherms, heat-flux vectors and local temperatures.

Figure 1: Greenhouse windows, such as this one, and other projecting fenestration products can now be modeled more accurately with THERM 2.0.

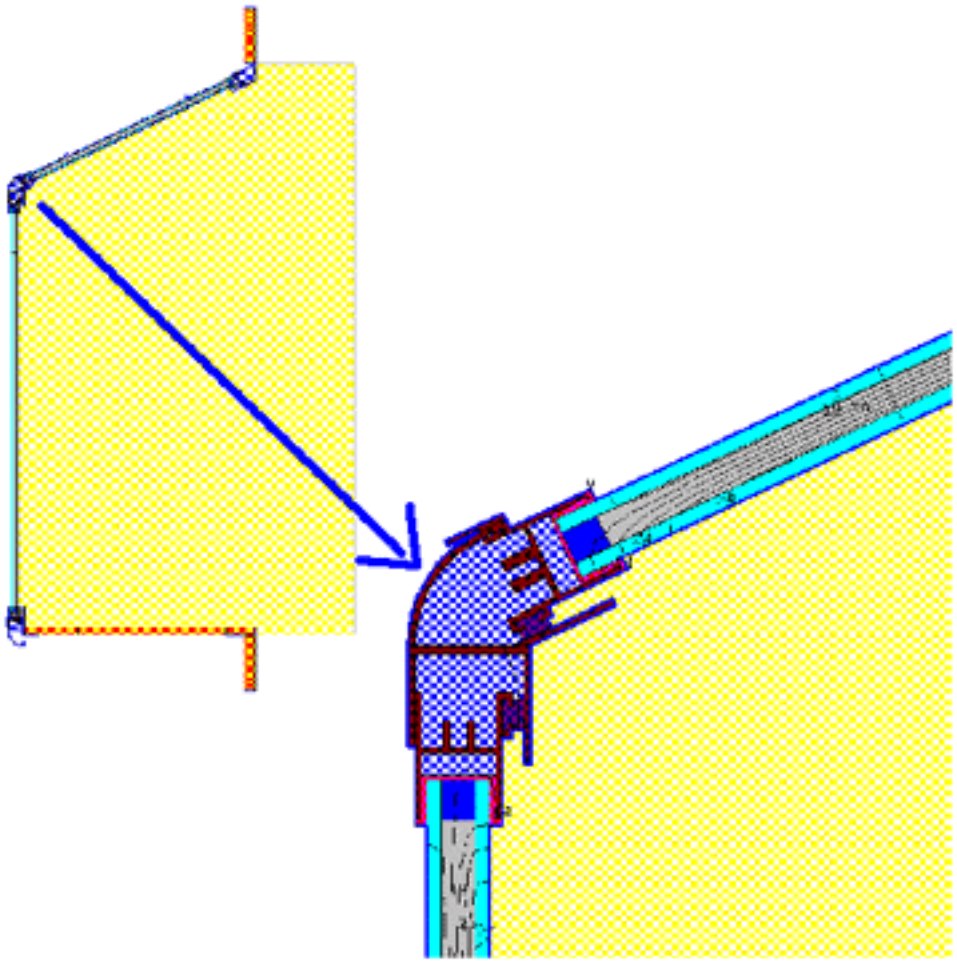

Figure 2: (Upper Left) Greenhouse window vertical cross-section defined with THERM 2.0. Shaded areas define a radiation enclosure; radiation view factors for all elements on the boundary are calculated. (Lower Right) Detail of the greenhouse window cross-section shown after heat transfer analysis; isotherms show constant temperature contours.

New Version Under Development

An update to THERM 1.0 is in the final stages of development. THERM 2.0 is a 32-bit application that will take advantage of new developments in personal computer operating systems. This release will include several new technical and user interface features-most significantly, a radiation view-factor algorithm. This feature increases the accuracy of calculations in cases where nonplanar surfaces at different temperatures exchange energy through radiation heat transfer. This heat-transfer mechanism is important in greenhouse windows and in hollow cavities.

THERM is a module of the WINDOW+5 program being developed at Berkeley Lab. THERM's results can be used with WINDOW's center-of-glass optical and thermal models to determine total window product U-factors and Solar Heat Gain Coefficients. These in turn will be used with the RESFEN module, which calculates total annual energy requirements in typical residences throughout the U.S.

—Dariush Arasteh

Dariush Arasteh
Building Technologies Program

This work is supported by DOE's Office of Building Technology, State and Community Programs.

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Thermal Performance of Phase-Change Wallboard for Residential Cooling

Cooling residential buildings in milder climates contributes significantly to peak demand mainly because of poor load factors. Peak cooling load determines the size of equipment and the cooling source. Several measures reduce cooling-system size and allow the use of lower-energy cooling sources; they include incorporating exterior walls or other elements that effectively shelter interiors from outside heat and cold, and providing thermal mass, to cool interior spaces during the day by absorbing heat and warm them at night as the mass discharges its heat.

Thermal mass features may be used for storage only or serve as structural elements. Concrete, steel, adobe, stone, and brick all satisfy requirements for sensible heat storage.

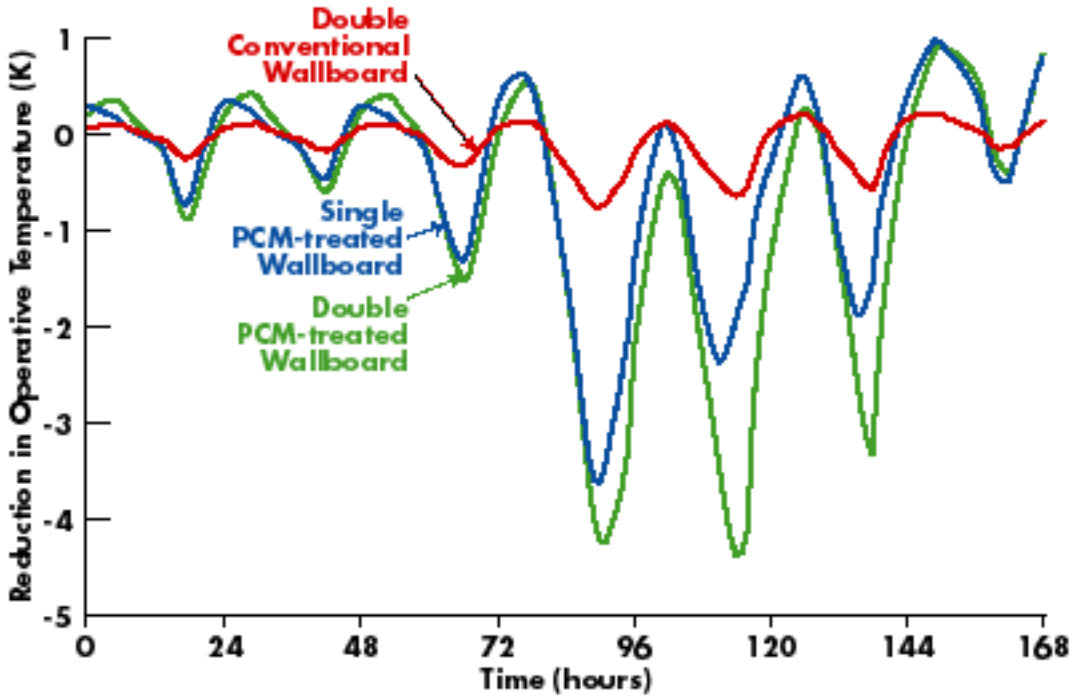

Figure 1. Reduction in operative temperature for double conventional and single and double PCM-treated wallboard, compared with single conventional wallboard.

Phase-change materials (PCMs), usually a paraffin that can be embedded in gypsum board, plaster, or other wall-covering material, form a class of building material that functions as a storage medium. Materials undergoing a phase change (freezing, melting, condensing, or boiling) store and release large amounts of heat with small changes in temperature. PCMs for thermal mass typically involve a liquid/solid transition-the PCM solidifies, releasing heat when cooling resources are available, and liquifies, absorbing heat when cooling is needed. PCMs offer an order of magnitude increase in heat capacity, and for pure substances they discharge their heat with almost no change in temperature.

PCM allows the thermal storage to become part of the building's structure, permitting substantial energy storage without changing the temperature of the room envelope. Because the heat is stored within the building where the loads occur rather than externally, additional energy transport is not required.

We have used RADCOOL, a thermal building simulation program, to perform a numerical evaluation of the latent storage performance of treated wallboard. In the model, each wall is divided into several layers, allowing for the modeling of multilayer walls. The modeled zone is a living room with a 35 m^2 (377 ft^2) floor area. The window area is 20 percent of the exterior wall area. All walls and the ceiling are covered with PCM-treated wallboard containing 20 percent paraffin; the room was also modeled for a double thickness of PCM-treated wallboard. The living room is assumed to be occupied by four people from 6 a.m. to 10 p.m. Climate conditions used in the model are those of June 11 through June 17, 1991, in Sunnyvale, California. The first three days of this period were mild; on day four, outdoor temperature reaches almost 40°C (104°F), and remained high for two more days. The room receives ventilative cooling, 10 air changes per hour below 25°C (77°F) and 1.5 ACH above 25°C.

Model outputs include the air temperature and operative temperature profiles of the room with conventional versus single-thickness PCM wallboard, and conventional versus double-thickness PCM wallboard. (Operative temperature is a measure of perceived temperature.) The model also generates outputs of the temperature difference between the wall surface and the air. The figure at left shows the operative temperature-reduction potential of different types of wallboard as compared to single-thickness conventional wallboard. PCM-

treated wallboard reduces operative temperature on the first day of the heat spell, day four, but saturation of the latent storage diminishes its reduction potential thereafter. Doubling the PCM-treated wallboard significantly improves operative temperature reduction.

To reconcile the flammability of paraffin with the traditional use of wallboard as fire retardant in construction, we performed a similar numerical evaluation for a "covered PCM wallboard" consisting of single-thickness PCM wallboard containing 40 percent paraffin, covered by a single thickness of conventional wallboard. Our results indicate that the operative temperature reduction potential of "covered PCM wallboard" is similar to that of double-thickness PCM wallboard containing 20 percent paraffin.

The extended storage capacity of double-PCM-treated wallboard can keep room temperatures close to the upper comfort limits without mechanical cooling. In climates with large diurnal temperature swings, night-time ventilation can be used to discharge the latent storage of the wallboard.

—Helmut Feustel and Corina Stetiu

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A-Team Report

Energy Savings Performance Contracts

The federal government is the largest single consumer of energy in the United States, spending more than $3 billion yearly to light, heat, and operate its buildings. Money is also spent to maintain aging buildings, many of which are inefficient, having been built before the 1970s. As these costs have increased, budgets have been dramatically cut back during the last two years at the Departments of Energy and Defense and the General Services Administration.

Last spring, DOE announced the award of a new type of contract for federal agencies to purchase "energy services," the super energy savings performance contract (Super-ESPC). This contract is a partnership between a Federal agency and a private-sector energy service company (ESCO). The ESCO pays the up-front cost of purchasing and installing new energy-efficient equipment, and the government repays the company over the life of the contract from the savings resulting from reduced energy costs. No capital funding through federal appropriation is required.

Applications Team members Brad Gustafson, Steve Kromer and Mike Holda are working on a project with DOE to develop guidelines, standard procedures, and training for federal agencies that want to develop ESPCs. Some $5 billion in investment is needed to repair or replace aging equipment in federal buildings between now and 2005 to meet a federal goal of reducing energy use by one-third. According to DOE estimates, each dollar invested in energy efficiency results in a savings of four dollars, which translates into federal deficit reduction as well as jobs in the construction and manufacturing industries.

Although some of the money for energy-efficiency projects may come from Congressional appropriations and some power companies provide energy-efficiency services in their role as energy suppliers, chances are that the ESPC will evolve into a major source of funding. The new DOE contract can help accelerate the use of ESPCs by streamlining the procurement process, reducing

the time required to buy more-efficient systems. This step reduces procurement costs and opens up the huge federal market to the private sector. The project team anticipates a total savings of $20 billion over 20 years from performance contracting, if it is widely adopted. At the time of this report, the first of six regional contracts has been signed. In addition, three contractors have signed letters of intent for the first ESPCs and are now making preliminary estimates of energy savings at federal sites.

—Brad Gustafson

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This work is supported by the Federal Energy Management Program.

For more information on ESPCs:

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