Energy Design Update®

The Monthly Newsletter on Energy-Efficient Housing, from Aspen Publishers

Vol. 24, No. 9 September 2004

INDUSTRY NEWS

Raising Furnace Efficiency Standards

After dragging its institutional feet for years, the US Department of Energy (DOE) has taken the first step toward establishing new energy efficiency standards for residential furnaces and boilers. On July 29, 2004, the DOE published an "Advanced Notice of Proposed Rulemaking" (ANOPR) inviting stakeholders to attend public meetings in late September on proposed changes in standards for three product categories: residential furnaces and boilers, electric transformers, and commercial air conditioners and heat pumps. The announcement is merely the first step in the standard-making process; any final rules are at least 18 months away, and implementation of new standards could occur, according to the DOE, no sooner than 2013.

In the July 29 ANOPR, the DOE announced its position on two contentious issues—whether or not the DOE has the authority to regulate the electrical consumption of furnace fans, and whether or not the DOE can give the green light to regional standards as opposed to a single national standard for residential furnaces. On both issues, the DOE's position has disappointed energy-efficiency advocates.

A Pattern of Delay

The current efficiency standards for residential heating appliances (78% AFUE for furnaces, 80% AFUE for boilers) were established by the DOE under the National Appliance Energy Conservation Act of 1987 and became effective on January 1, 1992. That act established a mandatory process for the periodic review and updating of efficiency standards. As far back as February 1994, ***EDU*** reported on the review process in an article optimistically titled "New DOE Furnace Efficiency Standards Process Gets Under Way." The article noted, "The US Department of Energy … was supposed to publish a final rule on new efficiency standards for air conditioners and furnaces in January, but the effort fell behind schedule due to disagreement with the appliance industry over how DOE should assess the impact of the new standards on manufacturers." Ten years later, the DOE's tendency to fall behind schedule has become standard operating procedure.

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As part of its statutory obligation to update its standards, the DOE determined on October 22, 1997, "based on the best information currently available, that it appears energy conservation standards for residential furnaces and boilers would be technologically feasible and economically justified, and would result in significant energy savings." Almost four years later, on July 17, 2001, the DOE held a public workshop on the rulemaking process for residential furnace and boiler efficiency standards. On that date it published the *Framework Document for Residential Furnaces and Boilers* ("the *Framework* document") identifying new residential furnace standards as a "high priority item." The document included a DOE timetable for releasing an ANOPR on residential furnaces in early 2002, with the final rule to be published in early 2004. Neither deadline was met.

The DOE's inability to comply with its own published timetables has long frustrated Congress. In a July 23, 2004 letter to DOE Secretary Spencer Abraham, Senator Susan Collins (R, Maine) and Senator Joseph Lieberman (D, Connecticut), called the DOE to task: "According to the [DOE] procedures, the entire process from the beginning of DOE's work on a new standard to issuance of a final rule 'should take no more than three years' (61 Fed. Reg. 36977). . . . DOE first designated the rulemakings for three product categories—residential furnaces and boilers, commercial air conditioners and heat pumps, and electric distribution transformers—as its 'high priorities' in 2001. In December 2001, DOE published a schedule setting out target agency deadlines for each stage of the rulemaking process. . . . All three final rules were to be done by fall 2004. . . . Despite full funding of DOE's budget requests for the program by Congress, DOE has failed to meet any of its target deadlines for even the initial ANPRM stage of the rulemaking. . . . With each passing year, DOE has given itself another six months to one year to get its work done. . . . In light of these standards' importance, we respectfully request an explanation for the Department's failure to adhere to its published schedules for advancing the 'high priority' rulemakings." According to a staff person in Senator Lieberman's office, Secretary Abraham has not responded in writing to the Senators' letter.

Harry Misuriello is the director of the Buildings and Utility Programs for the Alliance to Save Energy in Washington, DC. "In many instances, DOE just hasn't met the deadlines set by Congress," Misuriello notes. "The delays are an obstacle to completing designs on a new generation of products, deny consumers of the economic benefits of the new products, and delay the national enjoyment of the energy savings the products could provide. A lot of the problems in the process would simply go away if schedules and deadlines were met."

Katherine Kennedy, senior attorney for the Natural Resources Defense Council (NRDC) in New York City, echoes Misuriello's concerns. "The DOE for decades has been behind on many of the statutory deadlines," says Kennedy. "By our count they have missed 22 deadlines for 18 products. When the DOE misses its deadlines, there are no automatic penalties for the agency. The consumers and the environment pay the penalty for their delays."

Electrical Consumption of Furnace Fans

AFUE calculations do not take electrical consumption into account, and the inclusion of electrical consumption in furnace and boiler efficiency standards has been debated for years. In June 1995, ***EDU*** reported, "Despite nearly universal support for the basic concept, the US Department of Energy will give up its current effort to factor electricity consumption of residen-

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Energy Design Update (ISSN 0741-3629) is published monthly by Aspen Publishers, A WoltersKluwer Company 1185 Avenue of the Americas, New York, NY 10036. (212) 597-0200. One-year subscription costs $370. *To subscribe, call 1-800-638-8437.*
For customer service, call 1-800-234-1660. POSTMASTER: Send address changes to ***Energy Design Update,*** *Aspen Publishers, 7201 McKinney Circle, Frederick, MD 21704.*

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tial gas furnaces into efficiency ratings." Within the last two years, several researchers have compiled data showing the potential for significant, cost-effective savings in furnace electrical consumption (see ***EDU***, March 2003 and September 2003).

The DOE's 2001 *Framework* document noted that "Electricity consumption by fuel-fired residential furnaces and boilers is substantial and is not captured by the AFUE energy descriptor. The Department is considering ways in which the electricity consumption of fuel-fired residential furnaces and boilers could be improved. . . . A logical way to regulate the electricity use of fuel-fired residential furnaces and boilers would be to specify a maximum annual electrical consumption (E_{AE}) that would vary by the rated output of the equipment. The current DOE test procedure (10 *CFR* 430, Subpart B, Appendix N) provides a means to determine AFUE and also calculates E_{AE}."

Although the *Framework* document established a "logical way" to proceed on furnace fan efficiency standards, the DOE has now apparently precluded the option. In spite of the existence of contrary legal interpretations, the agency's July 29 *ANOPR Technical Support Document* declares, "The Department has determined that it does not have the authority to regulate electricity consumption in residential furnaces and boilers."

The DOE's current position was quickly hailed by the Gas Appliance Manufacturers Association (GAMA). Mark Kendall, GAMA's director of technical service, told ***EDU***, "I was glad to see that they have announced that they don't believe they have the legal authority to regulate furnace fans."

Considering A Cold-Climate Standard

Although the intent of statutes governing appliance efficiency (the Energy Policy and Conservation Act, the National Appliance Energy Conservation Act, and the Energy Policy Act of 1992) was to establish uniform national standards, the acts permit individual states to set more stringent standards by petitioning the DOE for "waivers from preemption." While a uniform national standard makes sense for refrigerators, it makes little sense for furnaces, since the cost-effectiveness of furnace efficiency improvements varies by climate. For example, the incremental cost of a 92% AFUE condensing furnace is easily justified in Wisconsin, but is questionable in Alabama. Moreover, a decision to raise the national standard for residential furnaces from 78% AFUE to (for example) 81% AFUE would have little effect in Wisconsin, where eight of ten furnaces sold already have an efficiency greater than 90% AFUE.

To manufacturers, a multiplicity of state standards would be a nightmare. To address this legitimate concern, while still permitting northern states to establish a climate-appropriate furnace standard, several national associations, including the American Council for an Energy-Efficient Economy (ACEEE) and the NRDC, have proposed establishing no more than two standards for furnaces. They urge the DOE to create a streamlined mechanism to quickly grant "waivers from preemption" to petitioning states seeking more stringent standards for residential furnaces, as long as the higher standard is consistent with that of other petitioning northern states. According to an ACEEE memo of June 7, 2002, "This strategy would *de facto* lead to two 'national' standards, one condensing and one non-condensing."

The DOE's July 29 ANOPR appears to slam the door on this proposal: "DOE believes that the [Energy Policy and Conservation] Act does not authorize the adoption of regional standards." Steven Nadel, ACEEE's executive director, disagrees with the DOE's interpretation. "We believe that DOE is misreading the law on both issues," says Nadel. "We believe that DOE has discretion to set regional standards and electricity standards for furnaces." In Nadel's view, the DOE's legal interpretations are shaped by the agency's agenda. "The [DOE's] current general counsel is trying to interpret this program very narrowly, because the counsel is not very supportive of standards," says Nadel. "That's part of their philosophical agenda. They are doing what they can to keep the program reined in."

Like Nadel, Misuriello finds the current DOE position frustrating. "I certainly think allowing the states some latitude to seek out the best solution is an important issue," says Misuriello. "If you have a number of northern-tier states that want to put higher standards into effect, and the public and the homebuilders will buy it, why should DOE get in the way? With commitment and leadership, the department could find a way to accomplish that. In fact there are legions of people that will help them to arrive at a different interpretation if they want to go that way. Their current position is kind of inexplicable."

Fortunately, there will be opportunities ahead for the DOE to change its position. "An ANOPR is the very beginning of the rulemaking process, and at this point nothing is written in stone," says Kennedy. "It gives a general sense of the DOE's position. The final rule is

still many months away."

The Need for Patience

The DOE's July 29 ANOPR provides a timetable for the rest of the rulemaking process: "According to the proposed rulemaking timeline … DOE expects to issue a Final Rule in September 2005. The effective date for any new standards for furnaces and boilers will be eight years after its publication as a final rule in the *Federal Register*"—that is, in September 2013. In light of the DOE's track record, implementation of new standards may be even further off. Misuriello hopes that stakeholders will succeed, for once, in pressuring the DOE to stick to its schedule. "These standards have been delayed so long that now it is time to really insist that DOE holds to its procedural guidelines and get out a final rule in 18 months and no longer," says Misuriello.

NEWS BRIEFS

Proposal for Massive PV Rebate Program in California

SACRAMENTO, CA—The "Million Solar Homes Initiative," a plan put forward by the California Environmental Protection Agency, proposes new incentives for the installation of residential photovoltaic (PV) systems. The California initiative calls for a new utility bill surcharge of about 30 cents per household per month to fund $100 million of PV incentives per year for a decade. The incentives would be available to owners of existing homes as well as to builders of new homes. The proposal would require builders to include PV arrays on half of new California homes by 2020, although the generous incentives would probably achieve that result well before the deadline required mandatory compliance. The agency projects that the incentives alone will result in PV systems being installed on 50% of new homes by 2013. Although the California Building Industry Association opposed earlier legislation mandating the installation of PV systems on new homes, it supports the incentive-based Million Solar Homes Initiative. If implemented, the initiative would make California a global leader in the installation of residential PV systems.

Residential Energy-Efficiency Research Project Launched

LEXINGTON, MA—Three energy-efficiency organizations are collaborating on a one-year research project to assess the potential for more energy-efficient residential HVAC installations in the Northeast. Among the project's goals is the development of a duct-sealing marketing plan. Researchers hope to visit and assess 76 homes in the Northeast and to monitor the performance of five houses for 12 months. The research project by the Northeast Energy Efficiency Partnerships (NEEP), the New York State Energy Research and Development Authority (NYSERDA), and the New Jersey Board of Public Utilities is made possible by a grant from the US Department of Energy. "There are tremendous efficiency opportunities yet untapped in the residential HVAC sector," said Susan Coakley, executive director of NEEP. "We anticipate that the outcomes will form a foundation of 'best practices' recommendations that will transform the residential HVAC landscape, and further lead to their implementation in various programs even beyond the Northeast region." Project partners include Conservation Services Group, Proctor Engineering, and Nexus Market Research.

NREL Gets a New Lab

GOLDEN, CO—Construction has begun on a new 71,000-square-foot research building at the National Renewable Energy Laboratory. Most of the lab will be dedicated to photovoltaics research, although the facility will also be used for research in electrochromic windows, solid-state lighting, and new uses of hydrogen. Completion of the energy-efficient building, dubbed the Science and Technology Facility, is expected in 2006.

Energy-Efficient Lighting Lab Created in California

DAVIS, CA—A new laboratory to study energy-efficient lighting has been created at the University of California, Davis. Researchers at the California Lighting Technology Center will partner with electric utilities and lighting manufacturers to introduce new types of energy-efficient lighting. The new facility is led by lighting specialists Michael Siminovitch and Konstantinos Papamichael, both formerly with the Lawrence Berkeley National Laboratory. The center is funded in part by grants from the California Energy Commission, the US Department of Energy, and the National Electrical Manufacturers Association.

ORNL Adopts New ZEH Label

OAK RIDGE, TN—Press releases from Oak Ridge National Laboratory (ORNL) have adopted a new term, "near-zero-energy house," to describe houses formerly called "zero energy houses." While a 2002 headline in *Science and Technology Highlights*, an ORNL newsletter, proclaimed, "ORNL and Partners Building

Village of 'Zero Energy' Houses," an ORNL press release from August 11, 2004 describes the same houses with a more accurate label: "In July, workers completed a fourth … Near-Zero-Energy House." ***EDU*** applauds ORNL for the switch.

PG&E Stops Taking PV Rebate Applications

SAN FRANCISCO, CA—With the demand for photovoltaic (PV) system rebates outstripping available funds, Pacific Gas and Electric (PG&E), a California utility, has stopped accepting applications for PV rebates. According to a news article on Solarbuzz.com, a solar energy Web site, PG&E closed the doors to new applications on July 31, when the utility had accumulated 109 unprocessed applications requesting a total of $76 million in PV rebates.

Smart Growth Group Highlights Energy Efficiency

CORAL GABLES, FL—A group advocating smart growth has released a position paper calling for smart growth advocates to pay more attention to energy efficiency. The paper, "Energy and Smart Growth," was recently released by the Funders' Network for Smart Growth (FNSG). According to the paper, "The smart growth and energy efficiency movements … are intrinsically linked, yet these two fields have mostly operated in separate worlds. Through greater use of energy efficient design and renewable energy sources, the smart growth movement could better achieve its goals of environmental protection, economic security and prosperity, and community livability." The paper is posted on the Web at *www.fundersnetwork.org*.

DOE Grants Support Residential Energy Efficiency

WASHINGTON, DC—The US Department of Energy has announced grants of $16.3 million to fund 162 energy-efficiency projects. Recipients of the State Energy Program Special Projects grants include 33 Rebuild America projects to improve the energy performance of existing buildings, including public housing units; six Building America projects to develop more energy-efficient houses; and 16 projects to develop state energy codes.

Meter Provides Real-Time Energy Info

MADISON, WI—A prototype Building America home under construction near Madison contains a touch-screen monitor to provide homeowners with real-time energy information. Homeowners can consult the monitor to determine how much energy is being used by the washing machine, refrigerator, or selected plug loads. The device also records energy-use data for later downloading by researchers. The meter, a prototype from Whirlpool Corporation, is not yet commercially available. The home is being built by Veridian Homes with consulting help from Steven Winter Associates of Norwalk, Connecticut.

Glazing With PV Cells and LEDs

OSAKA, JAPAN—Sharp Corporation has developed a window glazing product called Lumiwall that includes integral photovoltaic (PV) cells and LEDs for lighting. During the day, the electricity produced by the PV cells is stored in integrated rechargeable batteries, while 10% of the sunlight striking the panel passes between the PV cells to reach the interior. At night, the Lumiwall batteries power 320 inward-facing LEDs to light the room. Measuring 24 by 39 inches, each Lumiwall panel has a PV output of 35 watts. Lumiwall panels (model LN-H1W) will be available in Japan on November 1, 2004. Sharp Corporation has no plans to distribute the panels in the US.

ASHRAE Approves Addenda to Standard 62.2

ATLANTA, GA—The first addenda to ASHRAE Standard 62.2, the residential ventilation standard, were approved for publication at ASHRAE's June meeting in Atlanta. Addendum 62.2a eliminates the requirement to perform a backdraft test (see the "News Briefs" section of ***EDU***, April 2004), while Addendum 62.2b changes the term "severe cold climate" to "very cold climate," redefined as one having more than 9,000 heating degree days. According to David Grimsrud, chair of the Standard 62.2 committee, "This makes the standard's climate definitions consistent with the proposed revisions to the International Code Council climate zone definitions, which will simplify implementation of Standard 62.2 into code."

Shade Trees Don't Reduce Cooling Costs

TUCSON, AZ—A Tucson study has disproved the common belief that houses surrounded by shade trees have lower cooling costs than unshaded houses. In a study reported in the July/August 2004 issue of *Home Energy*, researchers Susan Schaefer Kliman and Andrew Comrie analyzed data from 105 Tucson homes. The surprise finding: "There were no landscaping variables that decreased the summer cooling load." The researchers discovered that trees on the north side of houses actually increased the summer cooling load, a phenomenon that may be caused by the trees' trapping warm air near the buildings. This effect was relatively minor, however; the researchers concluded that "the physical characteristics of the house, combined with the living habits of the occupants—in particular, how they set their thermostats—far outweighed the impact of vegetation on energy savings."

IEA Undertakes Hygrothermal Study

PARIS, FRANCE—The International Energy Agency has launched a major four-year study of heat, air, and moisture flows in buildings. Researchers in 19 countries will explore the physics of these flows, using basic research, computer modeling, examination of building materials, mock-up testing, and field testing. The researchers will study how heat, air, and moisture flows affect building durability and energy consumption. One of the participating organizations is the Institute for Research in Construction in Ottawa, Ontario. For more information, contact Dr. Kumar Kumaran at (613) 993-9611 or *kumar.kumaran@nrc-cnrc.gc.ca*.

Attorneys General File Global Warming Suit

NEW YORK, NY—On July 21, eight state attorneys general sued the five top US global warming polluters. The suit, filed in federal district court under the common law of public nuisance, represents the first time that state governments have sued private companies to require reductions in carbon dioxide emissions. The attorneys general of California, Connecticut, Iowa, New Jersey, New York, Rhode Island, Vermont, and Wisconsin have filed suit against American Electric Power Company, the Southern Company, Tennessee Valley Authority, Xcel Energy, and Cinergy Corporation. These five companies own or operate 174 fossil-fuel-burning power plants in 20 states that emit 650 million tons of carbon dioxide each year. Announcing the suit, Rhode Island Attorney General Patrick C. Lynch said, "It's imperative that we confront those responsible for unleashing an invader with the power to wreak unspeakable havoc on our climate and to damage and destroy our ecosystems."

Prototype Nebraska Home

LINCOLN, NE—The Nebraska Energy Office and Steven Winter Associates of Norwalk, Connecticut, are collaborating to design an affordable Building America house in Nebraska. The house will incorporate a plenum truss to provide space for ducts within the home's conditioned space. During construction, the prototype house will be used to train builders, subcontractors, and suppliers. After completion, the house's performance will be monitored by researchers.

Electricity From Human Feces

LONDON, UK—The Science Museum in London is considering a proposal to produce on-site electricity by burning human feces from the museum's toilets, according to a report from Reuters news service. "It would be a great way for visitors to give something back to the museum and help keep the overhead down," said museum head Jon Tucker. "We have almost three million visitors each year and have huge electricity bills."

Minnesota Offers PV Rebates

SAINT PAUL, MN—Minnesota homeowners installing residential photovoltaic systems can apply for both a $2 per watt rebate from the state and a $2 per watt utility rebate. To be eligible for the rebates, a system must be grid-connected and must be rated between 1 and 4 kW. The utility-funded program is being administered by the Minnesota Department of Commerce State Energy Office. For more information on the Minnesota Solar Electric Rebate Program, visit *www.commerce.state.mn.us*.

Quote Without Comment

"To illustrate the current state of the world's oil, [Colin] Campbell's Web site [*www.peakoil.org*] uses the analogy of champagne at a party. There were 24 bottles of champagne when the evening began, and half is left. Only one glass of the remaining champagne will come from America, but the sole American at the party is drinking about 25 percent of the champagne being consumed." ["How Will the Coming Oil Peak Affect You?", *Sustainable Minnesota*, Summer 2004; available at *www.me3.org/newsletters*.]

RESEARCH AND IDEAS

Pollutant Transfer from Attached Garages

Data from a recent Canadian study of the transfer of pollutants from attached garages to indoor living areas provide a strong argument against locating a furnace mechanical room in an attached garage.

The principal researcher of the Canada Mortgage and Housing Corporation (CMHC) study was Innes Hood of Sheltair Group Resource Consultants in Vancouver, British Columbia. Hood and his fellow researchers performed a variety of tests—including house airtightness tests, garage airtightness tests, and balanced airtightness tests—on 42 homes with attached garages in Vancouver, Winnipeg, and Saskatoon. (The average airtightness of the studied homes ranged from 3.1 air changes per hour in Saskatoon to 8.4 air changes per hour in Vancouver.) The researchers also analyzed data

acquired in a previous study of 25 Ottawa houses with attached garages.

Computer Modeling

Although the researchers did not measure pollutant levels in any of the houses being studied, they used a contaminant and airflow modeling program called CONTAM to calculate carbon monoxide and benzene levels in the studied houses under two scenarios: the "cold start" scenario (starting up a car in the garage and allowing the engine to idle for 30 seconds) and the "hot soak" scenario (representing the emissions given off by a hot engine as it cools off after being parked in the garage).

The CONTAM program allows the input of measured blower door data for each house being studied. The model was run under a static condition (that is, assuming that house exhaust fans and the HVAC system are not operating).

Of the geographical areas studied, houses in Vancouver had the highest level of house leakage originating from the garage-to-house interface—0.8 air changes per hour. On average, the garage-to-house leakage accounted for between 10% and 13% of the total house leakage area. However, in four houses in Vancouver, over 25% of the house air leakage originated through the garage-to-house interface. All four of these houses had furnaces located in a mechanical room accessed through the garage. CONTAM modeling showed that in these four houses, indoor levels of carbon monoxide exceeded the recommended exposure limits (see Figure 1).

According to the CMHC Research Highlight describing the study, the primary leakage paths for these four houses were: "Poor weatherstripping of the mechanical room doors; unintentional leakage of the return air ducts to furnaces causing depressurization of the mechanical room and resulting in entrainment of garage air and air transfer to the living space; and excessive sized holes for penetrations between the mechanical room and living space."

Problems in 10% of the Studied Houses

In 90% of the houses studied, computer modeling did not reveal any hazards. However, in 10% of the houses—that is, the houses that had at least 25% of leakage coming through the garage-to-house interface—the researchers concluded that "garage-based emissions could cause significant house indoor air quality problems."

In three Vancouver houses, the researchers tested a variety of remediation strategies, including improved air sealing of the garage-to-house interface, installation of a passive grille between the garage and the exterior, and installation of a timer-controlled exhaust fan in the garage. All three remediation strategies were effective to varying degrees.

The lesson for builders is that houses with attached garages need meticulous attention to air sealing, especially at the garage-to-house interface. In an existing

house, improving the air barrier between an attached garage and the living space can be tricky. As the CMHC Research Highlight notes, "Living spaces over attached garages are particularly difficult to seal in the case of existing dwellings. Air may enter stud walls and pass through the wall top plate into the joist space from where it can get into living space above the garage. . . . To be effective, air sealing would require that ceiling drywall be removed around the perimeter of the garage and all joints in the wood framing be sealed with foam or sealant. For this situation, installing an exhaust fan [in the garage] that runs for 30 minutes is likely a more cost-effective solution. Fans providing 25 liters per second [53 cfm] to 100 liters per second [212 cfm] are acceptable. The fan could be controlled on a timer and interlocked with garage lights."

Introducing a final note of caution, the researchers point out that their computer modeling assumed that a car idles for no more than 30 seconds, and that the car exhaust has average levels of pollutants: "Note that cars with dirtier exhausts or idling periods longer than the 30 seconds will result in higher indoor conditions than those modeled."

For builders in regions where mechanical rooms are often located in garages, the lessons are clear. As Innes Hood recently told ***EDU***, "Don't install the mechanical room such that it is accessed through the garage. If you are going to have a mechanical room adjacent to that wall, make sure there are no penetrations."

The report, "Garage Performance Testing" (Technical Series 04-108), can be ordered from Canada Mortgage and Housing Corporation, 700 Montreal Road, Ottawa, Ontario K1A 0P7, Canada. Tel: (613) 748-2000; Fax: (613) 748-4069; Web site: *www.cmhc.ca.*

NEW PRODUCTS

Nighttime Ventilation Cooling

For those who live in areas of the country where summer temperatures drop significantly at night, using a whole-house fan can save energy compared to running an air conditioner. However, not all homeowners are willing to commit to the whole-house fan routine, which requires opening up the downstairs windows at bedtime and closing them the next morning. Moreover, most whole-house fans have unsophisticated controls—sometimes just a toggle switch—and may therefore run longer than necessary, wasting energy.

In hopes of developing a "smart" whole-house fan integrated with forced-air ductwork, researchers funded by the California Institute for Energy Efficiency have been working since 1994 on a project called Alternatives to Compressor Cooling (ACC). As a result of their work, a ventilation cooling system called the NightBreeze is now on the market. In some climates, use of the NightBreeze can eliminate the need for air conditioning.

The NightBreeze includes a variable-speed air handler with an ECM blower, a hydronic heating coil, a large motorized damper to control the intake of exterior air, and a wall-mounted control unit (see Figure 2). The thermostat-like control unit also regulates the operation of the air conditioner, if any. In addition to providing nighttime ventilation cooling, the NightBreeze system provides year-'round whole-house ventilation.

Automatic Cooling Without a Compressor

In order to pull in enough outside air to cool the house at night, the NightBreeze requires a large exterior intake grille—usually about 3'x3' (assuming the grille has 50% free area). If the air handler is located in the attic, the air intake grille can be mounted in a gable, in

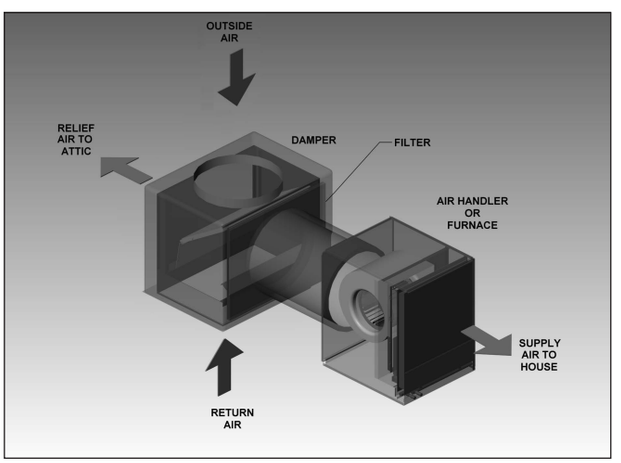

Figure 2. When the exterior air temperature is low enough, the NightBreeze cools the home by ventilating with 100% exterior air. In ventilation cooling mode, the motorized damper directs all of the return air to be exhausted (as so-called "relief air") to the attic or to an exterior exhaust grille.

a doghouse dormer, or at the top of a false chimney (see Figure 3).

The air-intake duct is connected to a damper box containing a large hinged motorized damper blade. Damper leakage is minimal—at 25 Pascals, it's about 1.4% of total fan flow. According to David Springer, the president of Davis Energy Group, one of the main consulting groups that developed the NightBreeze, "It is possible to achieve 6 percent duct leakage in a system that includes the damper."

The wall-mounted NightBreeze control replaces a conventional thermostat (see Figure 4). "At my house, the control is set for a 5-degree delta T," says Springer. "The upstairs thermostat is set to 80°, so it'll start ventilating when the outdoor temperature drops to 75°. By morning, the outdoor temperature might be in the fifties or low sixties, and the indoor temperature might be 68°."

Figure 3. In this photo, the NightBreeze air intake grille is behind the lower set of louvers.

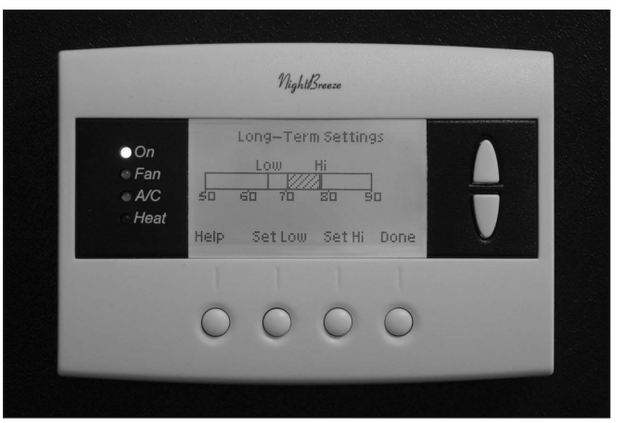

Figure 4. The NightBreeze thermostat controls the motorized damper as well as the ECM blower in the air handler. It can also control a conventional air conditioner as well as a hydronic circulator connected to the air handler's hydronic coil.

The control unit uses historical monitored temperature data to predict next-day outdoor temperatures. When the control predicts relatively mild weather, the ventilating blower will run at a lower speed than when hotter weather is predicted.

Whole-House Ventilation

The NightBreeze functions not only as a smart whole-house fan, but also as a conventional air handler. It comes with a hydronic heating coil; when connected to a properly sized water heater, the coil can provide up to 100,000 Btuh of heating.

During the heating season, the control operates the damper and blower as required to introduce enough outside air to meet ASHRAE 62.2 ventilation levels, even when there is no call for heat. While conventional air handlers have large energy-hungry two-speed blowers that circulate more air than required for ventilation, the NightBreeze's ECM blower moves only as much air as is required for the task at hand.

The NightBreeze is a balanced ventilation system, exhausting the same quantity of air as it introduces to the house. Since the system's motorized damper has only two positions, the air handler supplies either 100% outside air or 100% recirculated air. Whenever outside air is introduced, all of the air coming back to the air handler's return plenum is exhausted to the exterior until the control determines that ventilation needs have been satisfied. At that point the motorized damper changes position from 100% outdoor air to 100% recirculated air.

While most balanced ventilation systems pull exhaust air from the smelliest, most humid rooms in the house—typically from bathrooms and laundry rooms—the NightBreeze pulls its exhaust air from the return air grilles, which are usually located in hallways or the living room. Since the NightBreeze mixes the air in the house, however, effective ventilation of bathrooms is nevertheless provided.

Field Test Results

Between 2001 and 2003, the Public Interest Energy Research (PIER) division of the California Energy Commission conducted field testing of the NightBreeze system at two homes: a 1,600-square-foot house built by Clarum Homes in Watsonville, California, and a 3,000-square-foot Centex home in Livermore, California. Although Watsonville has a mild coastal cli-

mate where air conditioning is rarely required, Livermore is hotter, and most new Livermore homes include air conditioning. Although the Livermore test house includes a four-ton air conditioner, the test data reveal that a two-ton air conditioner would have been adequate.

According to "Alternatives to Compressor Cooling," the PIER report on the testing, "The Watsonville house maintained comfortable temperatures without air conditioning installed. The Livermore house operated its two air conditioners a combined total of 8.9 hours (average of 3½ minutes per day) during the summer of 2003, which included 15 days with temperatures over 100°F."

Because the NightBreeze system shifts the electrical load to off-peak hours, some California utilities are now promoting ventilation cooling. According to the PIER report, "Total annual HVAC electric use was 93 kWh for the Watsonville house and 901 kWh for the Livermore house, of which 85% was used during off-peak hours. . . . Average monthly maximum peak summer demand by HVAC systems was 2.2 kW for the Livermore house (2003) and 0.04 kW for the Watsonville house (2002)."

Springer emphasizes that residents of NightBreeze-equipped homes didn't sacrifice comfort to save energy. "When the two houses in Livermore were compared—one with the NightBreeze, and one with a conventional air conditioner—the indoor temperatures in the house with NightBreeze were consistently lower," says Springer. "The NightBreeze kept the house more comfortable and provided more fresh air."

According to PIER's Phil Spartz, "The performance of the hot inland climate zone [Livermore] demonstration house was particularly encouraging—the house went through a five-day heat storm (100+°F) without the need for the standard air conditioner to operate."

Shell improvements enhance the performance of any house, including a house equipped with the NightBreeze system. The ACC project recommends the installation of high-performance windows, radiant barrier roof sheathing, and generous roof overhangs. To increase a home's thermal mass, it helps to upgrade from ½-inch drywall to ⅝-inch drywall, and to install as much hard-surface flooring as possible. "Your energy savings will be good if you install the NightBreeze in a normal house," says Springer. "But if you are trying to achieve complete elimination of the AC, then you need the benefits of added thermal mass."

Climate Matters

Like a whole-house fan, the NightBreeze system will not provide effective ventilation cooling in all climates. According to Springer, ventilation cooling works best in areas of the country with a mean daily temperature range of at least 30°F. According to the ASHRAE *Fundamentals* book, such areas include Idaho, Nevada, Utah, and Wyoming, as well as most of Arizona, California, Colorado, Montana, New Mexico, and Oregon. In most of the rest of the country, however, the mean daily temperature ranges are narrower than 30°F.

An investment in ventilation cooling equipment makes more sense in a dry Western climate than in a humid Eastern climate. "I was convinced it would never work in Florida, but Danny Parker [from the Florida Solar Energy Center] convinced me otherwise," said Springer. "He showed me that even in Florida you can do some good with ventilation cooling, at least during a few weeks of dry weather in the fall. Whether the investment in the equipment can be justified is another question."

Available Now

Since HVAC manufacturers have shown little interest in the NightBreeze project, Davis Energy Group has formed a start-up company called Advanced Energy Products to manufacture the units. Springer hopes to help develop more ventilation cooling units in the future, including a furnace-based unit and one with dehumidification capabilities for humid climates.

The NightBreeze sells for $2,850. The price includes an air handler equipped with a hydronic heating coil, a motorized damper unit, and the wall-mounted control. The ECM-equipped air handler delivers a maximum of 2,200 cfm, adequate to handle the needs of a 3,600-square-foot house.

For more information, contact Jerry Best, Advanced Energy Products, c/o Davis Energy Group, 123 C Street, Davis, CA 95616. Tel: (530) 753-1100; E-mail: *jbest@davisenergy.com*; Web site: *www.davisenergy.com*.

The Public Interest Energy Research report on the NightBreeze field trials, "Alternatives to Compressor Cooling," is available on the Web at *www.energy.ca.gov/pier/buildings/reports.html*.

Humidistat-Controlled Crawlspace Exhaust Fan

An exhaust ventilation system—for example, a continuously operating bathroom exhaust fan—is one of the simplest ways to provide mechanical ventilation for a home. For a house with a crawlspace, installing a crawlspace exhaust fan can provide mechanical ventilation to the house while helping dry out the crawlspace. For this to work, all crawlspace vents must be sealed, and a floor grille needs to be installed to connect the conditioned space above with the crawlspace below. The crawlspace exhaust fan depressurizes the crawlspace, drawing drier air into the crawlspace from the conditioned space above. The conditioned air leaving the house is replaced by fresh air entering through random cracks.

Figure 5. The Humidex crawlspace exhaust fan is housed in a cabinet that measures 7 inches deep by 11 inches wide by 30 inches tall. In a low (e.g., 24-inch-high) crawlspace, the manufacturer recommends installing the unit at an angle.

Humidex Atlantic manufactures a humidistat-controlled exhaust fan specifically designed for crawlspaces. The 200-cfm variable speed fan is housed in a narrow aluminum cabinet (see Figure 5). The cabinet's three intake grilles are located at the base of the unit. Since the makeup air enters the crawlspace from above, pulling the exhaust air from the region near the crawlspace floor helps to mix the crawlspace air.

The Humidex crawlspace fan is available in two models. The UNS 103 has a 42-watt 200-cfm fan, while the HDS 103 has a 60-watt 280-cfm fan. Both fans are variable-speed; the humidistat control slows the fan as the humidity drops. At the lowest speed, the fan moves about 30 cfm. The manufacturer recommends setting the humidistat in the 50% to 60% range. A remote humidistat for mounting in a room above is available as a $20 option.

Installation Details

Installation of the Humidex crawlspace exhaust fan requires drilling a 6-inch-diameter hole in the rim joist. The fan comes with a dryer-type exterior termination with plastic flaps. It also comes with a 12″ by 12″ floor grille equipped with a Mylar backdraft damper. The grille is mounted in the floor above, ideally on the opposite side of the crawlspace from the exhaust fan.

Humidex provides the usual crawlspace advice: seal up all existing crawlspace vents; insulate any crawlspace ductwork; and install a poly vapor barrier on the floor.

Humidex spokesperson Phil Konigsberg estimates that the installed cost to the homeowner for one of their fans is about $1,000. The wholesale cost of the 200-cfm fan is about $300, while the 280-cfm fan costs about $375. For basements, Humidex Atlantic also offers two models of exhaust fans (UNS 209 and HDS 209) housed in a taller cabinet, adjustable to any height between 83 inches and 102 inches.

For more information, contact Humidex Atlantic, 3573 Maple Court, Oceanside, NY 11572. Tel: (800) 293-9577 or (516) 678-6002; Fax: (516) 678-5992; E-mail: *info@humidexatlantic.com*; Web site: *www.humidexatlantic.com*.

INFORMATION RESOURCES

MemBrain Video

CertainTeed has released a new computer CD with a video promoting MemBrain, the smart vapor retarder (see ***EDU***, June 2003). The video, "Experts Discuss Moisture, Mold, and MemBrain," includes interviews with Joseph Lstiburek, a principal of the Building Science Corporation in Westford, Massachusetts, and Glenn Singer, CertainTeed's manager of building sciences.

In the video interview, Lstiburek puts in a good word for MemBrain. Asked whether his comments amounted to an endorsement, Lstiburek told ***EDU***, "I like the product, and wherever appropriate I recommend the product be used. There is very little risk associated with it, and there is a great deal of positive associated with it. The problem with CertainTeed mentioning my name is they also get the bad with the good. With MemBrain, although the product is excellent, it isn't necessary everywhere. The best use of this product is in the mid-range climates between Cincinnati north to Canada."

Unfortunately, the video includes an animation showing moisture molecules moving the wrong direction. At one point, Singer explains, "Normally, MemBrain has the same perm rating as polyethylene, and it does the same job repelling moisture molecules." The job of "repelling moisture molecules" occurs in winter, when MemBrain or polyethylene retards the movement of water vapor from the interior of a building into the wall cavity. However, the animation accompanying Singer's voiceover shows moisture molecules being driven from the exterior of the building into the wall cavity until they are stopped by the vapor retarder under the gypsum wallboard (see Figure 6). Such inward vapor drive typically occurs not in winter but in summer, when MemBrain should not be "repelling moisture molecules" at all, but allowing them to pass through to the interior.

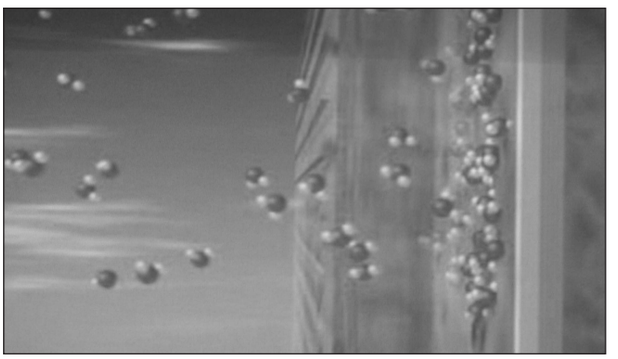

Figure 6. In a promotional video from CertainTeed, this illustration of inward vapor drive is accompanied by a voiceover explaining, "Normally, MemBrain has the same perm rating as polyethylene, and it does the same job repelling moisture molecules."

Because of the misguided animation, CertainTeed's video fails to educate builders about vapor drive, and instead ends up muddying the waters. To obtain a free copy of the CD, call CertainTeed at (800) 723-4866.

Window Cartoons

The Dumb Architect's Guide to Glazing Selection is a slim 53-page book that uses cartoons interspersed with short paragraphs of text to help architects and builders understand the technical factors affecting window selection (see Figure 7). The book defines relevant terms, including R-value, U-factor, visual light transmittance, solar heat gain coefficient, and air leakage rate. It also explains the function of gas fills and low-e coatings.

If the little animated paperclip that pops up on newer versions of Microsoft Word drives you crazy, you may have little patience for this book's "dumb architect" cartoons. Here's a typical exchange between two of the cartoon characters: "All this math is making my head hurt!" laments Sidney the architect. Quips Seamus the fruit fly, "His brain has a low U-value." (Apparently

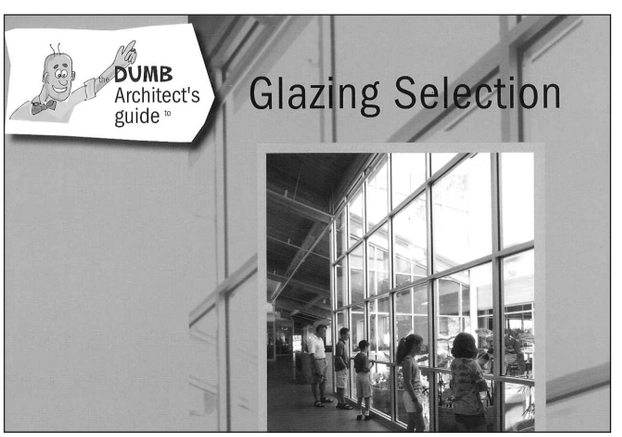

Figure 7. *The Dumb Architect's Guide to Glazing Selection* uses a light tone to provide technical information on windows.

the cartoonist forgot that a low U-factor, like a low golf score, is considered desirable.)

The most likely purchasers of this book are homeowners, since most architects in search of window information will probably feel more comfortable with a more sober writing style. For those who don't need to keep the information on their bookshelf, many Web sites provide useful technical information on windows:

- Efficient Windows Collaborative: *www.efficientwindows.org*.
- "Choose Your Glazing By the Numbers": *http://oikos.com/esb/35/glazing.html*.
- "How to Buy an Energy-Efficient Residential Window": *www.eere.energy.gov/femp/technologies/eep_res_windows.cfm?print*.

The Dumb Architect's Guide to Glazing Selection by Jason McLennan (ISBN 0-9749033-1-0) is available for $19.95 from Ecotone Books, P.O. Box 7147, Kansas City, MO 64113-0147. Tel: (816) 363-3304; E-mail: *info@ecotonedesign.com*; Web site: *www.ecotonedesign.com*.

READERS' FORUM

Thought-Provoking

Dear Editor,
Re Zero Energy Homes (July 2004): Great ZEH article! Hopefully it'll get folks thinking about the ZEH label a bit.

Robb Aldrich
Steven Winter Associates
Norwalk, Connecticut

You Call That Energy-Efficient?

Dear Editor,
Ten thousand kWh per year for a zero-energy house (July 2004)?! That's higher consumption than 40% of Wisconsin homes *with* electric water heaters and 70% of those without. (See Scott Pigg's study at *www.ecw.org/ecw/infopackagedetail.jsp?infoPackageId=27*.)

Jonathan Beers, Residential Services Manager
Madison Gas and Electric Company
Madison, Wisconsin

Joe Wiehagen Responds:

The electricity use of the Tucson ZEH is *total* energy use—no fuel oil, natural gas, propane, or firewood was used at the site. We would all expect that when heating is removed from the equation, the electricity consumption would be far less, especially in a heating climate. In addition, the simplified analysis of total energy use for a particular year leaves out the effects of weather for the year being monitored; in Tucson, for example, the cooling degree days for the 2003 cooling season listed in the table in the ***EDU*** article were approximately 25% more than long-term averages. On our Web site (*www.toolbase.org/ZEH*) we have separated the energy use for various subsystems of the home. Yes, we all have a ways to go on this path to ZEH.

[Editor's note: Joe Wiehagen is a senior project engineer at the NAHB Research Center in Upper Marlboro, Maryland.]

Jeff Christian responds:

The Habitat for Humanity near-zero-energy home in Tennessee reported in ***EDU*** is all-electric. It has electric heat pumps for space heating, an electric stove in the kitchen, and an electric clothes drier. The data from Wisconsin apply to homes that are predominately heated with natural gas. Also contained in the Wisconsin data are large fractions of gas stoves and driers.

However, I agree that to attain zero-energy goals, substantial reductions in plug loads will be needed. The first attempt in Tennessee at zero energy clearly illustrates that 500 kWh per month of electric usage for appliances, lighting, and other uses must be aggressively addressed. The use of a solar water heater in these homes would also make a substantial reduction in monthly electric usage. These homes are occupied by Habitat families, which has influenced the selection of equipment in an attempt to balance energy savings, first cost, and minimal additional family maintenance requirements and stay within the mission of Habitat for Humanity of simple and affordable. The goal for the series of houses under construction near ORNL is to generate a baseline and progress toward affordable zero energy. We welcome suggestions on what technologies and research needs will help us attain the DOE goal of affordable zero-energy houses by 2020.

[Editor's note: Jeff Christian is the director of the Buildings Technology Center at Oak Ridge National Laboratory in Oak Ridge, Tennessee.]

More ZEH Monitoring Data

Dear Editor,

While I was intrigued by the discussion on Zero Energy Homes in your July issue, I was disappointed not to see our original Lakeland Florida ZEH home in your summary. We have a full year of complete data for the project. Accordingly, I thought I would provide the relevant numbers for its performance (see Table 1).

As a minor issue, we did have the PV "Electricity produced" number for the New Smyrna house, which was 4,049 kWh for the year.

At the Lakeland house, our PV system output was about 16% lower during the monitoring period shown below than it had been during a previous year due to a missed fuse problem with one source circuit of the array. Even so, I think the numbers look quite good.

In any case, I believe the information you provided in Table 1 of your article only tells part of the story. Note that in this first experiment we had a matched pair control house which was virtually identical to the Zero Energy Home—same size, same floor plan, and same block and builder. Only the equipment and technologies included differed, which makes for a very interesting comparison (*www.fsec.ucf.edu/bldg/active/zeh/lakeland/index.htm*).

The key thing is that during the monitoring period from July 2001 to June 2002, while the ZEH home used 7,227 kWh with a net load of 2,150 kWh, its twin control home used 21,240 kWh! This is a clear indication of how much efficiency can buy. While the ZEH home produces about 65% of its electrical needs, efficiency along with solar reduced the energy use of the ZEH compared to a conventional identical twin home by 90%!

Moreover, if you look at the long-term annual composite demand profile for the houses, you see that during the Florida utility peak period from 4:00 to 5:00 pm, the control home has a typical demand of 2,400 Watts compared to -200 Watts for the ZEH home. As one of my friends in the utility industry says, "That's monster!"

Unfortunately, these facets don't come out in your comparison in ***EDU*** simply because, other than our one-time experiment, there have been no instances where there was a control home and a twin ZEH home which were monitored at the same time. Similarly, time-of-day data, while available, has seldom been analyzed to show the true value of these homes to the utility system.

While I am encouraged by your "truth-in-advertising" challenge to the research community to be more aggressive in reaching zero energy, I have long been saying that zero energy remains a goal. For now, "approaching zero energy" is a more worthwhile moniker for the holy grail of residential energy efficiency.

Is it difficult to reach zero energy? You bet. But can it be done? Yes again, but there are many difficulties—particularly with plug loads. Fortunately, I think we are up to the challenge, with the US Department of Energy now developing very strong capability towards this goal within its building research efforts.

So, is the zero energy cup half full or half empty? No matter. We just go on to find a better way.

Danny Parker
Florida Solar Energy Center
Cocoa, Florida

Table 1—Monitoring Data from Lakeland House

House	Size of PV array	Monitoring period	Electricity used	Electricity produced	Percentage electricity use provided by PV	Gas and firewood consumption
FSEC ZEH #1, Lakeland, Florida	4.0 kW	7/1/01-6/30/02	7,227 kWh	4,710 kWh	65%	54 gal./year propane for dryer, fireplace, and backup DHW

Editor's Reply

I am grateful to Danny Parker for providing the above data. Unfortunately, Mr. Parker was in Europe during the month of June when I contacted the Florida Solar Energy Center (FSEC) to obtain ZEH monitoring data. Although Stephen Barkaszi at FSEC worked valiantly to provide information, he did not have access to the data that Mr. Parker provides here. Since the monitoring data for the Lakeland house fall within the ranges of the data for the houses listed in Table 1 in the July article, Mr. Parker's data, while welcome, provide no basis for changing the conclusions reached in the article. I agree with Mr. Parker that a well designed ZEH like the Lakeland house uses far less energy than the typical new home; as noted in the ***EDU*** article, "these houses use remarkably low levels of energy, and are among the best-performing houses in the country." [Martin Holladay, editor]

EDU Needs Fact Checkers

Dear Editor,

Thank you for taking a look at the Energy Efficient Rehab Advisor (***EDU***, July 2004). We would appreciate your posting our response, because we believe ***EDU*** did not carefully examine this Web tool during your "review."

After correctly pointing out that the Rehab Advisor is easy to use and is intended for homeowners, contractors, and architects (note: it is also intended for development agencies, lending agencies, and technical assistance providers), the reviewer trivializes the tool's recommendations by mentioning the most obvious (furnace tune-up and replacing appliances with Energy Star) but doesn't say the recommendations also include (among others) replacement window specifications, insulation recommendations, and replacement HVAC efficiency recommendations; along with budget cost and savings information for the recommendations—and more information if the user wants to delve further.

Then the reviewer states that there is "little evidence to support" the Rehab Advisor's "questionable and misleading" advice, even though the assumptions are clearly presented on the site and are easily accessed. The reviewer's example of this "misleading advice," a programmable thermostat saving $150/year in a northeastern [pre-1970s] home, can be confirmed by using EPA's Home Energy Advisor for Long Island, NY ($257/year savings with air conditioning) or Burlington, VT ($131/year savings without AC).

Then the reviewer says, "...HUD is probably mistaken in its premise that 'increasing a home's energy efficiency is relatively simple.'" It is very easy to make most homes 5 to 10 percent more energy efficient. Many Web sites, information pamphlets, and textbooks tell you how, and many interested homeowners have achieved that modest goal. Are there no fact checkers at ***EDU***?

Sure, the Rehab Advisor isn't perfect. In some cases it oversimplifies, because energy efficiency can, indeed be a complex subject. But it is an excellent start for most of the remodeling community, who can always benefit by making their residences more energy efficient but have neither the time nor the expertise to do extensive research on the advantages of energy efficient remodeling.

We invite any additional comments on the site (*info@rehabadvisor.com*). Because it is a government-funded Web tool, we try to incorporate the best information available on residential construction technology.

Glen Salas
D&R International
Silver Spring, Maryland

Editor's Reply

Mr. Salas correctly surmises that ***EDU***, unlike the *New Yorker*, lacks the resources to employ a full-time fact-checker. We nevertheless strive for accuracy; when accurate, stand by our statements; and when mistaken, publish corrections.

Mr. Salas correctly points out that reducing residential energy use by 5% or 10% is relatively easy; however, the complexity of the task increases as one's energy-saving goal increases beyond 10%. ***EDU***'s conclusion that few contractors or architects are likely to find the Rehab Advisor Web site's energy-saving tips—two of which were quoted in our review—particularly useful is a judgment, not a fact; judgments differ, so on that matter ***EDU*** and Mr. Salas, who helped develop the Web site in question, can honorably disagree.

EDU stands by the statement of fact disputed by Mr. Salas—that "there is little evidence to support the Web site's claim that the installation of a programmable thermostat in the Northeast will save $150 a year." ***EDU*** articles reporting data that support our statement appeared in our November 2000, January 2001, and October 2003 issues.

BACK PAGE

The War Against Water

While conducting research into the history of vapor barriers, William Rose, a building researcher at the University of Illinois in Urbana-Champaign, came across an informational booklet from the early 1950s titled "How to Win Your War Against Water." Writing during the McCarthy era, the brochure's author, Lonore Kent, combined a flowery writing style with the metaphors of constant vigilance that were common during the Cold War. Some excerpts:

"Whether he realizes it or not, every householder is engaged in a continual war against water. If you're to come out of the battle as conqueror, you need to know the exact nature of your enemy and the tactics he employs. ... While he frequently resorts to direct attack, his most insidious methods include infiltration. . . .

"Listen to the saga of three little pools of moisture. . . . There is a shrill, insistent whistling as the singing tea kettle on the stove chirps cheerfully that the water it contains is boiling lustily. Above the kettle, a cloud of steam rises heavenward. Oh! But it doesn't get there! Its progress is impeded by the ceiling. And the misty vapor halts, undecided.

"The voice of the tea kettle is joined by another. From the bathroom comes Dad's barbershop tenor—above the rushing sound of the shower. Here, too, clouds of steam are rising and—lacking suitable outlet—are forming whole battalions of droplets on the bathroom walls and ceiling. Crash! And gurgle! Another sound joins the symphony. This time it's Junior's bottle as he flings it from his high chair. . . .

"They seem innocent enough, these three pools of moisture: the milk from the bottle, the steam from the shower, the vapor rising from the whistling tea kettle. But are they? Oh, no! … Where do they go from here? Believe it or not, they have an engagement. At the 'dewpoint'—if you please. . . .

"Scientists must have been feeling poetic when they named this point for the drops of dew that look like diamonds on a cobweb at dawn. If *you* could cut a cross section through the walls of *your* house—if *you* could get a clear view of this procedure, *you* wouldn't feel poetic. *You*'d feel like screaming 'Don't!' and christening it the '*don't*-point!'…

"The defense of your home lies in YOUR hands—in your constant watchfulness—and in the finishes and vapor barriers you apply to give constant, 'round-the-clock protection."

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