Environmental Building News™
The Leading Source for Environmentally Responsible Design & Construction
A Publication of BuildingGreen, Inc. www.BuildingGreen.com Volume 23, Number 4 · April 2014

Go with the Flows: The Promise and Peril of Hygrothermal Modeling

Tools modeling heat and moisture flows in building envelopes, such as WUFI, offer vital information for architects and engineers—but their misuse can do harm.

By Paula Melton and Peter Yost

Quick: what's the worst design mistake you've ever made?

Chances are it had something to do with heat and moisture transfer: cavity insulation that molded because it couldn't dry; a roof damaged by moisture-laden air leakage; a cold steel stud on which water condensed, wicking into surrounding materials.

Heat and moisture dynamically interact in every nook and cranny of our buildings, every minute of every day. *Hygrothermal* movement (*hygro* for moisture, *thermal* for heat, put together because they move together) is driven by the laws of physics and is fairly predictable in uninsulated building assemblies. But as we air-seal, flash, vapor-retard and super-insulate—making it very difficult, but never impossible, for heat and moisture to flow through the building envelope—we lose that predictability and can sometimes actually increase the risk of a failure (see "The Hidden Science of High-Performance Building Assemblies").

Enter hygrothermal modeling—simulation software meant to help project teams assess and avoid such risks when designing complex building assemblies.

With code requirements and customer demand pushing envelope performance to its utmost, more project teams have been seeking out this type of modeling. But detractors say the exercise is worthless, possibly outright dangerous. And even advocates warn that proper hygrothermal modeling requires highly specialized expertise—not only software skills but also a solid building-science background rooted in experience of actual buildings and how they can fail.

All Models Are Wrong …

Hygrothermal modeling began as a research tool. Developed by physicists to help them perform material testing, it began to get wider use in North America as Germany's Fraunhofer Institute for Building Physics began rolling out WUFI (short for *Wärme und Feuchte Instationär*, or transient heat and moisture transfer) in cooperation with Oak Ridge National Laboratory (ORNL). WUFI is now an expanding suite of tools intended for multiple types of users and has become the worldwide industry standard, although there are other options—see "Choosing the Right Hygrothermal Modeling Tool.")

Today's software has spoiled us by doing hard work behind the scenes while we enjoy an effortless interface. But hygrothermal modeling doesn't work that way, and user error remains a major—and sometimes legally actionable—issue with these tools.

What could possibly go wrong?

WUFI is "an incredibly detailed and robust program," enthuses Adam Cohen, an architect with Structures

Insulation Can Damage Masonry

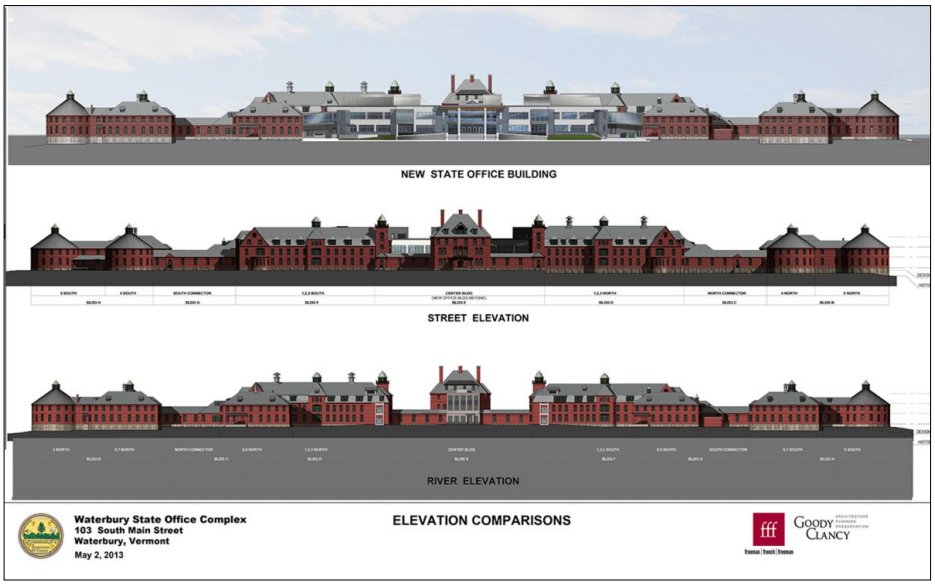


Image courtesy Freeman French Freeman Architects, Inc.

Making historically significant buildings more energy-efficient can damage the structure if hygrothermal issues are not considered. These Waterbury, Vermont buildings are being rehabilitated and renovated after water damage from Tropical Storm Irene destroyed some of the campus.

Design/Build in Virginia and a Fraunhofer-trained advanced teacher of WUFI. Because of that, "there are lots of shiny knobs to touch. Yes, you can really get yourself into trouble." He adds, "I can show you in WUFI Pro how to make it look like walls that have been standing for 100 years would melt." Likewise, "I can show you how to make a wall 'survive' when you know it won't."

Hygrothermal modeling involves three different sets of inputs—the inside of the building, the outside the building, and the stuff that separates the two—and modeling can go awry in any and all three areas.

Bad weather data—Hygrothermal performance depends on constantly changing exterior conditions, including temperature, wind-driven rain, solar radiation, and relative humidity. Yet "WUFI doesn't have that many cities in North America," notes M. Steven Doggett, Ph.D., principal scientist and CEO at Built Environments, Inc., "and you have to be careful with using data from a nearby city." Doggett claims he's gotten unreliable outputs when basing his models on built-in weather files and says his company creates "location-specific datasets" based on measured data—not exactly a job for a casual user. Discussions on WUFI forums include a variety of unaddressed regional issues, like snow cover on roofs not being considered in cold climates. (For more on how weather data affects building modeling, see "Designing for the Next Century's Weather.")

Photo: NRC Canada

This "Field Exposure of Walls facility" in Ottawa helps complement related lab work performed by Natural Research Council Canada—which in turn provides data for hygIRC, a hygrothermal modeling tool. Test bays allow researchers to monitor real-world hygrothermal performance of a variety of assemblies side by side.

Faulty interior conditions—Interior conditions aren't necessarily predictable either—and if you don't understand the assumptions WUFI makes, you will likely get bad results or outputs you don't understand. "The results are really sensitive to what you say the interior relative humidity is," explains Dave Bryan, AIA, of Third Level Design in Minneapolis. "You have to make conservative assumptions—but you don't want to be so conservative that you can't build things. It takes a lot of judgment."

Incorrect material properties—WUFI tools include an extensive material database—of European products. Results rely heavily on the hygric and thermal properties of your materials, and if you choose the wrong products, you haven't modeled the assembly you meant to. For example, brick can contribute significantly to moisture issues in exterior walls—but different types of brick absorb, transfer, and release moisture quite differently. "I've had projects go through extensive analysis based on a certain kind of brick, and then the brick is substituted" for aesthetic reasons, says John Hannum, P.E., of New York-based engineering firm Vidaris, Inc. "Unbeknownst to the architect, that can change substantially the moisture activity of the surface."

Material data also varies in its detail: practitioners say to watch out for graphs of data that look too smooth when you know there should be evidence of multiple data points (more tests at different moisture content levels).

Although some fault WUFI itself for these pitfalls, others point out that all models have this problem and that complex simulation tools of any kind are not intended for casual users. "Garbage in, garbage out" was an oft-repeated phrase in our interviews.

However, we also heard indications that it's disturbingly easy to put garbage into WUFI without knowing it. That's at least partly the tool's fault, suggests Wagdy Anis, FAIA, principal at Wiss, Janney, Elstner Associates. Contrary to common belief, "good brick doesn't absorb very much moisture," he claims. The material database in WUFI Pro "includes the material properties of brick but doesn't include brick as an assembly with mortar and joints that may be sucking moisture into the wall. That's a place where a lot of people go wrong—even experienced WUFI users."

Though he says you can choose to model a brick assembly that includes mortar, you need to know to look for it among many brick options, and many users simply don't realize that. "It's a really big deal," he said, because a wall of straight brick with no mortar would absorb significantly less moisture, leading architects to make decisions based on an absurd assumption.

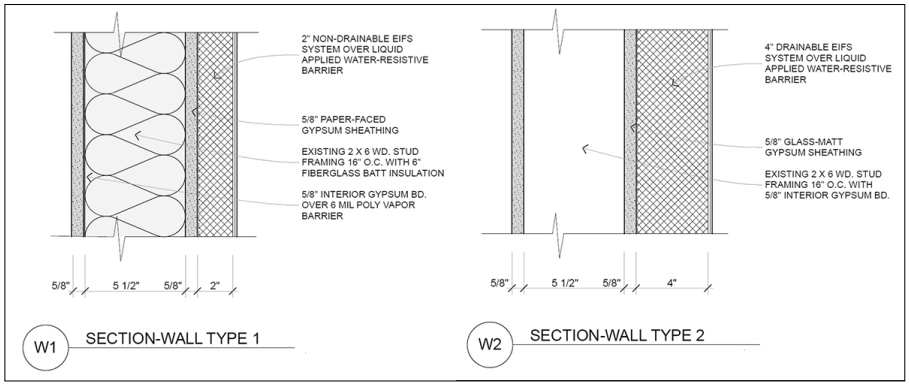
EBN investigated this charge and met with confusion among WUFI users—and silence from WUFI administrators on official forums. (We'll update this article when we receive a clear answer.)

In part because of confounding issues like these, Joe Lstiburek, Ph.D., P.Eng., goes further than Anis, calling the process of hygrothermal modeling "ridiculous." Unlike the high-mass stone structures of historic buildings in Europe, where WUFI was invented, "North American buildings are hollow and are dominated by complex, three-dimensional airflow networks, which are almost impossible to model." He maintains that because typical hygrothermal models focus on vapor drive rather than unpredictable air or bulk water leaks, it makes a lot more sense as a research tool rather than a decision-making tool for projects. (See below for how some project teams use the tools to model assemblies' response to leaks.)

… But Some Are Useful

Despite some serious drawbacks, most users of hygrothermal modeling are still quite enthusiastic.

Comparing EIFS Performance



Source: Built Environments, Inc.

These wall sections represent two common ways of designing an exterior insulation finishing system (EIFS), according to M. Steven Doggett of Built Environments, Inc. Doggett argues that careful, expert modeling is key to evaluating long-term hygrothermal risk—charted in the graph below.

"The power of WUFI and other hygrothermal modeling is this: it's a process," says Doggett. "When it's used with the right understanding and right appreciation of its limitations, it can be a valuable tool." He points out that simulation "shows tendencies of where moisture and heat are going to move. It does not show and is not intended to show absolutes."

Bryan notes that adopting the IECC 2012 energy code will lead to higher R-value requirements and speculates that this might incite interest in hygrothermal modeling. "It's a heck of a lot better than guessing," he argues.

When to Consider Hygrothermal Modeling

"I've been a building designer for a long time," says Bryan, pointing out that real buildings are the most reliable tests we have of hygrothermal performance. At the same time, learning from real buildings is a decades-long process—even field-testing can take years—and we don't have time to wait, he argues. "We've come to a point where, because of the destruction of our environment, we need to be in a big hurry to start to produce high-performance buildings. WUFI is one way to explore lots of alternatives quickly."

Hannum adds that the industry has moved far beyond the "dew-point method" of evaluating risk—in which relatively simple calculations predict where in a building assembly water vapor may condense, leading architects to design in such a way that the at-risk layer can dry. "There were a lot of problems with that methodology and a lot of articles written about it," says Hannum. Some users moved to static programs like THERM, "which allows you to determine heat flow through a wall assembly." This method, however, is mostly limited to "a point-in-time analysis" (unlike hygrothermal modeling's dynamic, hour-by-hour outputs) and doesn't include material properties besides thermal ones. Hannum rattled off a list of conditions, including absorption, capillary action, wind, rain, and solar drive, that affect vapor migration. "WUFI attempted to solve a lot of those problems, and it has gotten some traction" despite known limitations, he says.

Still, many architects have been using the same assemblies for years and may not feel they need software to tell them how the assemblies perform. When might modeling might be needed?

Working in a new climate

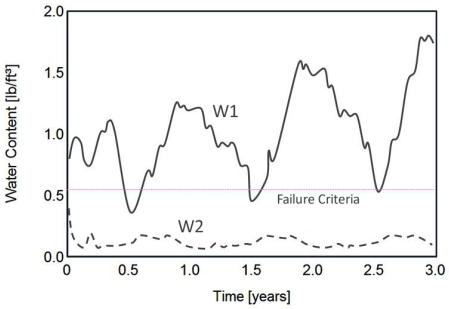
"In 2005, my company got a project to design a $100 million casino in a climate I wasn't familiar with," relates Bryan. "We were considering a wall system of simulated stone, which was troublesome to begin with, and I thought, 'Holy crap—one mistake and we're going to get sued out of business!'" That project led to his first experience with WUFI because the manufacturer was using an early version of the software. "I thought, 'What a great way to reduce risk.' That sold me on it, and after that, I started using it regularly in my own practice."

According to Wahid Maref, Ph.D., P.Eng., senior research officer at the National Research Council in Ottawa, having a basic understanding of building science will help architects decide whether they should request hygrothermal modeling. "If you work in Québec, you know by experience that [an assembly] will work," he says. "If you take that system to Vancouver and try to put it there, is it working there or not? You have to have an initial idea of what to expect." Maref suggests that a tool like hygIRC—developed at NRC and distributed free upon request—should help architects study whether they can use the same system in a new climate, or whether they need more building-science support to make changes as they move forward with design.

Working with new materials or systems

Good energy performance often relies on very thick walls and roofs—and thick layers of insulation dry more slowly than thin layers. If you're thinking about a new material or trying out a new type of assembly with more insulation, consider hiring a consultant to check what might happen

Comparing EIFS Performance



Source: Built Environments, Inc.

As seen in this chart, the difference between walls 1 and 2 (see wall sections, above) is significant, with wall 1 staying above acceptable moisture levels almost constantly. This result depends not only on the presence of an interior vapor retarder in wall 1 but also on how the user models wind-driven rain in WUFI, according to Doggett.

inside the assembly during normal operation as well as during a worst-case scenario like a hurricane or a series of rain showers followed by solar drive and more rain showers. This step can be especially important if the project is in a humid or cold climate.

"What's kind of pushed this is this idea of using continuous insulation outdoors of your weather barrier," notes Sean O'Brien, associate principal at Simpson Gumpertz & Heger (SGH). With new code requirements, "you're almost always ending up with insulation on either side of your barrier," he says, which increases the risk that wet assemblies won't be able to dry out quickly enough to avoid moisture damage.

"Common sense no longer applies because we are changing things so dramatically now," concurs Doggett. "We are in some ways experimenting with these assemblies, and a lot of architects are scratching their heads on why they are experiencing these failures. We expect more of the assembly and know less about it." Hygrothermal modeling can help architects experiment and explore in a virtual sandbox instead of in an actual wall assembly.

Retrofitting

"Once you start throwing insulation on a masonry wall, bad things can happen," notes O'Brien. Heat and moisture move together, so uninsulated walls typically dry quickly, and insulated walls may dry slowly or not at all, depending on how they're designed and detailed. The stakes are quite a bit higher with historic buildings, which are increasingly being modeled to determine which insulation materials can be installed without compromising the structure (see two case studies below).

Diagnosing an existing building

O'Brien also relates the story of a hotel with severe moisture and mold problems. SGH was called in to help determine whether the issues were caused by the design, the detailing, or something else. By inputting actual interior conditions and material properties, the firm was able to accurately predict where moisture and mold would likely occur (more in the case study below).

Assessing Risk in a New Assembly

Hygrothermal modeling can be used for research or diagnosis, or can aid design reviews or design decision-making. "About 90% of our services ultimately move into some assistance of the design because they want to tap into our forensic knowledge," says Doggett. "We will make a recommendation to increase or decrease insulation thickness," for example.

Reducing potential for mold growth

He recalled reviewing the design of a concrete spandrel system for a building in Minneapolis. "They had in place a minimal amount of [fiberglass] batt insulation and were worried about the potential for condensation," he said, and analysis indeed found "a very real potential for mold growth. We made modifications to the design that included changing the type and thickness of insulation and were able to get good modeled outcomes that agreed with what we see in the field. Almost all of our hygrothermal analyses move into that process."

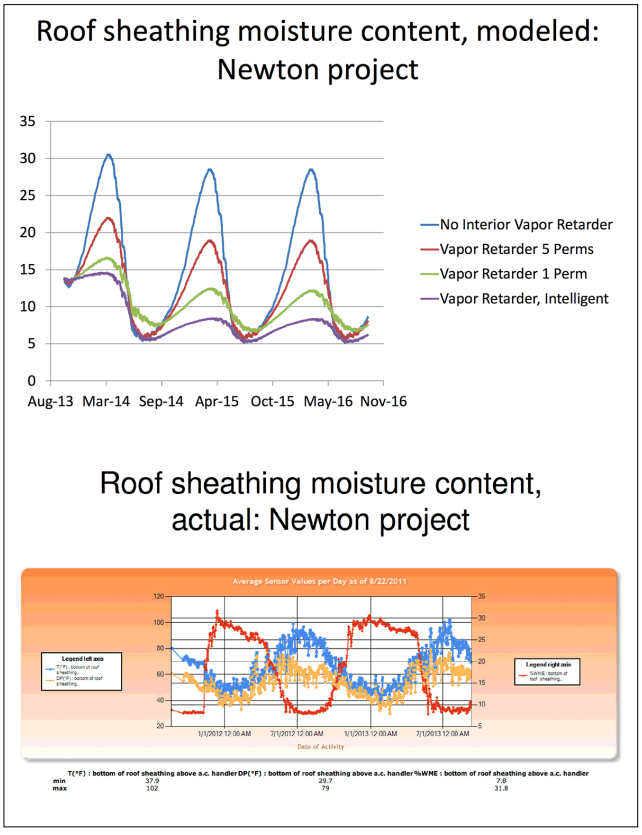
It's not just the modeling alone, he emphasizes: "We rely heavily on the forensics" to drive and support the modeled results.

Replacing plastic foam

Another example comes from Bryan, who has used modeling to assess the relative moisture risks associated with rigid foam insulation and rigid mineral wool.

"There's this idea of the 'perfect wall,' with rigid insulation outside of the studs," he says. "That wall, if it's built right, is pretty foolproof; the trouble with that is that you're using rigid foams, which are bad for the environment" (see "Can We Replace Foam Insulation?"). And adding cavity insulation, which is often necessary to push R-values higher, can create problems. "You have to make sure it breathes like crazy or that there's rigid insulation outside the cavity insulation at a certain ratio, so you keep the cavity warm enough that you don't get near the dew point" and risk condensation inside the cavity. Based both on modeling and field experience, "I have found that mineral wool is ideal—at least from a breathability standpoint," Bryan says. "It looks good even for a flow-through wall with a ton of

WUFI Meets the Real World



Source: DEAP Energy Group

WUFI runs closely match actual moisture conditions in this roof assembly, based on charts shared by Mike Duclos and Paul Eldrenkamp of DEAP Energy Group. Combined the charts helped solve the problem of a missing vapor retarder in a Boston-area home.

cellulose; you can put mineral wool outside of that, and it still breathes."

Fixer-Upping

Oops, did somebody forget something? An air barrier, perhaps? If they didn't seek hygrothermal modeling during design, someone might end up paying for it anyway—after a callback.

Repair for missing vapor retarder?

Mike Duclos at DEAP Energy Group shared a Boston-area homeowner's horror story of a plywood roof deck installed with open-cell spray polyurethane foam (SPF) and no vapor retarder. Closed-cell foam provides a vapor retarder, but open-cell does not, and the SPF manufacturer offered "less than clear advice," says Duclos, with its website suggesting that *all* its products "help provide support against vapor diffusion."

Photos: Freeman French Freeman Architects, Inc.

Moisture damage from Tropical Storm Irene (top) doomed several buildings on the Waterbury State Office Complex campus in Vermont. Yet others survive and will be repaired and insulated. Hygrothermal modeling helped the team decide which remaining buildings could be retrofitted with interior SPF (the lower picture shows adjoining buildings, one of which will not be insulated).

Data loggers installed in the existing roof assembly confirmed dangerously high moisture content in the plywood: the next step was to determine how the assembly could be fixed. The team ran WUFI simulations comparing the no-vapor-retarder baseline with a variety of vapor-retarding options. Data exported to a spreadsheet (see charts) reveal spikes of up to 30% moisture content in the wood; installing a smart vapor retarder, in contrast, would allow the assembly to dry out over the course of a year and then keep the plywood's moisture content below 10% under normal conditions. Although some might suggest that answer is just common sense—everyone knows you need an interior vapor retarder in Boston!—the manufacturer's misguided instructions, and the fact that an installer actually adhered to them, belie that logic.

When working with its clients, Duclos adds, "the simulations are helpful in decision-making because they convey a rough estimate of the magnitude, timing, and duration of high moisture events in the sheathing." He argues this is "something that other approaches, such as the dew-point method, do not provide in any detail."

Water water everywhere

Hygrothermal modeling can also help diagnose and repair water leakage, supporting observation and other research, notes Judd Peterson, AIA, president of Minnesota-based building envelope consultancy Judd Allen Group. "WUFI use would be considered after the original design documents, plans, and specification have been reviewed and compared to observations made during an initial site inspection," he says. Researchers may open up the wall to identify actual products used and assess how carefully they were installed.

The accounts of building occupants are also key: "For example, you might notice that the interior of the building has high humidity, and the owner has complained that after a cold winter, a flood of leakage came pouring into the house even though the sky was blue and the sun shining," Peterson says—guiding "a knowledgeable building scientist toward condensation" as a likely explanation (combined with failure of one or more envelope components).

Exploratory hygrothermal modeling can then support further investigation. "Sometimes the buildings are large or complicated, and the mystery water problems are widespread," says Peterson. "Very often, mold and rot are present, and the forces driving the water damage are both temperature- and moisture-dependent. WUFI can sort out those factors."

Using actual interior conditions, materials, and recorded weather data as inputs, "we can replicate the interior and exterior conditions of temperature and humidity, and the effects of sunlight and weather cycles for the site." With solid data in hand, modeling can help isolate whether leakage or condensation is a more significant issue, or it can identify which layer is most likely to leak, which is most prone to mold, and other factors.

Taking WUFI to Court

Simulation's value as a forensic tool means it has potential as expert evidence—and it is sometimes referenced by both sides in a case. Employed as a supporting tool combined with other evidence, hygrothermal modeling can be an important part of a legal battle.

Mold hotel

"We did a hotel in a cold climate," relates Sean O'Brien. "There were lots of mold and moisture problems in the exterior walls as well as water leakage and other things. One of the claims was that the wall wasn't designed properly," and another was that the vapor barrier stopped a foot short of the bottom of the wall.

After onsite investigations of various types, SGH "shot down the argument about the vapor barrier," O'Brien recalls. In addition, "we actually recorded conditions inside the space and some of the walls." Hygrothermal modeling using actual conditions and materials as inputs allowed the team to figure out "whether the design would have worked on paper. In every case, it worked fine. It was not a design issue. It had to do with airflows and other things through the walls" resulting from extremely high humidity and negative pressure in the bathrooms.

Too easy to game?

Taking WUFI to court can be a tricky business, though, notes Wagdy Anis. "Trying to explain [leakage] through WUFI is highly subjective. Somebody like myself can stand up and critique the analysis to the point where it becomes questionable. Using WUFI to prove a point… as a company we have shied away from that."

"There are enough guys out there doing it wrong that a lot of people don't trust it," concedes O'Brien. Yet he says in the hotel's case, there was "nothing exotic" about the materials, and they relied on actual conditions to present an airtight analysis. "The program is validated; there are three different standards it goes by. We didn't assume anything." What's more, the runs showed, given actual conditions, where to expect water and mold, and where to expect dry materials; and field conditions bore out the accuracy of the analysis.

Photo: Cynthia Dubberley

The Pan Am Building is historically significant due to its early Modernist approach to the New Orleans climate. Hygrothermal modeling informed the team's insulation plans, saving money and the historic envelope in the process.

Retrofits

Improving the energy performance of a building that has little or no insulation is one of the classic games of green building whac-a-mole. It's easy to create a moisture problem by solving a thermal problem—and when it comes to historic preservation, the stakes are high. Although many turn to hygrothermal modeling to assess risk, it's particularly important with historic buildings to ensure the software draws from authentic material data.

"Limestone from a German database developed 20 years ago? The chance that that's the same as the limestone on your building is very, very small," says O'Brien. SGH tests actual material samples from existing buildings, and the company builds its own material data into the database because results are otherwise unreliable. "For a large project looking to insulate an entire [brick masonry] building, if you run the numbers from the German database, they are too wet and fall apart. When you run it with the real properties, everything looks like it turns out fine. That's not the kind of thing the average user is going to do, but that's really the only way to do it."

Balancing energy and history in Vermont

Severely damaged in 2011 due to flooding from Tropical Storm Irene, Vermont's Waterbury State Office Complex has been partly demolished. New construction on the campus will feature sculpted, locally quarried Bethel White granite as cladding, while most of the historic brick masonry buildings that survived the flooding will be repaired and retrofitted for energy performance.

SGH did an analysis of multiple insulation options, notes Andrea Brue, AIA, associate at Goody Clancy, historic preservation architect for the project: closed-cell spray polyurethane foam (SPF), open-cell SPF, and semi-rigid mineral wool. The goal: to assess the safety of insulating historic walls under the possible scenarios. A key issue to consider is whether changing an assembly so it can no longer dry to the interior—or will dry more slowly—increases risk of freeze-thaw damage.

After Goody Clancy took samples from around the campus, SGH laboratory testing found that different bricks' properties varied considerably. To be on the safe side, SGH chose to use one of the lowest-performing bricks (i.e., the most likely to become and remain saturated with water) in the WUFI model as the default for the entire project. Even assuming this level of performance, the historic walls showed fairly low risk of damage from freeze-thaw cycles after insulating because of the brick's very low moisture content, explains Jeff Ceruti, P.E., senior principal at SGH. In preparing for the modeling, the team also found a large airspace between two wythes of brick—perhaps originally intended as an insulating layer—that provides a capillary break, limiting moisture migration into the interior wythe from the outside.

Both SPF options provide an air barrier, notes Ceruti, but "with mineral wool and open-cell SPF, you would require a separate vapor retarder, which is a little a more complicated to achieve and has to be detailed correctly." The mineral wool, though environmentally preferable, also requires a carefully detailed air barrier, which can increase costs as well as failure risks (if the detailing isn't careful enough). Typical in masonry retrofits, closed-cell foam—if it can be used—cuts the Gordian knot for project teams.

Building Products That Work

"What kind of material do we need here?"

That's a question many manufacturers of building envelope products ask during research and development, according to Stan Gatland II, manager of building science technology at CertainTeed Corporation—and they often use hygrothermal modeling to answer it. In fact, he claims, CertainTeed's variable-permeability vapor retarder, MemBrain, was developed by the Fraunhofer Institute for Building Physics using WUFI.

"They used the software to come up with a fictitious layer that would provide a dynamic vapor retarder," he explains. After lighting upon the hygroscopic properties that would be required (see "How 'Smart' Vapor Retarders Work"), they looked around for an existing material that actually had those properties—and found a type of nylon in the food packaging industry. CertainTeed uses the same approach, he said, and has developed and refined various products this way.

Theresa Weston, a research fellow in DuPont's Building Innovations lab, describes similar comparative analyses. "One way I've used it is to look at how walls perform versus putting a leak in," she explained. "You can actually deposit water in the wall cavity and look at how robust it is in terms of drying in a specific climate and building assembly." Weston may take whole systems and "put water behind things and measure the drying rate," and the results help determine "optimal ranges for certain material properties."

Yet State officials were leery of the effects of closed-cell foam on the historically significant structure, relates Brian Leet, AIA, of Freeman French Freeman in Burlington, prime architect on the project. Energy goals had the team "initially looking at something as thick as 4 inches" of SPF, explains Leet. "The energy geeks wanted four, and the historic preservation people were nervous about any. This is a really useful process to have that conversation about how much you're going to do—with real data as opposed to everybody's reactions to what they want to do."

WUFI results showed low risk of freeze-thaw damage from the closed-cell SPF, in part due to the airspace between the wythes, though costs increased with thicker foam. "In the end, because of the WUFI analysis and the energy and other design goals, we struck a balance between the two and got a cost-effective solution with a two-inch spray approach," concluded a member of the project team.

Using WUFI to manage costs in New Orleans

Another storm much farther south led the Veterans Administration to seek new quarters after its Southern Louisiana Veterans Health Care System (SLVHCS) was devastated by Hurricane Katrina in 2006. The agency chose a new site that includes the historic Pan Am Building, "a 1950s design by SOM, which is on National Historic Register because it is one of the early Modernist adaptations to hot and humid in the South," explains Cynthia Dubberley, AIA, associate at Eskew+Dumez+Ripple. With concerns about the effect of the hot-humid climate on retrofits to the assembly, which featured limestone cladding over hollow clay tile, modeling helped the team assess hygrothermal risks, and results led to a much lower-cost solution than the one originally planned.

"We couldn't be sure of the existing conditions," Dubberley told *EBN*. "At first, we were very conservative about our assumptions of performance of the building envelope, and we called for it to be gutted down to the structure." New limestone, steel studs, and new air and weather barriers would be installed. But "the budget couldn't support that approach," she said, so the team engaged Morrison Hirshfield. Models suggested that moisture problems would be unlikely after the addition of closed-cell SPF on the interior, even with so-called reverse vapor drive (moisture drawn from hot, humid outdoor air toward the cold, dry interior). The SPF solution was far less expensive, and "we were able to save a lot more of the historic building fabric."

Assemblies That Work

For firms (or even studios within firms) that specialize in one or two building types, especially if they work in a limited number of climates, hygrothermal modeling can be a cost-effective way to develop and standardize a set of high-performance assemblies that are hygrothermally "safe." This was the case for BKSK Architects in New York City, which worked with consulting firm Vidaris to develop an in-house library of standard details.

The project began because of the firm's transition to a new building information modeling (BIM) tool. "Our IT department was making these standardized libraries," says Jennifer Preston, AIA, associate and sustainable design director. Experience told Preston that "walls keep getting inserted over and over again, but you want to stop that process and make sure that you're not copying and pasting something that didn't work." She and John Hannum of Vidaris worked together on the project of creating high-performance details "to make sure our library was not informed by rule of thumb or standard New York practice or a project we just liked a lot—that it was driven by data," explained Preston.

Thanks in part to the influence of hygrothermal modeling, the details are regionally and building-type specific.

And the connection must be made to the tenant, for example, on a core-and-shell project that cannot account for final interior conditions. "No matter what you do to the skin of the building, the owner can totally muck it up," notes Preston. "We need to educate and inform" about things like interior relative humidity and vapor-impermeable finishes. "It's an extension of the architect's role."

Proceed with Caution

"This isn't a video game," jokes Dave Bryan. "You can't just sit in your office and play with your computer and save the world!"

Hygrothermal modeling is a risk-management tool that has real-world implications and requires real-world building-science expertise. Given how easy it is to screw up, project teams should proceed with caution and keep a few principles in mind.

Understand what you are asking for

"I'm not sure to what degree architects understand what WUFI is telling them," laments Judd Peterson. "I have seen WUFI promoted as a 'required' tool on a website listing this requirement in their Facilities Design Standards for architectural compliance," and yet what's being asked for isn't a good match with what WUFI really does. He says, "Some architects simply use the dramatic WUFI output charts and graphs as a marketing tool rather than for its true purpose."

When they are clearly acting in good faith, though, "I am concerned that they have no idea there are any limitations or assumption judgments at all. They are simply running the program and relying on the results without critical thought and review." Architects need to think and ask questions, especially if the output is counterintuitive, he says.

Although several modeling experts told us that project teams are looking for pass-or-fail results, this suggests both a misunderstanding and an underestimation of what hygrothermal modeling can truly do.

Use it to compare systems

EBN has discussed this with energy modeling and whole-building life-cycle assessment. Hygrothermal modeling is no different: building simulations don't spit out an authoritative result; the true answer is usually relative to other options, with an iterative process helping arrive at an optimized design.

"Sometimes it helps to look at doing parametric studies," says Theresa Weston, a research fellow in DuPont's Building Innovations Lab. "If you are doing a metal-clad building and you know there's an airspace, you can model it flat against whatever's behind there and then increase or decrease that air, getting an idea of how important having that airspace is," for example. "Actually assessing what makes a difference to the risk of that building may be more important than just getting a pass/fail on a particular situation—but it takes a lot more time." A similar sensitivity analysis can help establish safe interior conditions, she says. "Maybe you'll want to look at what your setpoint is on humidity. What if I go up 10% higher in humidity, what does that do to my assembly?" It's not about plugging in numbers an expecting a single result, she says.

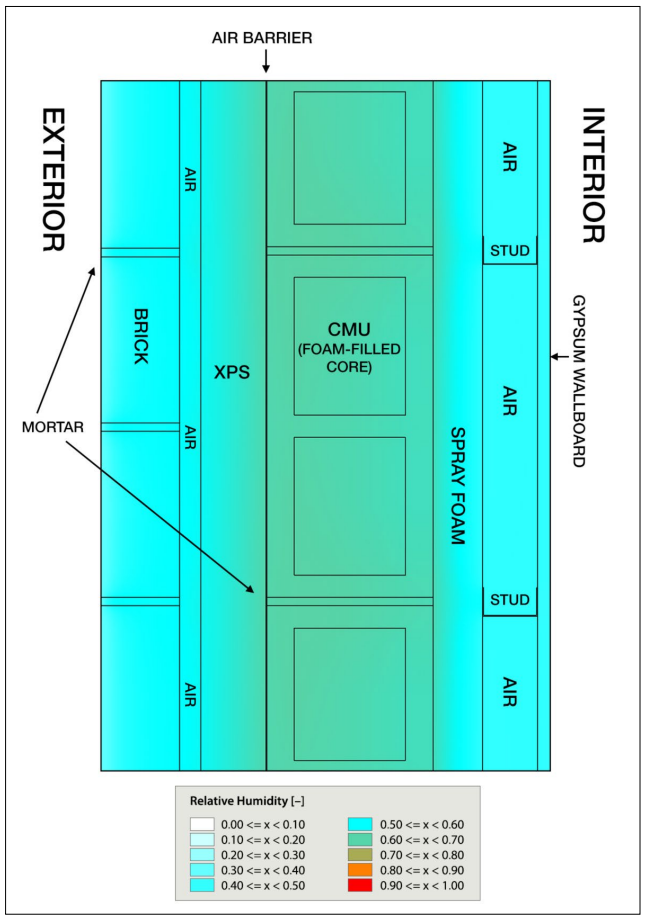
Seek credible material data

Hygrothermal modeling is based on a large number of material parameters, like porosity, thermal conductivity, vapor permeability, and "hygric extensions" like water storage and liquid transfer coefficient, explains Doggett. "These provide refinement in the mathematical model with some degree of precision about whether that moisture and heat are going to be at a given time. When you change or further estimate, then anything that is governing that movement of moisture and heat through the assembly is affected."

Doggett adds, "I have asked for data from manufacturers for a number of products. I never got any."

HygIRC has an extensive material database of North American building products actually tested in the NRC labs, according to Wahid Maref. "We are simulating what was already tested. They are not theoretical or from [manufacturers'] literature."

Wall with Spray Foam: Summer Relative Humidity



Source: BKSK and Vidaris

Summer moisture content in this wall assembly rarely rises above 70%, indicating fairly good performance given the materials involved, according to John Hannum of Vidaris. The image is the result of a research collaboration between Vidaris and BKSK aimed at developing a BKSK library of wall sections that perform well based on the building type and climate.

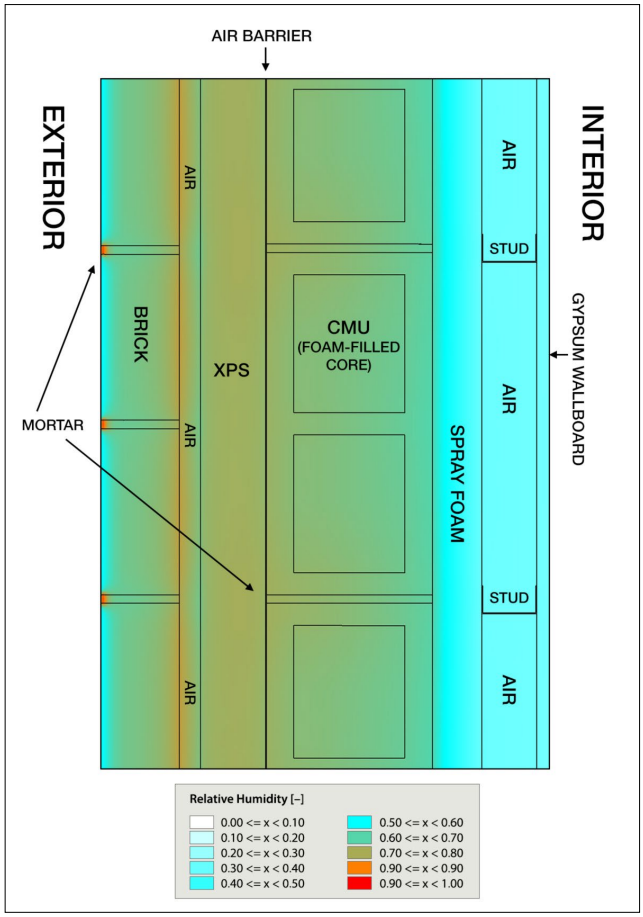
WUFI has the ability to expand its database with manufacturers' product data, but few manufacturers have provided it. Users shared with *EBN* that material data is very difficult—though not impossible—to acquire. For DuPont's part, says Weston, "We have thought about getting them by name in the WUFI program, but we just never pulled it together." Weston says her company provides one-on-one technical guidance on how to incorporate its products while doing hygrothermal modeling. Other companies do as well, including CertainTeed and Owens Corning.

Work with experts

Hygrothermal modeling tools on the market today are intended for use by architects—but knowledge of building science is absolutely necessary. Those learning to use these tools will gradually develop that knowledge, but expertise is another thing. If you are looking for specific help for a complex assembly, seek out a firm with extensive experience with both the tools they are using and the building-science principles that drive them.

Lstiburek drives this point home with an anecdote about a project team for a Houston building that relied on modeling instead of common sense: everyone knows that vapor barriers don't go on the inside of an assembly in a hot-humid climate, he maintains, but "an analysis was done saying they have to have the vapor barrier" due to unusually high humidity levels in the specialized building. "We got involved because it didn't work," Lstiburek says. Although "it's a reasonable thing to ask yourself" whether you need a vapor barrier in a humidified Houston building in winter, he says, "They didn't run the summer!" This mistake led to mold. "The building smelled. And it wasn't Chanel No. 5," Lstiburek quipped.

Wall with Spray Foam: Winter Relative Humidity



Source: BKSK and Vidaris

Relative to the summer conditions shown above, winter conditions in this wall section show higher moisture content. Orange points in the brick assembly indicate higher levels of moisture absorption by the mortar in comparison with the brick itself.

Ask for graphics

Some building envelope consulting firms know what they are doing but are not good at communicating the results. If you ask for parametric runs to compare options, request a report that includes graphical representations that you can share with colleagues and possibly even clients.

"It is really easy to work with John [Hannum] because the Excel document is graphic, and the first thing is that it's kind of beautiful and engaging," says Jennifer Preston. "While mysterious at first, it is engaging. I've found that during the presentation to the broader design staff at BKSK, people really got it. They got it because it was graphic and because John's kind of great at breaking it down to really simple issues—not just understanding the problems but also understanding the solutions."

A good presentation may cost more, but if your consultant cannot explain the results in a way that makes sense to non-experts, your project team won't be able to use the outputs to make better design decisions.

Don't let WUFI wag the dog

Any type of modeling can provide counterintuitive results; some are legitimate, and some are not. Anyone who understands the principles behind the model won't accept these results at face value.

"If something doesn't sound right, we investigate further and see if it's because of user error," says SGH's O'Brien. "I've gotten plenty of things where I said, 'This looks completely wrong. I don't stop working at the problem till I can physically explain it." If the explanation isn't clear after more iterations of the model, attempting to isolate what's driving the iffy result, "we distrust it and try a different approach."

He offers an example from energy modeling for a small office building. When the team increased window performance in the model, "it said we used more energy," he explains. Suspicious, they performed a sensitivity analysis to ensure one aspect of the model wasn't "throwing things off." Eventually, they realized the model was actually correct: in summer, they were keeping too much heat in the building and using more air conditioning, and in the winter, due to the shading coefficient of the glass, they were not achieving passive solar gain. "After we looked at it that way and could physically explain it, *then* we would trust a counterintuitive result."

Yet Lstiburek still advises against modeling. "It took five of us—some of the most skilled people on the planet—an entire day" to get inputs

right to make "a simple wall that has had a history of performance" to run accurately in WUFI in all the major climate zones in North America. His interpretation? "What you're having to do is manipulate the properties of the model to force it into giving you the right answer."

Not so, objects Duclos; that stage is just part of the learning curve. "I start out with something very simple: I know how it works. If I can duplicate that in the tool I'm using, I start proceeding with incremental experiments." (Indeed, what Lstiburek and Duclos both describe is simple calibration: adjusting a new tool to arrive at a known result before using the tool in situations where the result is not known.) The danger, he says, is in skipping that step: "Some people have taken it upon themselves to just test-drive it and draw conclusions from it," he said. "This is quantitative information, but with large error bars. You need to understand that those error bars exist so you can understand where are the leverage points."

As Adam Cohen puts it, building simulation is "a quarter science, a quarter art, a quarter experience, and a quarter pure voodoo"—in other words, the laws of physics, the ability to interpret results, the intuition that comes from field work, and the one or two parameters about which you just have to make an educated guess.

The trick is knowing which is which—and how they work together. If you don't, dabbling in hygrothermal modeling might do more harm than good.

NEWS

Feds and Green Building: Behind the Scenes of LEED, Green Globes Rulemaking

There's public wrangling over green building policy, and then there's the stuff that goes on behind closed doors. We got a rare peek through the keyhole.

By Paula Melton

LEED, Living Building Challenge, or Green Globes?

By law, the federal government, led by the U.S. General Services Administration (GSA), is supposed to decide every five years which programs it should use to meet its green building goals. In its most recent review, GSA recommended for the first time that federal agencies should be allowed to choose between LEED and Green Globes (see "Feds Put Green Globes on Pedestal with LEED"). The U.S. Department of Energy (DOE) is about to issue a final rule codifying GSA's recommendation.

How did the government make that decision? Parts of the process happened in the public eye. Timber- and chemical-industry groups have vocally raised the political stakes through various efforts to elevate Green Globes—influencing both congressional legislation, like the Shaheen-Portman bill and military spending bills, and executive-branch regulations like the DOE rulemaking process.

At the same time, Freedom of Information Act (FOIA—see sidebar for details) requests reveal also that certain players have worked behind the scenes for years to influence federal green building regulations.

Green Globes Correspondence

The bulk of emails between the Green Building Initiative (GBI), developer of Green Globes, and federal officials are of two overlapping types:

Attempts to convince specific federal agencies to adopt Green Globes tools for their own buildings

Attempts to influence broader federal regulations about which certifications may be used

Questioning GSA's choice of LEED

Erin Shaffer, vice president for federal outreach at GBI, urged decision-makers at the Department of the Interior (DOI) to comment in GBI's favor during a crucial federal rulemaking period. In 2009, DOE intended to codify an earlier GSA recommendation of LEED certification for federal buildings (see "Only LEED Meets Its Needs, Says GSA").

"Is there any chance that Interior will weigh in on this so that the federal government is not supporting ONE BRAND?" Shaffer wrote to three U.S. Department of Interior (DOI) officials on April 21, 2009. "Let me know if there is any information I can help to provide." The email goes on to criticize the study that was used to recommend LEED as the preferred certification system. "We are very hopeful that you will weigh in and call for a different approach...." The subject of this email ("FW: DOE Proposed NOD for LEED") references a "notice of determination" put out by DOE to solicit comments from other agencies.

Shaffer found a receptive audience at DOI. Kathleen Bartholomew, of the agency's Office of Environmental Policy and Compliance, replied, "We have an opportunity to submit comments on this subject and we plan to recommend the standard be what we currently define it as in our Sustainable Buildings Implementation Plan." That plan explicitly recognizes LEED and Green Globes as equal certification paths. "Hope this helps," Bartholomew added.

Shaffer took the opportunity to send more arguments in GBI's favor. "I thought it might be helpful to clarify one point, although you likely are familiar with it," she wrote on April 24, 2009. "The GBI is in the process of moving the Green Globes tool through the ANSI process and later this year it is on schedule to become the first and only green building rating system for commercial buildings that will be an ANSI standard. Both the GBI and USGBC are ANSI Standards Developers, however, only GBI has taken the step of putting our tool into the ANSI process."

DOI's policy requires certification developers to be ANSI standards developers but does not require the certification systems to be ANSI standards.

"We appreciate your support"

Later in 2009, Catherine Cesnik (then DOI's program manager for sustainable buildings) reached Shaffer to ask how many DOI buildings had been registered or certified under the Green Globes system; this was to help DOI prepare a report to Congress regarding federal green building certification rules, Cesnik said in her August 5 email. "We appreciate your support," Cesnik wrote.

Shaffer replied the following day with the requested data (two free trials for new construction registered by the Bureau of Land Management and one existing building "subscription" purchased by the National Park Service), stating, "Unfortunately, it appears that the Department of Interior has not been very pro-active in using our Green Globes tools. We would be pleased to offer a web-seminar at no cost if some of your sustainability / building managers would be interested in learning about our tools."

Still later in the year (November 30, 2009), Shaffer contacted Heather Davies, another official in the Office of Environmental Policy and Compliance, asking, "Is it possible to discuss revising your existing buildings requirements to also include Green Globes, Continual Improvement of Existing Buildings (CIEB) tool?" There is no record of a reply from Davies among the documents sent to us by DOI's FOIA office.

Shared talking points

By mid-2010, DOE's rulemaking process on green building certification systems had advanced, and the agency was soliciting public comments in addition to comments from other government entities.

"I have attached the Green Building Initiative's final draft comments to the DOE NOPR [Notice of Proposed Rulemaking]," Shaffer wrote to DOI's Cesnik on July 15, 2010. "I hope you find it useful and also hope that you will be able to support naming the Green Globes rating system as one that DOE should add to their list of approved rating systems for federal agencies."

In its August 12, 2010, comments, DOI expressed the opinion that "any rating system developed by an ANSI-accredited standards developer should be considered." The rule in question (Energy Efficiency and Sustainable Design Standards for New Federal Buildings, Federal Register #2010-14752) had been stalled since comments closed on that date in 2010. It is now a final rule that recognizes both LEED and Green Globes and is awaiting approval in the Office of Management and Budget.

"The door is open"

Shaffer attempted to influence the policies and comments of other agencies during this crucial rulemaking period as well. A June 2, 2010 email appeals to Diane Stewart, AIA, then the senior leader of the Facilities Policy and Program Office for Facilities Management & Policy at the Department of Health and Human Services (HHS).

"I am forwarding to you the DOE Notice of Proposed Rulemaking that addresses several sections of EISA [the Energy Independence and Security Act] of 2007," Shaffer wrote. "You will note in this NOPR that the door is open for other certification systems. … I hope you will be in a position to provide input to this NOPR. You may note the Green Building Initiative's Green Globes design, assessment and rating system meets all of the criteria called for in the regulatory language for selection for use by federal agencies for new construction and / or major renovation."

"Yes, I have already seen," Stewart replied. "Do not know if I will have the opportunity to provide specific feedback since we are in the middle of budget formulation. If you have a white paper or other document that demonstrates GG meets all the criteria that would definitely be useful."

There is no record of a reply from Shaffer, and HHS does not appear to have commented on the DOE rule. Several months later, however (March 23, 2011), Shaffer got in touch again, this time about HHS's building policies. "I have understood that HHS has been supportive of both LEED and Green Globes," Shaffer wrote. "I was surprised to see only reference to LEED in the attached document." She pasted a passage from the 2010 HHS Strategic Sustainability Performance Plan, which pointed out that "some HHS components have defined within their AE design guidance the minimum LEED credits required and equivalent to the Guiding Principles." Shaffer asked, "I wonder if it would be useful to work together to highlight the Green Globes credits that would be comparable?"

Photo: AgnosticPreachersKid. License: CC BY-SA 3.0.

The Department of the Interior is one of three federal agencies whose FOIA offices sent us a substantive response.

Stewart replied that "the statement below is factual" and not a matter of policy. However, she wrote to Shaffer two weeks later (April 6, 2011): "I thought you all had a mapping guide similar to USGBC's for LEED that crosswalks Green Globes credits to the MOU Guiding Principles. … Can you steer me in the right direction?"

Shaffer replied with these "crosswalk documents," which were not included in the FOIA response.

EBN requested these documents from GBI but was told by the organization's new president, Jerry Yudelson, that the documents pre-date "everyone currently on staff in the Portland office, and we really don't have the resources to go searching for them." (*EBN* provided Yudelson the file names, so a simple computer search would have taken a few seconds—and would have been been performed by Shaffer in D.C., not a Portland staff member.)

The email trail ends there, but HHS's language about LEED credits was removed completely from the 2011 version of HHS's Sustainable Buildings Plan. Also in that plan, Green Globes was given explicit parity with LEED throughout.

Emails from DOI and HHS suggest that GBI's Shaffer strategically identified, contacted, and attempted to influence officials responsible for agency policies, including those in a position to contribute to federal rulemaking. Shaffer's own Strategic Advocacy Solutions website reflect these intentions, stating that she is a "lead advocate supporting federal policies that encourage competition in the green building market place." It also claims she "initiated all policy strategic development for GBI at the federal level," and that the "results of this effort are reflected in the federal agency sustainability policies."

LEED Correspondence

EBN received no evidence of communication between USGBC staff members and either HHS or DOI officials—only email newsletters to which certain federal officials had voluntarily subscribed. The hundreds of communications we read between USGBC staff members and DOE officials are of two main types:

- Technical emails about LEED
- Technical emails about other issues

Two brief exchanges provide exceptions to this rule, one of them notable (see below).

LEED Online and the LEED Volume Program

Messages between Melissa Gallagher-Rogers, USGBC's manager of government sectors, and DOE officials focused on development of the LEED Volume Program and using LEED Online to track large numbers of projects at once.

"I spoke with Sandia Labs this week about their LEED for Existing Buildings work," Gallagher-Rogers wrote to Josh Silverman, director of the office of sustainability support, on September 9, 2009. "I'm trying to get an idea of how many other sites with a similar size and number of buildings are in the total building stock for DOE. … It is important for me to be able to pass along this information to our technical team so that they understand the needs of the market as we continue our build out of the volume certification program."

Silverman replied with data (8,591 buildings comprising 121,707,513 ft2), adding that "several other sites might participate, depending on how the program is structured."

As we reported in *EBN*, the volume program launched about a year later, with government agencies listed among its potential customers, though there's no further indication in these emails that DOE participated in program development.

In another series of exchanges, DOE contacted Gallagher-Rogers about the possibility of using LEED Online to more effectively track government projects.

Codes and disclosure laws

USGBC staff members serve on a variety of committees and working groups aimed at improving the energy performance of buildings; some are federal initiatives, while others are private-sector groups that include representatives from the federal government.

The overwhelming majority of emails we received from DOE's FOIA office reflect USGBC's engagement with technical issues that have little or no direct relationship to LEED. For example, Chris Pyke, vice president for research at USGBC, exchanged a series of emails in 2012 to 2013 with Cody Taylor, energy technology and policy specialist in the Office of Energy Efficiency and Renewable Energy, on the topic of developing unique identifiers for buildings in mapping databases.

Other USGBC staff members served on committees developing model codes or supporting building energy disclosure policies in state and local governments.

Wood certifications

We identified one exchange suggesting a possible USGBC attempt to influence federal legislation.

"I've been asked to find statistics on the use of structural wood in the U.S. green building industry to inform the Cmte on Science, Space and Technology about the significance of the FSC certified wood LEED requirement," wrote DOE's Sarah Jensen to her colleague Tom Fisher on April 30, 2012. "Do you have any stats at your fingertips that shed light on the facts?" (This note regards a politically charged May 8, 2012 hearing on "The Science Behind Green Building Rating Systems" regarding ANSI accreditation and federal definitions of consensus.)

Fisher connected Jensen with Scot Horst, senior vice president for LEED at USGBC. After a series of exchanges (consisting of clarifications and additional CCs), the job of actually answering the inquiry fell to Bryan Howard, legislative director at USGBC. After speaking with Jensen on the phone May 2 (as shown by call information discussed in emails), USGBC's Howard later sent an email (May 4) with no body, headed "Subject: Care to do a testimony exchange?" Howard was asking for permission to share USGBC's talking points on the certified-wood issue—similar to Shaffer's sharing of GBI's draft comments on DOE rulemaking with DOI.

Jensen replied that she would rather not because "DOE is committed to objectivity with respect to building certification systems, and a testimony exchange might raise questions about that objectivity."

Federal Guiding Principles program

In late 2012, USGBC began developing a program aimed at helping agencies comply with the Federal Guiding Principles for sustainable design—similar to one jointly developed years earlier

Our FOIA requests

EBN submitted requests for documents from the following agencies, all of which have sustainable building policies, in February 2013: Air Force, Army, Department of Energy, Department of Homeland Security, Department of Health and Human Services, General Services Administration, Department of the Interior, Department of Justice, National Aeronautics and Space Administration, Navy, Department of State, Department of Veterans Affairs.

Note that quotes from documents obtained through these requests have not been edited to correct spelling, punctuation, or grammar.

Because we wished to gain insight into executive-branch contacts made by multiple green building organizations, the wording of all the requests was similar. An example:

Under the Freedom of Information Act, 5 U.S.C. subsection 552, I am requesting the following information.

All emails sent between the U.S. Department of the Interior and the following people and organizations between January 1, 2008, and February 15, 2013:

- *U.S. Green Building Council or "USGBC"*
- *Green Building Initiative or "GBI"*
- *Strategic Advocacy Solutions*
- *Erin Shaffer*
- *Hubbell Communications*
- *Ward Hubbell*
- *Podesta Group*
- *BGR Group*
- *Capitol Solutions*
- *Jason Hartke*
- *Van Ness Feldman*

Relevant keywords may include but are not limited to: LEED, Green Globes, Green building, Certification, Guiding principles, High performance, Sustainable, Sustainable buildings plan, Evaluation, Standards, Policy, Energy efficiency, Water efficiency, Consensus, ANSI, Points, Credits, Prerequisites, Life-cycle assessment, Greenhouse gas emissions, Review, Energy Independence and Security Act or "EISA," Executive order.

As a member of the news media, I request a waiver of all fees for this request. It pertains to an article I am writing about green building lobbying efforts and transparency, and I will be distributing the information to the public and receiving no direct financial benefit from this information. If you deny any or all of this request, please cite each specific exemption you feel justifies the refusal to release the information and notify me of appeal procedures available to me under the law.

We have received substantive information back from three agencies: the Department of Energy, the Department of the Interior, and the Department of Health and Human Services.

Significantly, our request to the General Services Administration (GSA) was delayed multiple times, the final time in October 2013, when we were informed that the request had "gone back up to Legal" for further review—suggesting it had been under legal review at least once before. However, when we received GSA's final response in January 2014, it contained only two documents, both of them open letters written in support of LEED v4 and forwarded to Brett Prather (in GSA's Office of Congressional and Intergovernmental Affairs) by Bryan Howard, legislative director at USGBC. We have not received a response from the GSA FOIA office to our request that they explain the paltry amount of information we at last received.

Our requests to the Veterans Administration, the Department of Justice, and the Department of State remained open at press time.

by GBI and the Department of Veterans Affairs.

Gallagher-Rogers of USGBC wrote to Josh Silverman at DOE on December 6, 2012 to discuss the new offering and subsequently attended a meeting with a number of DOE officials about the program. In March 2014, USGBC told *EBN* that program development is now complete, stating that USGBC "has been working with federal agencies for more than a year to develop an offering that will provide third-party verification of the Federal Guiding Principles for High Performance Sustainable Buildings."

Emails between USGBC and DOE show no apparent attempt to influence federal rulemaking in regard to certification systems (though, as we noted, we have virtually no emails from GSA). Even when USGBC weighed in through public comments, it made few direct arguments in LEED's favor, despite the fact that DOE was considering expanding the playing field to include Green Globes. The group's August 12, 2010 comments to DOE focused on technical suggestions—that DOE require ASHRAE 189.1 as a code minimum, require certification of existing buildings in addition to new construction, and promote integrated design.

Contrasting Approaches

As one might arguably expect from an up-and-comer, GBI has been more aggressive than USGBC in courting federal officials. Where USGBC delegated policy outreach to Howard, a registered lobbyist, and didn't communicate about policy with lower-level executive-branch officials, Shaffer—not a registered lobbyist—appears to have followed a strategy in which she identified, contacted, and attempted to

influence officials who actually make regulatory decisions.

Is this legal?

EBN found nothing to suggest that either USGBC or GBI acted outside the bounds of U.S. law in regard to influencing federal regulations, but the limitations of those laws are notable.

The Lobbying Disclosure Act (LDA), one of the major U.S. laws designed to increase government accountability and transparency, is "very focused on legislative-style lobbying," according to Sarah Bryner, research director at the Center for Responsive Politics. When it comes to the legislative branch—the people who write U.S. laws—lobbyists have to report contacts with virtually everyone on any Senator's or Representative's staff.

Not so with the executive branch—the federal agencies that implement laws in the form of federal regulations. Although the LDA explicitly covers executive-branch rulemaking, it focuses on political appointees almost exclusively. Contacts with the lower-ranking staffers who actually do the work of writing the policies (the executive-branch equivalent of lawmakers' staffers) don't count. If you are part of a special-interest group seeking to influence executive-branch regulations, you typically don't have to report your activities unless you get in touch with some of the highest-ranking officials—people like the President, the Vice President, or an agency secretary or under-secretary. (Just to keep things interesting, some non-profits go by tax law, which has different rules altogether, rather than the LDA.)

GBI maintains that its attempts to influence federal policy don't qualify as lobbying: "What we do is called marketing when the audience is career civil servants," Yudelson, president of GBI, told *EBN*.

Whether you accept Yudelson's distinction or not, many environmental regulations—including decisions about green building certification—are actually crafted by lower-ranking officials, meaning special interests may influence these regulations behind closed doors (and inside closed inboxes). Where the LDA falls short, FOIA requests can offer an enlightening glimpse into the federal rulemaking process.

Spurred by Chemical Industry, Ohio Moves Anti-LEED Bill Forward

Urging a LEED v4 ban, SCR 25 has passed in the Ohio Senate with support from the vinyl, coal, and forestry industries.

By Paula Melton

UPDATE: The article was updated with further quotes from Joe Uecker on the topic of risk assessment and from Jerry Yudelson on the Green Building Initiative.

A bill that could effectively ban use of LEED v4 for State construction projects, SCR 25, passed a key vote in Ohio February 25, 2014.

The resolution criticizes LEED v4 for not following ANSI consensus procedures and for not relying on risk-assessment methodology in a key material ingredient credit (MRc4 in LEED v4 for New Construction: Building Product Disclosure and Optimization–Material Ingredients).

"A lot of misinformation"

Due to the political makeup of the Ohio legislature, "we think the dominoes are probably going to fall," said David Scott, an attorney with Luper Neidenthal & Logan, of the bill's ultimate prospects. Having gotten the thumbs-up from the Senate, the resolution will now go to the House. (The governor's signature is not needed because SCR 25 is a non-binding resolution.)

Opponents of the resolution are a diverse group, notes Scott, who is also on the board of directors of the Central Ohio Chapter of the U.S. Green Building Council (USGBC). LEED supporters in the state, he says, range from the Ohio Federation of Teachers to the Natural Resources Defense Council to multinational companies like Siemens, Saint-Gobain, and Owens Corning.

Photo: Springfield News-Sun

The LEED Gold Edison School in Dayton is one of more than 100 Ohio schools with LEED certification. The legislature is seeking to ban use of the next version of LEED for state buildings.

He adds that opponents are continuing to lobby against the bill, and USGBC–Ohio has developed a website aimed at doing exactly that. "There was a lot of misinformation given to committee members," he says. "We need to try to correct that misinformation."

Scott listed anti-LEED talking points nearly identical to those put forward by the mainstream chemical industry and its allies in 2012 (see "Chemical Industry Attacks LEED: We Check the Facts"), including claims about jobs, chemicals of concern, and the consensus process.

Who's behind SCR 25?

Perhaps the overlap is no surprise, given the list of those who have already testified in the bill's favor, including representatives of the American Chemistry Council, the Vinyl Institute, the Ohio Forestry Council, and the Ohio Coal Association. Many of these groups object to the new credit in LEED v4, which is designed to encourage transparency about what goes into building products as well as reduction of health and environmental impacts of toxic chemicals.

Senator Joe Uecker told *EBN* that he introduced the bill because "I was approached by the chemical and manufacturing industry and associations about the potential loss of jobs in Ohio as a result of LEED v4."

Ohio boasts the highest number of LEED-certified schools in the nation, but "it should be noted that many of

Photo: State of Ohio

Senator Joe Uecker was prompted to introduce the anti-LEED resolution when approached by the chemical industry, he told EBN.

those schools may not have received certification under LEED v4," Uecker asserts. "When you walk into any Ohio school, you see lots of vinyl and lots of foam insulation. Many of those building products are excluded in version 4." (LEED v4 does not in fact ban any specific materials. For our fact-check of that claim, see "Does LEED v4 Ban PVC?")

"We think that it's not a big ask for LEED to go through a more open, consensus-type process as laid out by ANSI," argues Allen Blakey, vice president of industry and government affairs at the Vinyl Institute, who testified in favor of the resolution. "We would like to participate more in the development of credits that affect our material—more involvement than just the public comment period, because that has not been very much of a dialogue."

Blakey noted that he has met privately with USGBC staff as well, but he didn't feel his industry's views were heard during those meetings either.

Jeremy Sigmon, director of technical policy at USGBC, claims that proponents of SCR 25 aren't acting in good faith, stating, "Unlike most other industries with whom USGBC works, the chemical lobby has decided to lobby instead of innovate to get toward the outcomes that it would like to see."

Seeking consensus on consensus

Countering the opinion of the Vinyl Institute and other chemical industry groups, Sigmon calls LEED "a voluntary, flexible leadership standard" with a development process that is "open, transparent, and consensus-based."

A USGBC policy brief shared with *EBN* goes further, claiming that requiring an ANSI green building standard would create a "monopoly" because of ANSI's principle of coordination and harmonization. (ANSI's guidance leaves the possibility of multiple standards open but requires a "good-faith" attempt at streamlining competing standards into one.)

The brief also claims ANSI rules are designed to standardize "minimal performance" rather than "leadership" (see "Imperfect Consensus on Green Building Standards") and that a typical ANSI development process includes only a few stakeholders rather than the tens of thousands involved in LEED's development.

However, both Uecker and Blakey contend that the chemical industry was effectively excluded from the development of LEED v4. "The Council accepted their objections and never called them back in again," Uecker said. "There was no scientific process. The twelve people who made the decision for the Green Building Council—they don't like certain things."

"Why shouldn't they take a little more time with some of these credits?" adds Blakey, who points out that the material ingredient credit went through several radically different iterations throughout the v4 development process. "That's great that they want to take that on, but why couldn't they have taken a little more time and invited more stakeholders to the table?"

Risk a-what-ment?

In addition to the ANSI issue, SCR 25 calls on USGBC to use risk-assessment methodology in its rating systems. (A *hazard assessment* characterizes the inherent health and environmental dangers of a material without taking exposure into account; a *risk assessment* goes beyond identifying hazards and analyzes the level of risk involved in using a particular chemical in a particular way. See more about this in our LEEDuser guidance on MRc4.)

When asked to explain why that language was included in the bill, Uecker conflated risk assessment with the ANSI process itself: "That phraseology is in the resolution in regard to where the ANSI standards come into play," he said. "It's kind of clear that just asking for comments is not an inclusive and open process, so I pretty much think there's very little relationship between the way the process was done and the way independently accepted standards are developed."

The Vinyl Institute is clearer about its objections to MRc4: "It recommends tools that are anti-vinyl," says Blakey. Both the Cradle to Cradle system and a full GreenScreen assessment "would knock us out" of the running for contributing toward a second point in the credit. (Any product can count toward one point for transparency, provided it meets the criteria for ingredient disclosure.)

He adds, "How many architects and designers understand hazard material lists? Is this really what the A&D community needs?" (As we've reported, the sustainable design community is indeed seeking this hazard information and asking for Health Product Declarations from manufacturers. See "Finding Products for LEED v4—A Guide.")

Had the Vinyl Institute been involved, Blakey continues, "This credit would have been narrowed down to certifications showing that products, as purchased off the shelf" have certain health and safety attributes.

What if it passes?

Passage of the bill—which "urges" rather than requires use of green building rating systems and codes

developed through the ANSI process—may not strictly mean a ban on LEED in Ohio state building projects. But language in the resolution does resolve "that LEED v4 no longer be used" until certain conditions are met (ANSI process and risk-assessment methodology)—and in practice, a LEED v4 ban will be the effect, maintains Scott.

"What's a state agency to do?" he asks. "You now have the choice of using a system with proven benefits or reject[ing] that and throw[ing] some of your political capital around to keep LEED. Administrators are faced with an unfair choice."

Uecker explains that the Senate opted for a concurrent resolution over binding legislation because they wanted to give USGBC a second chance. He expressed hope that USGBC would "come to realize they have strayed from their mission of energy efficiency and have delved into the arena of political activism with what they've done here," adding, "We're not going to throw the baby out with the bathwater, but we're certainly going to give it a good scrubby."

And if agencies use LEED v4 despite the resolution?

"If and when it occurs, that's when we would take a step back and potentially create legislation. We're pretty serious about the fact that we will not stand for being bullied at the risk of Ohio jobs."

What will take LEED's place in Ohio?

It's not clear that any rating system can meet the requested standard set by SCR 25—even though Green Globes would be one obvious alternative.

As we reported in "Green Globes Board Member Quits Over ANSI Claims," there are some major discrepancies between the Green Globes tool and the GBI standard that went through the ANSI process.

For example, on materials and resources, the Green Globes 2013 Technical Manual relies entirely on life-cycle assessment (LCA) for choosing materials but doesn't require any particular LCA metrics, awarding 33 points for doing calculations and choosing lower-impact systems.

In contrast, the GBI/ANSI-01 standard has an LCA performance option that awards a range of points, up to 33, based on more or less favorable LCA results. It also offers a prescriptive option incentivizing a number of individual material attributes, such as recycled content, biobased content, and reduced transportation energy.

Both the Green Globes tool and the ANSI standard address health impacts exclusively through VOC limits for a limited number of interior products.

Blakey feels that discrepancies between the ANSI standard and the Green Globes tool may not be relevant. "The way I look at it is, as long as the organization has been willing to run their provisions in *some* form through an ANSI process and then base their rating system as much as possible on their ANSI document, that would probably—I'm not sure—that would probably meet our test."

Asked to comment on whether the Green Building Initiative (GBI), which develops the Green Globes standard, supports the legislation, president Jerry Yudelson told *EBN*, "GBI is not a lobbying organization, and, as a matter of policy, we don't comment on legislation, actual or pending, or on existing laws." The Vinyl Institute and other chemical and forestry industry groups have long supported Green Globes by serving as board members and lobbying for Green Globes-friendly legislation, but Yudelson said GBI does not "attempt to control or influence the actions of our members in their support or opposition to any legislative or regulatory proposal."

Asked about the resolution's prospects, Uecker told *EBN*, "I honestly think it will be easier in the House than it was in the Senate." The bill will reach the House next week, he said, where it will be sent to committee for further hearings.

Passive House Standards to Add Net-Zero-Energy Options

New categories of certification under the Passive House standards will recognize buildings that offset energy use with onsite renewables.

By Candace Pearson

The Passivhaus Institut (PHI), which sets strict criteria for reducing a building's energy demand through the international Passive House standard, will soon add new categories to recognize projects that meet their modest energy needs with onsite renewable energy.

Energy demand still foremost

Details will be explained by Wolfgang Feist, director of PHI, at the International Passive House Conference in April 2014, but according to a press release, the new categories will serve as the basis for net-zero or near-net-zero buildings. A new, single-family

Photo: Andrewglaser. License: CC BY 2.0.

This "solar settlement" in Freiburg, Germany, produces more energy than it consumes and is certified to the international Passive House standard.

home that produces as much energy as it consumes, for example, will be able to earn a new "Passive House Plus" label, and a "Passive House Premium" label will be awarded to projects with an energy surplus.

The emphasis will still be on reducing energy demand to ensure that wasteful buildings can't comply by simply adding large solar arrays, according to the press release, and calculations that determine a building's renewable energy potential will be based on lot area instead of floor area so as not to penalize multistory urban buildings. Because these buildings have a "far smaller roof area available per square meter of living space," it is more difficult for them to achieve an energy surplus, explains Dr. Benjamin Krick, senior scientist at PHI.

PHI hopes the new categories reposition the standard for the "nearly zero-energy building" mandate set to take effect for all new construction throughout the European Union by 2021.

PHIUS to follow suit

The new certifications are distinct from the PHIUS+ certification developed and managed by the Passive House Institute U.S. (PHIUS), which severed ties with PHI in 2011. While that certification mostly focuses on reducing energy demand, building to solar-ready standards is a requirement, according to Katrin Klingenberg, the co-founder and executive director of PHIUS. In addition, PHIUS is currently pursuing "zero-energy, zero-energy plus, and zero-primary-energy certifications" that the group expects to release by September.

Data Show Plaque Thresholds Push LEED Projects Higher

Researchers argue that almost 20% of LEED projects earn additional points simply for the marketing benefits of a higher certification.

By Candace Pearson

Based on point totals earned by LEED projects, a new study argues that the marketability of a higher LEED certification often pushes teams to construct greener projects than they otherwise would.

Daniel Matisoff, Douglas Noonan, and Anna Mazzolini, authors of "Performance or Marketing Benefits? The Case of LEED Certification," published in January 2014 in *Environmental Science & Technology*, observe that a disproportionate percentage of projects achieve LEED points just above the minimum cutoff for LEED's Silver, Gold, and Platinum certifications. The researchers argue that if project teams were only concerned with the cost-effectiveness of performance gains, the distribution of points would be smooth since, for example, the performance difference between 38 points for LEED Silver and 39 for Gold is not very significant.

Does it come down to marketability?

Assuming that firms base these decisions on maximizing profits, this leaves the marketing benefit of a higher rating to explain why so many projects ratchet up from where they would fall otherwise, Matisoff told *EBN*. The researchers estimate that approximately 15% to 20% of projects attain additional points beyond what might pay back in performance gains in order to capitalize on the "green signaling" benefits of the next certification level.

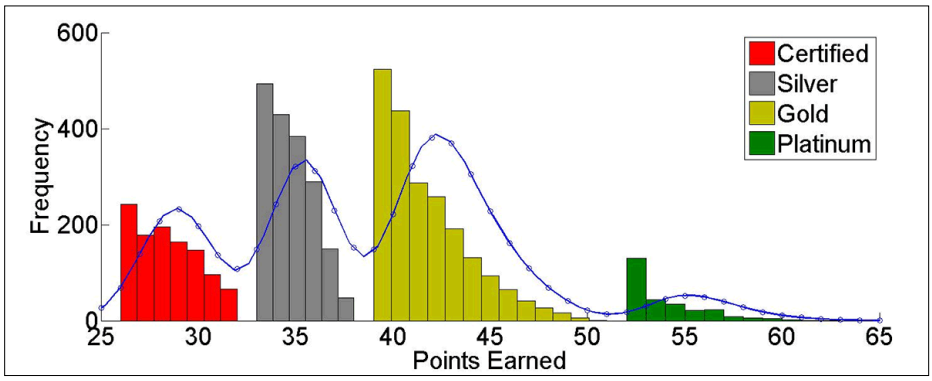
According to Matisoff, the study provides some backing for the value of the LEED brand in marketing; "If consumers weren't buying in, you would expect this effect to dissipate," he told *EBN*.

Others are less confident the behavior should be traced directly to the marketability of LEED. David Posada of GBD Architects questions whether the comparison between a motivation to increase performance or marketability is a "false choice" that ignores a host of other reasons for firms or clients to bump their project to the next bracket, including the satisfaction and pride that come from making the greenest building possible.

Using certifications as a stand-in for performance

Posada also commented on how the distribution might instead reflect how firms themselves use the thresholds as a marker for performance. "It makes sense to see projects not pursuing many credits beyond a level of certification because it's hard to evaluate the costs and benefits of each measure by itself," he told *EBN*. "We naturally create short-hand terms to capture levels of quality and performance." In other words, LEED Silver or LEED Gold certification is essentially a convenient and well-understood label for a package of green measures.

Point Distribution for LEED New Construction



Source: Environmental Science & Technology

The point distribution of LEED projects shows crowding around the certification thresholds beyond what would be expected for productivity gains (represented by the smooth line that the researchers term the "kernal density curve").

Echoing this thought, Mastisoff admits that it is still unclear whether signaling is overpowering performance considerations, either in the eye of firms or of consumers. Yet he dismisses the possibility that the thresholds may discourage teams from pursuing additional credits once they have reached their certification goal, calling it "conceivable" but "not consistent with economic theory" that credits with "positive payoffs" would be left on the table.

At the very least, Mastisoff says, this behavior around thresholds shows "firms are trying to outdo each other," and this competition means greener buildings are being built.

NEWSBRIEFS

ANSI to Pilot Greenwash-Busting Eco-Label Program

An ANSI accreditation program is meant to help users determine which certification bodies and green labels are legit.

By Candace Pearson and Paula Melton

The American National Standards Institute (ANSI) has launched a new pilot program meant to establish a method for certifying the environmental value of eco-labels—including whether their certification bodies are true third-party entities. The program establishes eligibility criteria for "Type I" (multi-attribute) environmental labeling certifications and creates a system for accrediting certification bodies using ANSI and ISO procedures (see "What's New in Multi-Attribute Environmental Certifications").

Under the pilot program, a labeling scheme is eligible for Type I certification if it complies with a suite of standards demonstrating conformance with international environmental declaration standards and assessment standards. Certification bodies have separate requirements, which align with ISO/IEC 17065 – "Conformity assessment — Requirements for bodies certifying products, processes, and services."

Although the program is a label for a label—potentially introducing more complexity into a confusing environment—ANSI-led accreditations have become a widely used method for verifying environmental claims, and the new program may offer a standardized way to compare eco-labels as well as the governing bodies that issue the labels.

ANSI is accepting applications for the pilot program until April 11, 2014.

Switching to Portland Limestone Cement Could Reduce Emissions

A life-cycle assessment of PLC shows a 12% improvement in environmental performance over ordinary portland cement (OPC) when used in concrete mixes.

By Candace Pearson

The Athena Sustainable Materials Institute recently prepared a life-cycle assessment (LCA) for the Cement Association of Canada confirming assumptions about the lessened environmental impact of portland limestone cement (PLC) relative to ordinary portland cement (OPC).

Results of the assessment indicate that PLC (cement mix with high limestone content) reduces greenhouse gas emissions by 9.6% compared with OPC mix. The argument that PLC could help reduce the environmental impact of concrete has long been proposed based on what was logically deduced from substituting more limestone for less clinker—the ingredient that is most responsible for cement's CO2 emissions as well as for the high energy consumption needed during manufacturing—but this study "gives solid numbers to evaluate," according to Kathrina Simonen, director of the Carbon Leadership Forum, which was not involved in this LCA. The report also finds PLC performed better across all measured environmental impacts, including having a lower ozone depletion potential and lower smog potential.

The assessment is not ISO-compliant because it is constrained to "cradle-to-gate" impacts, so it does not capture impacts during the use phase or end-of-life stages. Still, the work "should support the development of further research," Simonen told *EBN*.

The authors of the report hope it also drives efforts to increase the levels of PLC allowed by building codes. Since Canadian rules only allow limestone content up to 15%, the report concludes that employing levels "similar to those levels allowed in European codes," which permit up to 35%, "would go a long way to further

Cradle-to-gate life cycle impacts of PLC and OPC

Table 5: LCIA Results Summary for PLC and OPC – 1 kg, absolute basis

Impact category	Unit	OPC Cement- Canada - Cradle-to-Gate	PLC Canada- Cradle-to-Gate
Global warming	kg CO_2 eq	0.95	0.85
Total primary energy	MJ	6.62	6.02
Non-renewable energy	MJ	6.27	5.69
Acidification	kg SO_2 eq	4.1E-03	3.7E-03
Eutrophication	kg N eq	1.3E-04	1.2E-04
Respiratory effects	kg $PM_{2.5}$ eq	3.7E-04	3.2E-04
Smog	kg O_3 eq	0.048	0.043
Ozone depletion	kg CFC-11 eq	1.1E-11	9.6E-12

Source: Athena Sustainable Materials Institute

Results of the assessment show that PLC has a lower environmental profile than OPC across all impact indicators.

improving the industry's environmental performance." PLC content is limited to 5% in the U.S. because of concerns that the limestone will affect the strength of the concrete.

Virtual Energy Assessments Pinpoint High Plug Loads

Without an auditor ever stepping foot in their buildings, facility managers are gaining insight into how much plug loads account for their buildings' energy consumption.

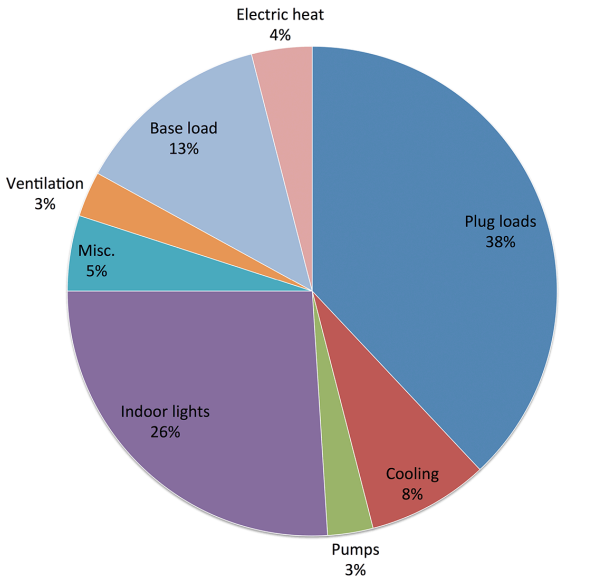
By Candace Pearson

Virtual energy assessments can provide useful recommendations for cutting energy use and are an affordable alternative to more comprehensive walk-through audits, according to a study conducted by A Better City (ABC), a nonprofit organization based in Boston, Massachusetts.

With only a building's address and a year's worth of 15-minute or hourly utility data, virtual assessments by the energy-audit software company Retroficiency produced an energy-use breakdown that revealed plug loads accounted for the biggest portion of energy use in the sample—38% in office properties and 35% in hotels. By implementing targeted "action steps" spanning all areas of energy use, the nine buildings studied could potentially save a combined $1,431,487 in energy costs, according to the report.

There were some limits to what an assessor could ascertain remotely. One building that was steam-heated and -cooled received an impractical recommendation to install variable-frequency drives (VFDs), for example. Study participants also expressed frustration over recommendations to reduce plug loads because they believed there was little they could do to influence occupant behavior. In general, however, most reported that they were surprised at how much information the virtual energy assessment could provide.

Composite Energy Consumption Breakdown for Six Office Properties



Source: A Better City

On average, plug loads accounted for 38% of the energy consumption in six office buildings analyzed by the study.

The U.S. Department of Energy and the General Services Administration have also used virtual energy-assessment tools to quickly identify areas of improvement in operations as well as to guide potential upgrades. ABC suggests that this technology be recognized as an alternative to the ASHRAE Level-2 audit, which is currently designated as a way to comply with Boston's Building Energy and Disclosure Ordinance taking effect May 2014.

Milk Byproduct Could Become New Flame Retardant

It sounds like it belongs in our April Fools edition, but recent research really suggests we could treat our fabrics with whey, replacing toxic chemicals.

By Candace Pearson

Leave it to Italy to figure out that cheese making could produce a good alternative to flame retardants. It sounds hard to believe, but researchers at the Polytechnic University of Turin are serious and have promising test results to prove it.

Think back to Miss Muffet and her curds and whey, and you may remember that whey is a byproduct of milk, often produced in the making of cheese. Whey contains proteins called caseins that researchers have found form a layer of char that blocks flames from spreading—similar to how some flame retardants function, but without the accompanying toxic compounds.

After treating fabrics in distilled water and casein powder, the researchers performed flammability tests. Only 14% of a cotton sample and 23% of a polyester cloth burned before the flames extinguished themselves. A cotton-polyester blend burned completely but smoldered 60% more slowly than the untreated material.

According to researchers, one of the biggest challenges ahead is one anyone might expect: the cheese-treated fabrics stink. The next task for researchers is to attempt to remove the molecules associated with the odor as well as to develop a binder that ensures the treatment does not wash off. If successful, it wouldn't be the first building product that makes use of whey, which otherwise requires intensive wastewater treatment: water-based floor finishes also use the dairy byproduct.

EPA Finds Coal Fly Ash Safe in Concrete and Gypsum Wallboard

A new study supporting the encapsulated use of fly ash in building products is a strong clue as to how EPA might shape pending regulation.

By Candace Pearson

As the December 2014 deadline draws near for the U.S. Environmental Protection Agency (EPA) to finalize regulations for fly ash—a byproduct of burning coal—the agency released a study offering evidence that the material is safe for use in concrete and gypsum wallboard.

Using a methodology that has become the EPA standard for evaluating products containing fly ash, the study found that concentrations of 18 constituents of potential concern were higher in cement with fly ash than in portland cement, and the lowest mercury emanation rate measured for gypsum wallboard with fly ash was three times higher than the highest rate for mined gypsum wallboard. However, after an exposure review and screening assessment, the report finds that the increased concentrations are still "below relevant regulatory and health-based benchmarks" and concludes that EPA supports the "beneficial use" of fly ash in these products.

Using fly ash in concrete offsets greenhouse gas emissions, and diverting it for use in other products means less of it is dumped into landfills, where toxic substances may leach into groundwater (see "Reducing the Environmental Impacts of Cement and Concrete"). However, some say even the latest EPA study fails to put their concerns over health impacts to rest. In a recent statement, The Healthy Building Network warns that the methodology discounts high levels of mercury, was not properly peer reviewed, and fails to investigate exposures that might occur during manufacturing and installation, or after disposal.

The study does not address fly ash used in products like ceiling tiles or carpet backing—other common uses in which the fly ash is not as clearly encapsulated (see "*EBN*'s Position on Fly Ash").

Comparison of Constituents of Potential Concern in Fly Ash and Portland Cement

Constituent	Fly Ash		Portland Cement		p-value
	Detection Frequency	Median	Detection Frequency	Median	
Aluminum	22 / 22	87,833	11 / 11	26,250	< 0.0001
Antimony	38 / 42	6.2	2 / 94	0.10	< 0.0001
Arsenic	97 / 100	50.1	64 / 109	12.4	< 0.0001
Barium	61 / 61	1,189	98 / 98	205	< 0.0001
Beryllium	24 / 32	10.5	93 / 94	0.98	< 0.0001
Boron	34 / 34	403	3 / 4	42.5	< 0.0001
Cadmium	70 / 91	1.3	42 / 98	0.03	< 0.0001
Chromium	91 / 91	107	109 / 109	58.6	< 0.0001
Cobalt	49 / 49	45.3	12 / 15	10.0	< 0.0001
Copper	47 / 48	108	15 / 15	36.0	< 0.0001
Iron	23 / 23	27,514	0 / 0	N/A	N/A
Lead	98 / 99	55.0	88 / 109	6.3	< 0.0001
Manganese	48 / 48	219	15 /15	465	0.99
Mercury	73 / 87	0.17	25 / 98	0.01	< 0.0001
Molybdenum	44 / 46	16.3	1 / 4	5.0	< 0.0001
Nickel	75 / 76	76.7	97 / 109	25.0	< 0.0001
Selenium	71 / 79	8.8	6 / 98	2.0	< 0.0001
Silver	16 / 26	0.55	93 / 98	8.6	1.00
Strontium	22 / 22	795	0 / 0	N/A	N/A
Thallium	19 / 27	2.1	32 / 94	0.30	< 0.0001
Uranium	10 / 19	5.5	0 / 0	N/A	N/A
Vanadium	43 / 43	267	15 / 15	64.0	< 0.0001
Zinc	51 / 51	141	14 / 15	64.0	0.04

mg/kg = milligrams per kilogram
N/A = Not applicable; available data not sufficient to conduct comparison

Source: U.S. EPA

Although concentrations of these potentially toxic elements are in most cases higher in cement with fly ash than in portland cement, EPA has determined there is little risk of dangerous exposure.

Urban Green Opens Call for EBie Awards

Submission entries are now open for the EBie Awards, which recognize those who make existing buildings more sustainable.

By Candace Pearson

Organized by Urban Green Council, this year's EBie Awards celebration will be held June 9, 2014 at the Hard Rock Café Theater in New York City. It's a night that Urban Green likens to the Oscars, with a twist: guests pause for a photo shoot on a *green* carpet, and the gushing acceptance speeches come from building operators, facility managers, engineers, and other building professionals.

The submission period is now open for the third round of these annual awards, which recognize individuals for making great strides in greening up existing buildings.

Recipients are honored for their often-thankless work of improving the energy and water use of existing buildings. The categories range from the Smooth Operator (for excellence in operations and maintenance) to the Verdant Brainiac (for green renovation innovation). Last year's winners included John Barnes of SL Green Realty Corp for upgrading the HVAC system at 360 Hamilton Avenue in White Plains, New York, and John Lalley for a lighting retrofit at the Davis & Warshow Distribution Center in New York City. Although Urban Green is the New York City chapter for the U.S. Green Building Council, entrants are welcome from anywhere in the U.S.

Entry forms must be submitted online, and scoring is based on savings reflected by source energy use intensity scores registered through EPA's

Portfolio Manager. Submissions are due March 20, 2014.

Soil Matters, Say Scientists at Ecosystem Conference

A recent conference highlighted the breadth of ecosystem services soils provide and spurred debate about how soil should be protected.

By Candace Pearson

Leading scientists recently gathered at a conference to discuss the value of a natural resource that is often overlooked—soil. The "Soil's Role in Restoring Ecosystem Services" conference was sponsored by the Soil Science Society of America, the Ecological Society of America, the U.S. Geological Survey, and the American Geophysical Union and spanned topics from food security to climate change.

"We have a Clean Air Act, and we have a Clean Water Act. What we don't have is a Clean Soil Act," Mary Stromberger, Ph.D., one of the conference organizers, told *EBN*. "It has been taken for granted, and people don't recognize it as a resource." Some of the most important conversations that came out of the conference, she continued, were about how to place value on soils so that they might be protected through regulation. Stromberger says she thinks the "majority favor economic assessment," or a cost-benefit analysis of the services that soils provide, but predictably, there are concerns that quantifying the value of soil would allow it to be "sold to the highest bidder," a particular concern where developing countries might sell their most fertile lands for foreign food production.

Closer to home, even urban soils should be recognized as "hyper-functional landscapes" according to Richard Pouyat of the U.S. Forest Service, one of the keynote presenters. In addition to sequestering carbon and regulating water cycles, soil provides aesthetically pleasing natural spaces that can support human well-being. These services justify conserving soils as much as any other natural resource during the design and construction of the built environment, he suggests.

Search for High-Performing Products in New NREL Database

Users can quickly compare energy performance of everything from LEDs to solar panels on the National Renewable Energy Laboratory's TPEx website.

By Brent Ehrlich

The National Renewable Energy Laboratory (NREL) recently launched its Technology Performance Exchange (TPEx), a website that provides standardized energy-performance data and allows apples-to-apples comparisons between products for various product categories. TPEx data is geared primarily toward commercial building professionals, but anyone from consumers to those who work for utilities can gain access by registering on the website for free.

According to TPEx, its intent is to act "as a bridge to help energy efficiency and renewable energy technologies overcome the 'valley of death'" between the risky early-adoption phase of innovative products and widespread adoption (when manufacturing finally becomes profitable). For example, some technologies, such as LED replacement lamps, can evolve before U.S. Department of Energy evaluation and other third-party testing is complete on earlier versions. By providing a platform for comparisons, TPEx could speed advancement and adoption of these new technologies.

TPEx's data is submitted by manufacturers, suppliers, third-party testing laboratories, and other contributors using standardized data entry forms tailored to each product category. End users can fine-tune searches using a variety of parameters and can compare product information that includes when the data was submitted, who submitted it, and how it was derived. The site is currently accepting data for 17 product categories—such as LED replacement lamps, photovoltaic panels, and boilers—and NREL intends to add eight more categories for envelope insulation, fans, wind turbines, and more.

The Technology Performance Exchange

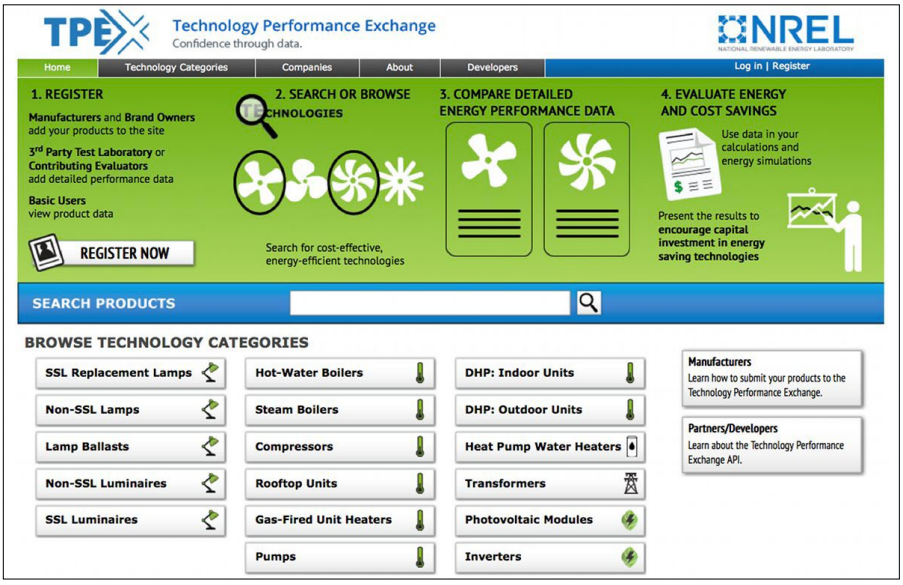


Image: National Renewable Energy Laboratory (screen capture)

Choosing the Right Hygrothermal Modeling Tool

From the free hygIRC software to an expanding suite of WUFI applications, the hygrothermal modeling world has many options to offer.

By Paula Melton

In the beginning, there was MOIST, one of the first hygrothermal modeling software tools invented.

"It only functioned in DOS," recalls Sean O'Brien, P.E., associate principal at Simpson Gumpertz & Heger (SGH), referring to the operating system whose heyday was in the 1980s. Developed by the National Institute of Standards and Technology (NIST) in the early 1990s, MOIST was never commercialized and did not receive ongoing federal support, so development ended in 1997. The tool is still available for download, though MOIST "didn't account for rainfall or water absorption," explains O'Brien. "But for a situation without any rain, it could tell you over the course of the year how the system would perform and where to put the vapor barrier."

Hygrothermal modeling tools have come a long way (even MOIST eventually worked in Windows). Here's a rundown of the most widely used tools. Be sure to check out our in-depth feature article on hygrothermal modeling as well, "Go with the Flows: The Promise and Peril of Hygrothermal Modeling."

Photo: Natural Research Council Canada

Testing equipment like the Environmental Envelope Exposure Facility, shown here, help NRC Canada perform hygrothermal testing of building materials that has in turn validated aspects of its free hygIRC tool. The chamber simulates interior and exterior climatic conditions over an extended period of time, including effects like wind-driven rain and solar radiation.

WUFI Pro Wind Wheel

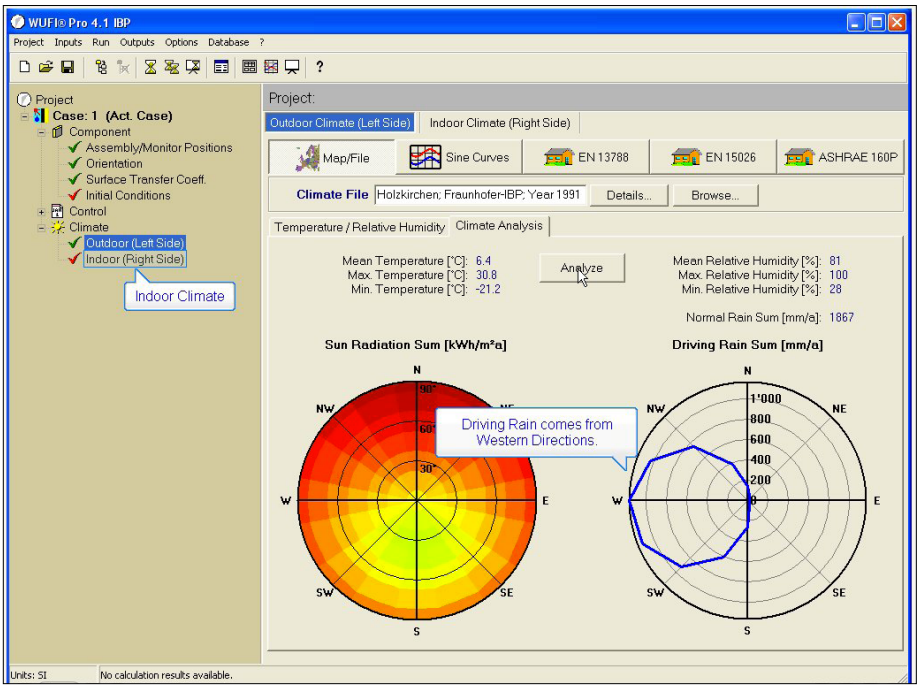


Image: Fraunhofer Institute (screen capture)

This screen capture from an online demo shows one of the stages of input into WUFI Pro, indicating where wind-driven rain falls on the building.

hygIRC

Developed by the Institute for Research in Construction (IRC), part of Canada's National Research Council Canada (NRC), hygIRC is a free, menu-driven software program intended for use by architects. The tool is "one-dimensional," meaning it looks at heat and moisture migration through a solid building assembly but can't handle a secondary type of movement, such as the compounding effects of air leakage and thermal bridges.

Appropriate for education as well as decision-making, hygIRC is ideal for aiding parametric modeling (in which certain parameters are kept constant while changing one additional parameter at a time to see how the model responds), says Wahid Maref, Ph.D., P.Eng., senior research officer at NRC. "It's a fast, reliable model of heat and moisture transfer," Maref told *EBN*. "This tool allows you to change parameters instead of doing a lot of testing"—for example switching insulation type, membranes, or even climate—"to avoid critical situations."

Maref pointed to hygIRC's extensive, independently developed material database as a particular advantage. "This is not theoretical or from literature," he explained. "They were tested here at IRC" using actual building materials from North America. He also said the tool has been validated in 30 North American climates and incorporates "an exhaustive list of cities," though users can also import their own weather data.

Although WUFI (see below) is more of a household name in the field, Maref said consulting firms from all over the world have ordered hygIRC and are still requesting updates. "It's also a good educational tool to teach a future engineer or architect to use hygrothermal tools," he says.

"It is effective, simple, and intuitive," confirms M. Steven Doggett, Ph.D., principal scientist and CEO at Built Environments, Inc.

Maref notes that users may need to write to NRC to receive a copy but that NRC provides the tool for free

and also offers some training and technical support.

WUFI Pro

WUFI—short for *Wärme und Feuchte Instationär*, or "Transient Heat and Moisture"—comes in many forms. (See "Using WUFI to Prevent Moisture Problems" for a brief introduction.)

WUFI Pro is what people are usually talking about when they talk about WUFI. It is also informally referred to as "WUFI 1D" and is similar to hygIRC in its capabilities, though recent versions of the program (WUFI Pro 5.2 and above) can also account for air leakage, according to Achilles Karagiozis, Ph.D., director of building science at Owens Corning and a developer of WUFI and other hygrothermal modeling tools. The WUFI Bio plug-in can also help assess the risk of mold growth.

WUFI users have criticized its database of materials, which may not reflect the reality of building products in North America, though Karagiozis says developers are gradually building up the database through partnerships with manufacturers. WUFI databases are the same across all tools, and their functionality "has been vetted by 16,000 users who have downloaded WUFI 1D" and has been validated in climates worldwide, he says.

WUFI Pro has become the industry standard for hygrothermal modeling, and training is available globally through Fraunhofer Institute programs. The cost of a single, ten-year software license is €1,950 (approximately $2,700 U.S.), and the cost of a single two-day seminar could run around $1,000 (plus travel, since workshops haven't been offered online).

Two demo versions are available for free (you may need to squint at the WUFI Online Shop to find the "Free versions" tab). North American users will want the WUFI ORNL application, and other users can choose WUFI Light.

WUFI 2D

"WUFI 1D is just like putting your finger through a wall: where you put your finger is all you see," explains Dave Bryan, AIA, of Third Level Design in Minneapolis. "We're always looking at what happens at the insulation, what happens at the stud." That's useful, he says, but a wall "is not at a single stud between two areas of insulation. A two-dimensional model can look at a wall section."

Aside from being able to account for effects like thermal bridging, this is also the tool typically chosen for investigating the impact of air leakage. It may be more valuable as a research tool than a decision-making tool, however, and it typically calls for an engineering background. Bryan describes the program as "very klutzy" and said it can be frustrating to get results (let alone evaluate them). But engineers we spoke with were equally frustrated with the limitations of one-dimensional analysis and preferred WUFI 2D for its more realistic modeling capabilities.

A single ten-year license for WUFI 2D costs €3,000 (about $4,100 U.S.).

WUFI Plus

WUFI Plus, sometimes called WUFI 3D, is a whole-building simulation tool that uses a rough sketch of the building size, shape, orientation, and envelope assemblies to produce an energy model that takes hygrothermal effects into account. Users can also drill down into assemblies to explore one- or two-dimensional hygrothermal activity.

As a whole-building simulation tool, it incorporates complex effects like those from interior loads (like heat generated by equipment), mechanical system setpoints, and passive solar gain through glazing. The cost is €4,250 (about $5,900 U.S.) for a ten-year license.

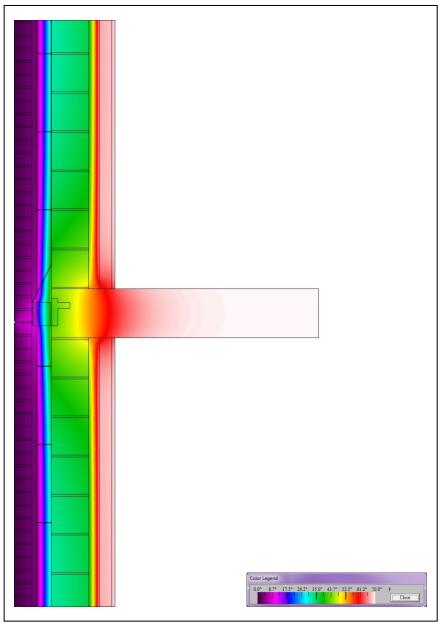
None of the experts *EBN* spoke with were actively using this tool. "I have not gone there; I think it's too complex," said Wagdy Anis, FAIA, principal at Wiss, Janney, Elstner Associates. He clarified that he was not criticizing the tool "as a model" but speaking to his own choice on keeping track of the intricacies.

Adam Cohen, an architect with Structures Design/Build in Virginia and a Fraunhofer-trained advanced teacher of WUFI, adds that WUFI Plus "with some development, could take state-of-the-art of energy modeling beyond where it is now" because of its unique focus on the envelope. However, he acknowledges, WUFI Plus has had "weaknesses in some of the other modules," including the way it models the mechanical system.

WUFI Passive

WUFI Passive has resolved those weaknesses, according to Cohen. A version of WUFI Plus specialized for Passive House, the tool modifies certain aspects of WUFI Plus by using assumptions from the Passive House Planning Package (PHPP), the spreadsheet-based tool used for energy modeling in Passive House projects.

THERM Runs for Thermal Analysis



Source: Vidaris, Inc.

In collaboration with BKSK, Vidaris produced a series of iterative analyses aimed at developing a library of hygrothermally high-performing assemblies for a particular climate and building type. The team looked at purely thermal results—assessing, for example, how effectively a given assembly could provide thermal breaks—as well as two-dimensional hygrothermal simulations.

"It's a fair bit different" from WUFI Pro, explains Mike Duclos, principal at Boston-area DEAP Energy Group. "Fraunhofer could choose better ways of naming their products. People hear all sorts of things about WUFI and then they have feelings about all the tools based on WUFI 1D."

Duclos attended a training session on WUFI Passive but said he's still getting to know the software. "They have a tool with which you can draw a building, which is very clumsy," so Duclos recommends using the new Sketchup interface to speed things up. He also said the tool would be most valuable as a way to compare performance of various design choices through early-stage energy modeling: "The real value I see in WUFI Passive is to give feedback to an architect about how the building is going to perform given overhangs, window sizing and position, that kind of stuff." He also praised the tool's uniquely user-friendly interface. Unlike other WUFI tools, he said, the software will alert the user that a specific input is missing or seems flawed.

Duclos noted that he hadn't used the "drill-down" capabilities of WUFI Passive to focus on the hygrothermal performance of a specific part of the building. "It's a tool for a different purpose. It's much easier to use WUFI 1D for a single assembly."

Cohen, in contrast, praised the tool's "levels and levels and levels of detail," pointing out that if you choose the more complex input options (everything from HVAC setpoints to the activity of particular ducts and fans), the output possibilities are endless. "You could dedicate years to playing with that program," he said.

WUFI Passive is a veritable bargain at €460 (about $630 U.S.) for a one-year license or €2,100 (about $2,900 U.S.) for a ten-year license.

THERM

Developed by Lawrence Berkeley National Laboratory (LBNL), THERM bears mention here. Although not a hygrothermal modeling tool, THERM is a sophisticated thermal simulation tool that allows two-dimensional modeling of thermal properties of whole assemblies. By beginning with THERM—which is free and in many ways simpler to use than a hygrothermal modeling tool—project teams can scan proposed assemblies for potential problem areas, such as thermal bridges, based purely on heat movement. With a fair amount of building-science knowledge, architects can also look at thermal properties to assess which parts of an assembly may be potential hot spots for moisture issues.

"What About Air Krete?" A Deeper Look at the Insulation Alternative

The foamed magnesium oxide cement is often seen as a blue-ribbon contender for least-toxic insulation. But the manufacturer falls short in providing key metrics.

By Tristan Roberts

When discussing the challenges of finding a healthy, high-performing, affordable product amongst today's insulation materials—and in particular, in confronting the environmental performance of spray polyurethane foam (SPF)—we are often asked, "What about Air Krete?"

Going back to 1997 (see "Air Krete: Foam Without Plastics"), *EBN* has generally endorsed the use of Air Krete, with some caveats. On the plus side, it insulates about as well as other common fibrous insulation materials (at about R-3.7 per inch); is spray applied and flows into small voids particularly well; and, most notably, is primarily inorganic cement, containing no flame retardant chemicals, and being inert to insects, fire, and moisture.

Recent changes in the product's distribution as well as dramatic changes in the company's performance metrics led us to reexamine Air Krete, however, and we're concerned about the accuracy of some of the company's new claims.

More bubbles, more R-value

The most striking claim currently being made by Air Krete is that it offers an insulation value of R-6 per inch. That's pretty high—much higher than the R-3 to R-4 values that we expect from most other building insulation materials.

The basic formula to make Air Krete uses compressed air, heated water, and magnesium oxide (MgO) cement combined in a special rig onsite and sprayed into wall or ceiling cavities. As Bill Szabo, vice president for Air Krete, based in Weedsport, New York, describes it, "Air Krete is billions of uniform-sized soap bubbles with a coating of magnesium oxide cement on the surface of those soap bubbles." It comes out of a spray rig feeling like "gritty shaving cream," and as it cures and dries out over a period of weeks, it has "the look, feel, and consistency of dried sponge cake," according to Szabo—if sponge cake had a greyish-blue hue.

To achieve the new, higher R-value, R. Keene Christopher, the CEO and co-inventor of Air Krete, told *EBN* that the installation procedure has changed substantially. He explained

Photo: Chris Magwood

This installation at the Haliburton Highlands Museum in Haliburon, Ontario, was a great fit for the existing building, says Chris Magwood of Endeavour Centre. Air Krete, he says, "has lots of great advantages, including being non-toxic and having a great R-value, low embodied energy, and easy installation." Here clay plaster and wood lath are installed over Air Krete.

that the Air Krete material is pushed through successively finer mesh screens and glass beads, ultimately resulting in "more bubbles per cubic inch." In addition, those bubbles are being strengthened by an additional pozzolan. "We are not only making a finer cell but capturing it better than before," says Christopher.

Szabo said that Air Krete applied for new patents in the fall of 2013 and has been converting its installers over to new spray rigs. As always, Air Krete has very little structural integrity and is intended for cavity installation only—in masonry walls, wall cavity retrofits, or behind insulation mesh like that used for blown cellulose.

Will the real R-value please stand up?

A stronger, reformulated, higher-insulating Air Krete is an exciting development—or should be. The only trouble is that Air Krete has used an unorthodox testing method to demonstrate the R-6 result and may even be in violation of Federal Trade Commission rules for how insulation sold to consumers must be tested. Those rules require testing according to one of several ASTM standards, the most commonly used being ASTM C 518-04, "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus." Yet Air Krete, whose website trumpets "NEW High R Value of 6.0 per inch makes airkrete insulation the top competitor in insulations," (sic) has published two test results to back that (dated Oct. 2013, June 2013), with neither one citing any ASTM method.

Both tests, by Dynalene Laboratory Services in Pennsylvania, use the "transient line source heat methodology" to show an R-value of 18 for a 3-inch Air Krete sample. The tests were done with a temperature probe designed for testing thermal conductivity of soils and minerals, according to Christopher. Also known as the "heated needle" technique, the probe creates a burst of heat and then measures the rate of transmission of that heat with an adjacent probe. Christopher says that the method is compliant with ASTM standards for testing conductivity of soil and rock, and the company making the probe is working on ASTM approval for insulation, something "we expect momentarily," he said.

Photo: Air Krete

The company behind Air Krete, a foam insulation made of 98% cementitious materials, is claiming that it insulates to an impressive R-6/inch with a new formulation—up from R-3.7. Air Krete is installed in cavities such as behind webbing as shown here.

Asked why Air Krete isn't using the standard ASTM C518 test (as it has done in the past to establish its R-3.7 value—see those results), Christopher complained that C518 "has never worked well" for Air Krete. It is "so light and friable," he said, that "sealing around the edges" of the test apparatus has always been a problem. He noted that Air Krete is mostly mineral content, making it appropriate for use with the thermal probe.

That doesn't make sense, David Ober, an independent building science consultant based in North Carolina, told *EBN*. C518 equipment has been the standard for measuring the thermal performance of all types of insulating materials for years; it simply measures heat flow through a monolithic material placed between two plates under steady-state conditions, and it is designed to be well insulated and guarded around the edges, according to Ober. (And it's not clear why Air Krete would have unique problems with C518, compared with any other fibrous insulation material like cellulose, fiberglass, or foam.)

"The insulation industry uses C518 equipment day in and day out in their plants to measure the thermal characteristics that are produced," with each testing taking at least one to several hours to perform, says Ober. "It would be ideal if the probe method would work and a reliable answer could be obtained in ten minutes. But so far that has not been the case."

EBN spoke with G. Todd Vanek, thermal market manager for Decagon Devices in Pullman, Washington, which makes the KD2 Pro device that Air Krete's R-6 results rely on. Vanek confirmed that "there is no ASTM standard for the heated needle technique in insulation." He said that the company was embarking on a research project that would verify the performance of its sensors in insulation products. That research would use the company's sensors to measure insulation materials with known R-values. He said that the company was "comfortable with our results" currently but was prepared to make calibrations on its devices if the company or other researchers found inaccuracies. "If the results aren't perfect, we can make adjustments so they are," he said.

Ober isn't convinced. "The FTC rule works really well." He says, "If it really has R-6, put it through a C518 [test].

In two or three hours of testing, you'll know."

Is R-6 plausible?

Test methods aside, Ober argues that it's not clear on a physical basis how Air Krete can achieve R-6. Polyisocyanurate insulation, which can achieve R-6, is a foamed plastic in which the pores have been filled with a low-conductivity gas, reducing the heat transfer that would normally take place across air molecules in those pores. Another approach to achieving R-6 or better is with aerogels, which are small enough to isolate individual air molecules, preventing them from bumping into each other and conducting heat.

Christopher told *EBN* that he did not know the size of the pores in the reformulated Air Krete; he could only guess that they were very small based on the mesh screens. According to Ober, achieving nanosized insulation pores is a specialized process that Air Krete was not likely achieving with equipment in the field (nanogels are made in factory settings). "The [plastic] foam guys aren't any closer to doing it either," he said. Ober also doubts that such performance is achievable with only 2.5 pounds per cubic foot (pcf) of material, as is being used.

John Straube, Ph.D., P.Eng., of Building Science Consulting in Waterloo, Ontario, echoed those concerns. Reviewing Air Krete's older R-value test results showing R-3.7, he told *EBN*, "That is pretty good, but believable, as it is right on the curve of density-versus-R-value for a wide range of products." R-6 is hard to believe, says Straube.

Air barrier?

While they're at it, Szabo and Christohper could perform testing in accordance with Air Barrier Association of America (ABAA) standards to establish whether Air Krete is an air barrier. Because of its reputation for friability, lack of adhesiveness to framing, and lack of test data, *EBN* has assumed that it is not an air-barrier material.

Szabo, however, told *EBN* that Air Krete is an air barrier, and that "it's on our list to get that [testing] done." In the meantime, Szabo offered to provide before-and-after blower-door testing from a home with Air Krete installed in roof slopes, showing reduced air infiltration. However, filling cavities with insulation materials such as cellulose could be expected to reduce overall air infiltration, even though cellulose is not an air barrier.

Photo used by permission

Occupants of the Robertson residence in Georgia are complaining about strong odors from this attic installation of Air Krete. In speaking with other installers and projects, EBN could not identify problems of a similar nature. Unfortunately it was hard to put such concerns to rest in part because the manufacturer is not forthcoming with Air Krete's emissions or ingredient information.

Ingredients not clear

Air Krete has not been forthcoming about its product formula, even as the product transparency movement (see "The Product Transparency Movement: Peeking Behind the Corporate Veil") has raised expectations that environmentally progressive companies will be more forthcoming about the chemistry they use.

Air Krete's marketing emphasizes that its basic ingredients are "air, water, and MGO cement," but there seem to be other ingredients in the mix. Asked about Air Krete's formula, Christopher at first referred only to a State of Connecticut test showing that the product is 98% mineral content. Asked if there were other ingredients, he said they were "minimal," but, pressed by *EBN*, stated that it is "fair to say there's 2%" organic compounds—that is, most likely some kind of plastics or other non-mineral-based ingredients.

Emissions testing out of date

If Air Krete isn't yet on board with transparency programs like Declare or the Health Product Declaration format, providing solid emissions tests results might help reassure consumers that it is little more than just cement. Air Krete's main emissions test, conducted in 2009, is based on ASTM D5116 and concludes, "Neither formaldehyde nor volatile organic compounds are emitted." Unfortunately, that's not a useful test result, according to an indoor air quality testing expert from one of the nation's best-known laboratories, who spoke with *EBN* anonymously on the basis that he didn't want to disparage another laboratory's work.

The expert noted that D5116 is a guideline setting certain parameters for emissions testing: "It's not a test method." Moreover, he said, "I don't believe the specific measurement techniques that they used in the test report are in compliance with D5516, certainly not the state of the art." The current state of the art for emissions testing of green building products is CDPH Standard Method (sometimes referred to as California Section 01350), which is used by reputable third-party emissions certifications like Greenguard and SCS Indoor Advantage.

One key difference between the method used by Air Krete's test and a more standard method is how VOCs (volatile organic compounds) are collected and analyzed. In Air Krete's test, VOCs were collected and analyzed in two ways: a water dish was placed with Air Krete in a chamber, and the change in color of the water was used to detect the presence of VOCs. Secondly, VOCs were extracted from that water by a charcoal filter and then in turn by solvents, before analyzing them with gas chromatography–mass spectronomy. Neither method of de-

tection is very sensitive, according to the expert *EBN* spoke with.

A more up-to-date method in compliance with CDPH is to use a cartridge to adsorb VOCs, then pull them off the cartridge with heat rather than solvents, and then analyze the results with spectronomy.

Basically, he said, "It's not clear what chemicals they looked for, and it's not a very sensitive analysis." He added, "This test doesn't indicate that it's a bad product; they just don't have any story related to emissions." A CDPH Standard Method test would cost Air Krete about $3,000, said the expert—not a huge sum for a company marketing a product nationally on the basis of being chemically inert.

As with the R-value claim, Air Krete may very well have low or no emissions, but the company isn't doing a very good job of proving it.

Is something being added to Air Krete?

Throughout *EBN*'s investigation of Air Krete, a question persisted that clashes with the product's image as an inert insulation material: what is that 2% organic material that Christopher refers to, and might it cause harmful emissions?

The question was first raised by an Air Krete customer—the Robertson residence in Georgia (the homeowner did not want to divulge personal details out of concern for privacy). The customer complained that Air Krete, installed in an attic in November 2012, smelled unpleasant—"like latex caulk"—and caused queasiness and other health effects in anyone who spent time in the attic or downwind of the attic hatch. *EBN*

received a small sample of the product installed in Georgia, and while there was a very faint odor coming off the product (distinct from the earthy smell one could expect from drying concrete), we couldn't tell how significant it was (or would be in a closed attic).

EBN spoke with the contractor, Reid Hipp of Energy Logic in South Carolina, who confirmed installing Air Krete at the project but denied that there was any issue. Asked if it was possible that a licensed Air Krete contractor would doctor the formula and add content associated with emissions, Christopher told *EBN* that licensees have the right do that, but he didn't have any knowledge that it was happening.

Two other Air Krete contractors *EBN* spoke with—Greg McMillan of California (who installed Air Krete for 20 years but no longer does), and Douglas Palmer of Maryland, with 32 years of Air Krete experience—said that it was implausible that someone would successfully alter the formula onsite. "Combining the materials is a very meticulously laid-out system," says McMillan, who noted, "I have never experienced any kind of odor."

According to Palmer, "You can't mess with it. It works very well if you leave it be. If you start screwing with it, it does not work at all." He explained that if a hose is kinked, for example, the installer will quickly see that the air bubbles are not forming properly and can fix the problem.

Where there's smoke, what's burning?

As a cement product, Air Krete is not supposed to burn—a major selling point. Online videos show people putting a blow torch to Air Krete—and basically nothing happens, which is just what Christopher and Szabo said should be the case.

Oddly, that wasn't exactly our experience. *EBN* received an Air Krete sample from the Robertson residence in Georgia and an additional sample directly from Air Krete in New York. When exposed to a handheld blowtorch, both samples gave off some smoke. At a close distance, it emitted an acrid odor, browned, and developed white ash on the surface (see photos). Asked why this would occur, Christopher wasn't sure; he said that he is constantly doing research and development, and perhaps he sent us the wrong sample. He offered to send a new one—which hadn't yet arrived at press time.

While neither sample seemed remotely in danger of bursting into flame—consistent with the company's

Photos: Tristan Roberts

Air Krete is mostly cement: it's not supposed to burn. When we applied a blowtorch as shown here to these Air Krete samples provided by the manufacturer and by the Robertson residence in Georgia (on the top and the bottom, respectively), the insulation smoked mildly, browned in spots, and developed a coating of white ash. The samples did not appear remotely close to bursting into open flame, but the test clashes with the company's marketing of the product as completely inert.

claims—the samples' responses to flame seemed to indicate that they contained more than just cement.

For one more angle on what might be in Air Krete, we consulted the Pharos building product and chemical library as well as its senior researcher, Jim Vallette of the Healthy Building Network. Since Air Krete has not engaged with Pharos, the Air Krete information there is based on patent research and other public documents. Pharos lists several organic compounds as possible ingredients in Air Krete, but the main concerns that come up in Pharos have to do with the cement content—the toxicity of residuals in the cement or emissions during cement production. Vallette told *EBN* that his greatest concern about the chemistry was that Air Krete might contain isocyanates, a toxic ingredient in spray foam, but Christopher told us that is not the case.

Confronting cost and distribution

The uncertainties we found with Air Krete aside, it has some wind in its sails with a new distribution agreement through the Dr. Energy Saver network of home improvement contractors. Mike Rubin, product manager for Dr. Energy Saver, based in Connecticut, said that of the 80 contractors the company works with, a handful have started offering Air Krete. "There's a ton of interest, and I really feel like it's about to get blown wide open," he said, noting, "Air Krete didn't have the marketing support that it needed" prior to the new agreement taking effect in 2013. He said that "Air Krete is top of the list" for customers looking for safe insulation materials. At Air Krete headquarters, Szabo said the company would also continue to work directly with its network of 25 to 30 dealers.

Among professionals *EBN* spoke with, demand for Air Krete appeared limited to specialty projects. Palmer said he had three types of customers: those with multiple chemical sensitivities, who might only do one "safe room" in a home to limit expense; those with financial means looking for the greenest product (former Vice President Al Gore falls in this category, with Palmer having insulated his Tennessee residence); and those needing a retrofit for which Air Krete is a good performance fit due to its ability to flow into small voids.

Installed costs for the product vary, with Rubin quoting about $4/ft2 for a first-floor 2x4 wall, or $1 per board foot. Palmer said he charged from 80 cents a board foot to $2, depending on project specifics. Other cost estimators have quoted us $2.45/ft2 for a 2x6 wall, or less than 50 cents a board foot. Those prices put Air Krete well above products like fiberglass and cellulose in cost but competitive with or cheaper than rigid foam or spray-applied foam.

What's ahead for Air Krete?

We can hope that better days are ahead for Air Krete: that the company can do a credible update of its thermal performance and emissions tests, participate in an ingredient disclosure program, and continue to grow its distribution network while maintaining quality assurance. If it can do these things, we remain enthusiastic about its place in the green building industry.

Biobased Interior Panels from Drought-Resistant Sorghum

DurahStyle architectural panels are made in the U.S. from rapidly renewable, drought-resistant sorghum and formaldehyde-free MDI resins.

By Brent Ehrlich

Architectural panels made from rapidly renewable materials seem like a no-brainer. They take pressure off our forests, and many are made from agricultural byproducts (or *agfiber*) such as wheat straw or sorghum stalks that would normally go to waste. But in the past two decades, U.S. agfiber manufacturers have had a difficult time making a profit, and most have closed up shop. The few available products, such as Kirei, are usually made in China.

This may be about to change, however, because ChloroFill—a San Diego company with manufacturing facilities in Missouri—will be launching its DurahStyle sorghum architectural panels in the summer of 2014.

Why sorghum?

According to ChloroFill's founder and CEO, Michael Hurst, he began the company in an attempt to create a healthier, formaldehyde-free building panel but found he could make the product even more environmentally friendly by using readily available sorghum agfiber. These materials usually end up in the landfill or burned, releasing carbon dioxide and pollutants into the atmosphere. "We experimented with several different crops," he said, but sorghum offers unique environmental and performance characteristics compared to most fibers.

There are thousands of varieties of sorghum, but the two most familiar strains are grown for sugars (used for a molasses-like syrup and ethanol) and for grain (used for couscous, gluten-free flour, and livestock feed). ChloroFill uses stalks taken from local sorghum grain production, providing two revenue streams for its Missouri farmers. "It is a hyper-renewable resource," said Hurst. "It grows to full maturity in four months and reaches heights of 12 to 15 feet, so in some areas you can get more than one harvest per year." And sorghum requires very little water. During the 2013 drought in the Midwest, "we did not irrigate our fields at all," Hurst claims. "Our sorghum crop was the only green patch in the entire region."

Low-emitting architectural panels

Hurst did not choose sorghum based on its growth cycle, however. "We settled on sorghum because of good strength-to-weight ratios," he said. The fibers from the sorghum stalks are long and, when layered at appropriate angles and bonded together, they form strong, durable panels. Hurst claims the panel does not chip, has very low

Photo: Michael Hurst

DurahStyle's sorghum fiber creates a striated pattern that can be accentuated or downplayed depending on sanding and coating choice.

water absorption, and in testing has withstood more than 200 freeze-thaw cycles with no warping or deformation. The panels can accept paint or stain and have a unique look that Hurst says gives them an aesthetic advantage over wheatboard and other panels. Though DurahStyle could be adapted for structural applications, it is currently being marketed as an interior architectural panel primarily for use by architects, designers, and furniture makers.

ChloroFill uses methylene diphenyl diisocyanate (MDI) resins as a binder (formaldehyde-based resins are typically not compatible with agfiber). The isocyanates in MDI are severe asthmagens, so appropriate ventilation and other steps have to be taken to protect workers during production, but once cured, MDI-based panels have almost no emissions and pose little risk to occupants, which was Hurst's goal. He said the company is trying to create the most environmentally responsible panel it can and recently completed a Health Product Declaration (HPD) for DurahStyle.

Made in the U.S.

DurahStyle is being manufactured at a recently completed Nodaway County, Missouri, facility from sorghum that comes from local farms. The factory will produce 4'x8' panels in 0.25", 0.5", and 0.75" thicknesses. And though currently focused on architectural panels, the company is looking into other possible markets, including flooring, and Hurst claims the company will be ready to grow as demand builds.

ChloroFill estimates DurahStyle will be comparable in cost to bamboo and other high-end panels, and it plans on selling them through distributors. The company currently has one such distributor lined up in Canada and is "talking with a half-dozen more" in the U.S. as well as some overseas.

Agfiber panel manufacturers have had a difficult time surviving in the U.S. market, but most of those failures have involved wheatstraw products. (the recently revived CAFboard is a notable exception). Will sorghum's drought resistance and unique environmental profile combined with DurahStyle's performance, unique aesthetics, and "Made in America" pedigree be enough to tip the economic scales in its favor? We'll find out soon enough. Look for these products in the summer of 2014.

BACKPAGE PRIMER

Building Products and Health: A Look at Risk vs. Hazard

Use of "hazard avoidance" versus "risk assessment" for understanding toxicity of building materials is hotly debated. Why, and is there a common-sense answer?

The Living Building Challenge and other programs that include "red lists" of substances to avoid are based on the principle of *hazard avoidance*. The idea is attractive in its logic. Certain chemicals are dangerous; we should avoid using those chemicals.

For better or for worse, it's not always that simple. Things can be hazardous in a general sense without constituting any actual risk of harm to anyone in a specific setting. So why avoid using them in that setting? To make the point, consider water: drink too much, and you may suffer from water intoxication, also known as dilutional hyponatremia. But no one wants to put water on a red list.

The chemical industry uses arguments like that one to make the case for a *risk assessment* approach, which is a widely used tool in public policy and industry to estimate the chance that a given substance will actually harm anyone. In risk assessment, one deals with pathways of exposure—typically ingestion, inhalation, or dermal contact—and assumes that if something doesn't get into our bodies in high enough amounts, it won't harm us. No harm, no foul.

There are problems with risk assessments, however.

First, they require making a lot of assumptions about what happens to a product and the things inside it, and their results are sensitive to those assumptions. For example, researchers might assume installers will wear adequate protection, or that a product's recommended installation behind drywall will protect occupants from exposure to the material. Assumptions like these might be controlled by the entity funding the study—often the manufacturer of a substance—which creates an opportunity to minimize perceived risks. In the extreme, one can argue that anything is safe enough to use as long as it's handled correctly, even though we know that mistakes and accidents are inevitable.

Second, the work that goes into risk assessments means that they can take a long time to complete and approve for release. That can lead to delays in useful information becoming available; many exposed workers or building occupants could get sick or even die in the meantime.

Third, risk assessment tends to focus on one particular setting, such as occupant exposure in an office building or worker exposure in a factory. But hazardous substances also create risks for other populations that might not have the resources or political standing to get attention. These include people living in the "fence-line communities" near factories as well as other species and ecosystems as a whole.

Which is the best approach for the building industry? If you are only concerned about health risks in a specific setting, don't mind taking some extra time and effort, and are comfortable with the assumptions involved, risk assessment is a good approach.

If, on the other hand, you want to leverage the buying power of the building industry to drive toxic substances out of the manufacturing stream and out of our buildings, hazard avoidance offers a powerful model. But you still have to determine which substances are problematic enough to avoid at almost any cost (typically these are limited to persistent, bioaccumulative toxic chemicals, along with known and probable carcinogens and reproductive toxicants). You should also seek evidence that proposed alternatives will be better.

Each approach has its advocates, and some groups are using components of each. Either way, integrating transparency into the make-up of our products is helpful, giving us more data so that the design community can make better-informed decisions about which hazards may be too risky.

Traditional risk assessment would tend to tell us that since we won't be exposed to it in normal use, the mercury content in glass thermometers, CFLs, and drywall made with recycled gypsum (from coal power plants) are not concerns. However, risk assessments that account for unplanned events like breakage have helped move the market away from mercury-containing thermometers and CFLs. Meanwhile, a hazard-avoidance approach suggests avoiding mercury use in all these products as a precautionary measure.