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The PVC Debate: A Fresh Look

By Brent Ehrlich

PVC is banned by some green building programs and simply reviled by some groups. How did we get here, and has anything changed since vinyl became the enemy?

"Poison Plastic," "Toxic Plastic," or "Pandora's Poison": There is no shortage of unsavory monikers used to describe polyvinyl chloride (PVC) and the vinyl products made from it.

Few materials have been vilified as much as PVC, which has come under fire by the green building community over the last twenty years for containing hazardous materials and releasing toxic chemicals during manufacture, use, and disposal. All the while, the PVC industry, buoyed by incredible demand for the material, argues that complaints are exaggerated and emphasizes that it is made from "common salt"—implying that it is harmless.

Let's take a look at the history of PVC in the building industry, the realities of PVC production in 2014, and how this decades-long debate has informed our view of building products in general.

PVC: Still Popular

PVC is an extremely versatile plastic resin. It is found in pipe, wire insulation, flooring, window frames, wallcoverings, carpet backing, and a host of consumer products. It can be formulated to be rigid or flexible, clear or opaque, and finished products made from PVC are lightweight, inexpensive, durable, and UV-, chemical-, and corrosion-resistant. This versatility has helped make PVC the third most widely used plastic in the world behind polyethylene (PE) and polypropylene (PP).

A brief history

PVC was first synthesized in its raw form in 1835, but it wasn't until the creation of flexible, or plasticized, versions in the late 1920s that PVC was made into functional products. It was used as a rubber substitute in World War II and in building and consumer goods after the war.

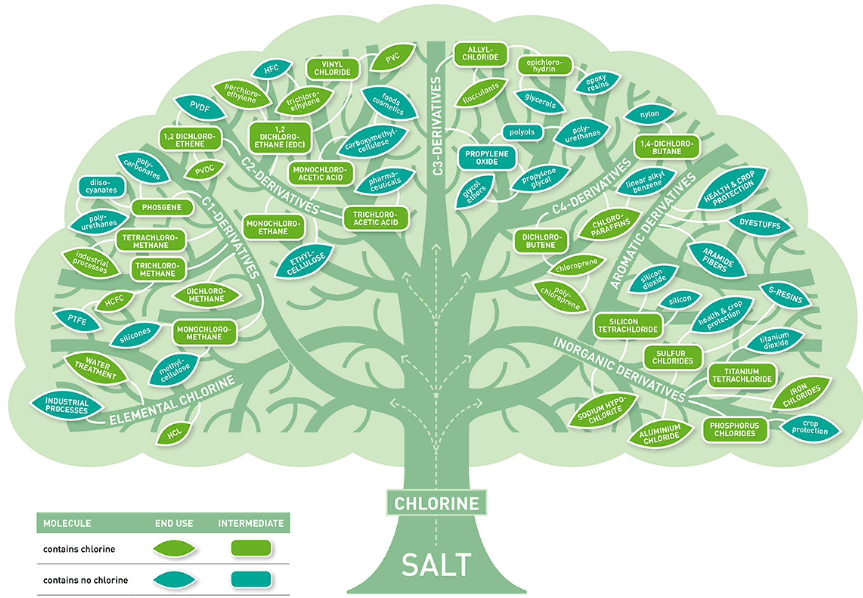
Worldwide, about three million tons of PVC were produced in 1965. And "approximately 7.5 million tons were produced in the U.S. alone in 2012, with more than 70% of that used in the building and housing industries," according to Allen Blakey, vice president of industry and government affairs at the Vinyl Institute.

Through the 1960s, PVC production—like many industrial processes—was not considered particularly hazardous. Vinyl chloride, the "monomer" known as VCM and the primary ingredient of PVC, was even used as an aerosol propellant in hairspray. All this changed in the 1970s, when exposure to VCM was linked to the liver cancer angiosarcoma in workers in PVC plants. The U.S. Food and Drug Administration soon banned its use in consumer goods, and Occupational Safety and Health Administration (OSHA) regulations limited worker exposure, which forced the PVC industry to redesign its production process to reduce emissions.

Photo: The Vinyl Institute

Vinyl, which is inexpensive, durable, and easy to sanitize, was used on the flooring, wallcovering, and ceiling mural of this children's hospital wing. Other hospitals, most notably those owned by Kaiser Permanente, have banned PVC use due to concerns over phthalate plasticizers and life-cycle impacts.

The Chlorine Tree



Source: Euro Chlor

This illustration depicts the uses of chlorine in both end-products and as an intermediary in the production of others materials.

While those moves reined PVC in a bit, its battles were only beginning. In the early 1990s, Greenpeace launched a campaign cataloguing the negative environmental impacts of halogens and chlorine-based industries, focusing first on pulp and paper processing and then on PVC (*EBN*'s oft-cited 1994 article "Should We Phase Out PVC?" was part of that era). According to Bill Walsh, executive director of the Healthy Building Network, "The bond between the halogens and organic matter are so strong, the chemicals provide outstanding performance in their targeted use, but then they are almost impossible to deal with effectively as emissions or waste. PVC comes into play because it is by far the single largest 'sink' for chlorine, or any halogen."

PVC became the most scrutinized building material—even more so in the 2000s when, at the urging of its membership, the U.S. Green Building Council (USGBC) considered a credit for its LEED rating systems that would have discouraged PVC use. USGBC reported in 2007 that other materials can be worse than PVC (depending on the application) and that an across-the-board ban could be counterproductive; but that didn't put an end to concerns, particularly in regard to other ingredients in PVC products, such as heavy-metal stabilizers and phthalate plasticizers. PVC is now restricted in hospitals run by Kaiser Permanente, and green building programs such as Cradle to Cradle and the Living Building Challenge have banned it via red lists.

Amanda Sturgeon, vice president of the International Living Future Institute and head of the Living Building Challenge, summed up her organization's policy: "When we put PVC on the Red List in 2009, we took the precautionary approach because we had concerns about phthalates and chlorine, the limited ability to recycle it, and health of the environment and workers." (See "The Precautionary Principle" for more on that approach.)

"Myths" and "Facts": PVC's Life Cycle

Most plastics are made from carbon and hydrogen—almost always from fossil fuels—with other elements added that provide specific performance characteristics and help determine the plastic's overall environmental impact: polyesters such as polyethylene terephthalate (PET) contain oxygen, for instance, while nylon contains nitrogen. What makes PVC special—and a target of criticism—is that it is made with chlorine.

PVC's life cycle begins with the production of chlorine through electrolysis at chlor-alkali plants. (A mercury-cell process is also sometimes used overseas. More on this later.) Here, an electric current is run through a solution made from rock salt (sodium chloride), separating out the chlorine from the sodium. Sodium hydroxide (also known as lye), chlorine, and hydrogen are collected for use by various industries.

The chlorine is mixed with ethylene, typically from natural gas refining, in a tightly controlled process to form ethylene dichloride (EDC), which is converted to the gas vinyl chloride (VCM). VCM is typically combined with water and additives that cause the monomers to combine and form the polymer PVC; the VCM-to-PVC manufacturing can happen at stand-alone facilities that control the entire process, but often VCM manufacturers such as Dow Chemical sell it to individual PVC manufacturers. A final step in making PVC a useful "vinyl" product is to combine the resin with fillers, stabilizers, plasticizers, and other additives, depending on the application.

The impact of chlorine

Chlorine is found in seawater, table salt, and as part of many compounds formed by plants and animals. Fungi that decompose wood can release chloromethane, for example. According to the American Chemistry Council, half of all chemicals manufactured require chlorine, where it is used as a main ingredient or as an intermediary for other chemical reactions. Chlorine is also used in many of the products and services we rely on daily, including water treatment; pharmaceutical, pesticide, and paper production; mining; and other industries, including the manufacture of many other plastics. But PVC is about 57% chlorine by weight; its production accounts for 35%-40% of the chlorine used in the U.S., and it is the only plastic that uses chlorine as a primary building block.

Common PVC Replacements

Polyethylene: Polyethylene is a thermoplastic (which can be melted down and re-formed) sometimes referred to as "polyolefin" that is available in low-density (LDPE) and high-density (HDPE) versions. It is woven into fabrics, used as carpet backing, and incorporated into TPO (thermoplastic polyolefin) roof membranes. Polyethylene is recyclable, but cross-linked versions (PEX) cannot be melted down or recycled.

Polypropylene: Polypropylene is another thermoplastic "polyolefin." Now found in pipe, TPO roofing, and some carpet applications, polypropylene is durable and resists heat and chemicals. Propylene is byproduct of petroleum refining with few other manufacturing burdens, so it is considered one of the more environmentally preferable plastics.

Polyethylene terephthalate (PET): PET is a thermoplastic common in beverage bottles and often recycled into carpet fiber, carpet backing, and other products. Like many products, it is made from ethylene glycol, which is made from the carcinogen and mutagen ethylene oxide.

Polyvinyl butyral (or **PVB**): Used as the inner layer of car windshields, PVB is recycled into carpet backing as a PVC replacement. PVB is a non-chorinated vinyl product with lower life-cycle burdens than PVC.

Other vinyl materials: The term "vinyl" is often used as a synonym for polyvinyl chloride products, but vinyl is the name associated with a group of materials that can include PVB, polyvinylidene chloride (PVDC; used in Saran wrap), polyethylene vinyl acetate (PEVA; polyethylene/EVA combination used in shower curtains), ethylene vinyl acetate (EVA; used in wire insulation and the foam in running shoes), and polyvinyl acetate (PVA; used in white glue). PVB, EVA, PEVA, and PVA, do not contain chlorine and do not have the same life-cycle burdens as PVC.

Acronitrile butadiene styrene (ABS): A thermoplastic that is used in some pipe and window applications and generally measures lower in life-cycle impacts than PVC. ABS can be damaged by sunlight and burns easily, giving off hydrogen cyanide in the process.

Polyamide (nylon): A thermoset resin that is abrasion resistant, nylon is used primarily in carpet fiber. Carpet fiber can be recycled, but other forms of nylon usually are not. When burned, it gives off hydrogen cyanide.

Polyurethane: A thermoset resin found in many foam cushions, some carpet backings, coatings, and adhesives, polyurethane is typically made with methylene diphenyl diisocyanate (MDI) or toluene diisocyanate (TDI), which are respiratory sensitizers listed as a chemicals of concern by EPA. Polyurethane is considered stable when cured, and exposure risk is limited to workers and occupants. It consumes significant amounts of chlorine during production.

Polylactic acid (PLA): PLA is a biobased polyester usually made from corn or sugar converted into lactic acid, which is then polymerized using bacteria. It can be used in fabrics, wall coverings, and other products. PLA can biodegrade over time, unlike most other plastics, but its production may include the use of fertilizers, pesticides, and genetically modified crops, and may involve other agricultural impacts, such as eutrophication.

Polyhydroxyalkanoate (PHA): Often made by bacteria fermenting sugars or fats, PHA has seen limited application so far, but a new process that uses carbon from methane produced by agriculture offers promise and is now being used in seating. Though PHA is usually biodegradable, rigid forms may not be.

Greenpeace started working against PVC because it is the "low- hanging fruit" for reducing overall chlorine consumption, according to Walsh, and because, among many reasons, PVC can often be replaced with less harmful, non-chlorinated options.

Whether PVC is the right target is a point of contention in the PVC wars. Though PVC's use of chlorine is significant, chlorine is used extensively in compounds that are intermediaries in the production of other building materials: polyurethane uses approximately 20% of the nation's chlorine; silicon and fluoropolymers 6%; and epoxies 4%. Even titanium dioxide, which is valued for its white pigment in many consumer and building products, including the majority of paints, uses chlorine as a critical processing chemical.

What's wrong with chlorine, anyway?

Chlorine, along with other halogens (namely bromine and fluorine), is extremely reactive and can combine with other compounds to form *persistent, bioaccumulative toxic chemicals (PBTs)*. Some of these include polychlorinated biphenyls (PCBs), polychlorinated dibenzofurans (PCDFs), and polychlorinated dibenzo-*p*-dioxins (PCDDs, or dioxins)—all of which are listed by the Stockholm Convention as *persistent organic pollutants*, or POPs. The most toxic dioxin is 2,3,7,8 tetrachlorodibenzo-*p*-dioxin (TCDD), which is listed as a Type I carcinogen by the International Agency for Research on Cancer (IARC) and has been implicated in a long list of other non-cancerous health issues, including endocrine disruption, compromised immune systems, and reproductive problems. Potentially hazardous doses of dioxin are small—measured in nanograms—and these substances build up in the environment and in human and animal tissue, so they are of particular concern.

Because chlorine compounds are common in the environment, dioxins and "dioxin-like" byproducts can be formed when almost any material is burned, especially at temperatures between 752°F (400°C) and 1,292°F (700°C); so any incomplete combustion, even of "natural" materials (from logs and paper to charcoal to cigarettes), produces dioxins. Chlorinated materials like PVC, chlorosulfonated polyethylene rubber, and chloroprene rubber (Neoprene) contain particularly large amounts of chlorine, however, so they produce more dioxin when burned at the wrong temperatures.

PVC and dioxins: Not so fast

Dioxins can also form during the PVC manufacturing process as EDC is converted to VCM. In 1993, Greenpeace estimated dioxin emissions from VCM production to be 5–10 grams per 100,000 metric tons, based on monitoring of four European facilities. Using the same monitoring equipment, however, the European vinyl industry produced data for these same facilities showing much lower numbers. The differences were attributed to Greenpeace's adjustments of the data to account for other *estimated* emissions, such as from waste products and other releases not measured by the monitoring equipment. These data adjustments, the limited sample size, and differences in PVC manufacturing facilities made it hard to extrapolate results to the U.S.

Data from a 2013 U.S. Environmental Protection Agency (EPA) draft document, which is still in review phase and out for comments, estimates releases of dioxin into the air from standalone PVC facilities to be 0.62 g/100,000 metric ton. These numbers are consistent with the EPA's Toxics Release Inventory (TRI) emissions data from PVC manufacturing facilities, which also show a 79% drop in air and water dioxin levels from 2000 to 2012, based on cradle-to-resin production.

The Vinyl Institute points out that PVC production also increased significantly during this time, suggesting that PVC manufacturing is not as much of a source of dioxin as is often implied. On the other hand, other potential dioxin releases into the environment, such as from accidental leaks, landfill fires, or hazardous waste sent to incinerators, are not included in the data, so overall emissions are likely to be higher. The different ways of estimating these emissions are at the core of the debate about whether the PVC industry is underestimating emissions, or, from the industry's perspective, whether anti-vinyl dioxin claims are accurate.

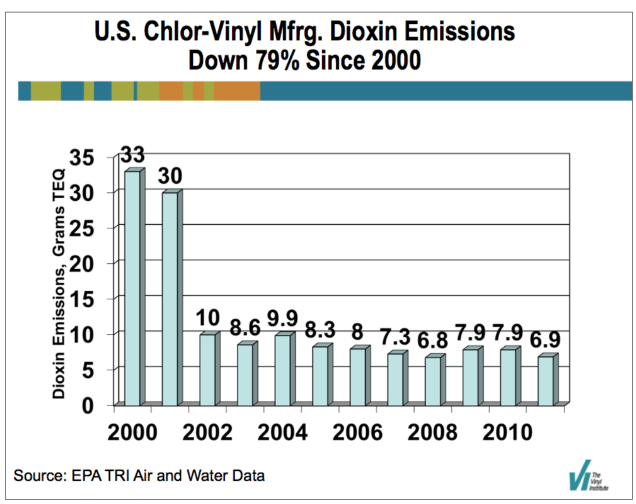
Is PVC the right target in reducing dioxins?

"Whenever critics have talked about dioxin, they have almost always pointed toward PVC but not to any of the other sources," said the Vinyl Institute's Blakey, and he has a point—sort of. According to the 2013 EPA draft document, the three largest emitters of dioxin are forest fires, "backyard barrel" burning, and medical waste incineration. PVC manufacturing is not in the top five. Good news for vinyl, right? Not so fast: though PVC *manufacturing* is not at the top of the list, the PVC contained in plastic waste is a significant chlorine source from backyard burning and from medical waste incineration and, hence, another way that PVC contributes to dioxin emissions.

That makes it worthwhile to target PVC, according to Mike Schade, former markets campaign coordinator at the Center for Health, Environment, and Justice (CHEJ recently shuttered this program). "If you look at the EPA dioxin inventory, you'll see that waste sources are the major source of dioxin in the U.S.," he said. "PVC is the primary chlorine donor to those sources, and thereby a major and preventable source of dioxin." Schade also points out that if you look at individual facilities instead of industry sectors (or broad phenomena like forest fires), some of the top individual industry sources of dioxin come from manufacturers that make chlorine-based products that include VCM.

As with chlorine consumption, PVC is not the only dioxin culprit. Polyurethane, which is specified as a PVC replacement in carpet backing, is also a major source of dioxin from chlorine-based intermediary chemicals used in the manufacture of isocyanates, according to Jim Vallette, senior researcher with the Healthy Building Network. Pound per pound, his research indicates, they are nearly equal during the manufacturing phase, though, again, PVC can also create dioxins if incinerated improperly, whereas polyurethane does not contain chlorine as a primary ingredient, so emissions from incineration would be much lower. Even so, "the only thing that is keeping polyurethane from releasing as much dioxin as PVC is scale of production," Vallette told *EBN*. Epoxies used in a number of building applications also use chlorine-based intermediaries and are also a major dioxin emitter—not to mention their use of bisphenol-A, an endocrine disruptor, as a feedstock.

Decrease in Dioxin Emissions



Source: The Vinyl Institute

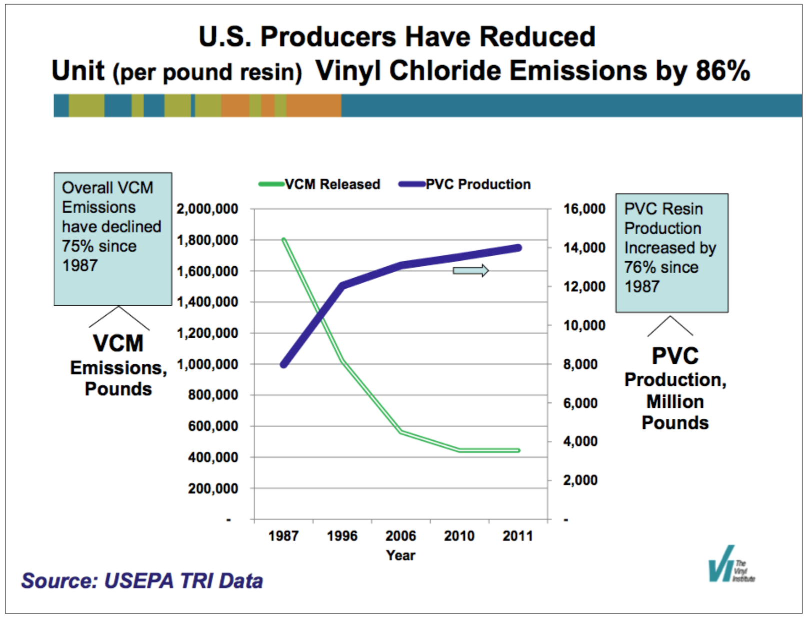
This Vinyl Institute graph shows cradle-to-cradle dioxin emissions from chlorine-vinyl manufacturing. It is based on EPA's Toxics Release Inventory data, which is reported by manufacturers and does not include all vinyl production or account for accidental releases or spills.

Mercury then and now

Mercury emissions from mercury-cell chlor-alkali facilities are often cited as a reason not to use PVC. In 1992, 14% of U.S. chlorine production came from these facilities, but there are only two mercury-cell chlor-alkali plants still operating in the U.S., and neither are used for PVC, according to the Vinyl Institute. The industry claims this is another myth perpetuated against vinyl. But if we look at mercury contamination as a global problem, the Vinyl Institute's assertions may provide cold comfort.

There are still 75 of these facilities in use throughout the world, according to the UN's [Global Inventory of Mercury Cell Chlor-Alkali Facilities](), and that figure doesn't include China, one of the world's largest PVC producers. To make matters worse, China does not have a large natural gas supply, and according to the International Conference on Mercury as a Global Pollutant (ICMGP), "Sixty-three percent of China's PVC production comes from a process that uses calcium carbide as feedstock. This process absorbs 7,000 tonnes of mercury catalyst, 770 tonnes of mercuric chloride and 570 tonnes of straight mercury each year." This production process makes it "the largest mercury consumer not just in China, but the world," according to the ICMGP. So while projects using U.S.-made PVC products may not be contributing to mercury pollutions, those specifying PVC abroad should vet materials carefully.

Decrease in Vinyl Chloride Emissions



Source: The Vinyl Institute

This Vinyl Institute graph shows cradle-to-cradle vinyl chloride emissions from PVC manufacturing from 1987 to 2011. It is based on EPA's Toxics Release Inventory data, which is reported by manufacturers and does not include all vinyl production or account for accidental releases or spills.

Releases of vinyl chloride still a problem

VCM was identified as a liver carcinogen in the 1970s (its precursor EDC is also a probable carcinogen), and it has since been linked to blood, lung, and brain tumors as well as other health problems. VCM is a volatile, explosive gas with an OSHA exposure limit of 1 ppm (VCM) averaged over eight hours, the same limit as benzene. VCM can be released into the environment from PVC manufacturing facilities, accidental releases such as spills or equipment malfunctions, and as the result of chlorinated solvents and other chemicals breaking down in the environment. At the U.S. Marine Corps Base at Camp Lejeune, for instance, VCM was detected as part of the base's extensive groundwater contamination. In this case, the breakdown of the dry cleaning fluid trichloroethylene and other solvents led to the VCM contamination, which was not caused by PVC. VCM leaching from landfills may come from similar contamination.

PVC resin undergoes a steam process that removes residual VCM, and additional VCM is driven off during product manufacturing, leaving very little in finished products. Potential leaching of VCM from PVC pipe that comes into contact with drinking water has still been of particular concern. In a [2011 study published in *Water Research*](), VCM leaching from PVC pipe was below EPA's maximum contaminant level (MCL) of 2.0 micrograms per liter, but some samples exceeded the MCL-Goal of 0 micrograms. These readings varied depending on the source and age of the PVC, with products from Japan and the U.S. produced after 1977 showing less leaching. Water sanitized by chlorination appears to be a factor in formation of VCM in these products, however, as VCM was even produced in copper pipe.

The Vinyl Institute's Blakey stated that "when production went from a small-batch, open-vat process to a closed loop, it virtually eliminated VCM [exposure] in workers." His organization points to EPA Toxics Release Inventory data that shows VCM emissions since 1987 have declined by 75% as PVC production increased by 76%.

But not everyone is convinced by this data.

Wilma Subra, environmental chemist and president of the environmental consulting firm Subra Company, has lived and worked near Louisiana's petrochemical industry her entire life. She acknowledged that establishing the EPA Toxics Release Inventory helped reduce emissions and said, "The production process is getting cleaner, especially for the workers," but added, "they [the PVC industries] are not looking at the impact that is happening outside their fence line."

Subra, who won a MacArthur Award for her work assisting low-income individuals and communities affected by industrial pollution (petrochemical facilities are typically located in low-income neighborhoods) said that accidents, off-site discharges, and emissions not tracked by the Toxics Release Inventory are the real problem. “They have a huge number of accidental releases,” she said, such as the 180,000 pounds of VCM released from a train derailment in Paulsboro, New Jersey, in 2012 or the more recent December 2013 explosion and fire at the PVC Axiall Corp’s manufacturing facility in Westlake, Louisiana. EPA fined Axiall for VCM spills totaling more than 300 pounds in 2012–2013 alone, according to news station KATC. “I’ve been tracking this since the late ’70s,” Subra said, “and when you look at the number of releases, it is still very, very high.”

She says tighter regulation and enforcement would help but that inspections are not as frequent as they need to be, partially due to the massive size, number, and complexity of facilities. Though all industries, including those that make other plastics, have accidents, the scale of production and the toxicity of VCM make releases particularly problematic.

Photo: InPro

InPro’s G2 wall protection panels, corner guards, and handrails are made from G2 BioBlend bio-based PETG. They offer the same performance as vinyl with approximately a 10% price premium.

Lead and other stabilizers

Stabilizers are added to all PVC to protect the resin from degrading while being formed into products, and to protect them from light and heat during use. Rigid PVC requires more effective stabilizing because of heat formed during extrusion.

Designers and architects have been especially concerned about exposure to lead and other heavy-metal stabilizers, such as cadmium, from interior products, but cadmium and lead are rarely used in the U.S. Though cadmium can be found in some colorants in plastic, lead now makes up less than 1% of the U.S. stabilizer market; today, it is found in wire insulation where added durability is required.

Calcium-zinc, barium-zinc, and organotin stabilizers have replaced cadmium and lead, and in the U.S., organotins—compounds made up of tin and hydrocarbons—are used in the majority of pipe and rigid PVC. There are many different organotins with different toxicities; some are banned in Europe, while others are approved by the FDA for food applications. Tributyltin is sometimes erroneously linked to PVC but is a biocide that is not used in PVC production. All organotins are on Living Building Challenge and Perkins+Will red lists. The PVC industry has responded to environmental concerns by offering less toxic calcium-based and organic stabilizers.

It’s not the PVC: It’s the plasticizers

PVC is available in a rigid, unplasticized form (uPVC) used in pipe and window frames, but flexible PVC found in wallcoverings, flooring, and carpet backing contains plasticizers. Plasticizers essentially provide a lubricant between PVC molecules, and because they do not form a strong chemical bond with the resin, they can easily leach out, especially in contact areas such as flooring and wallcoverings—which can contain more than 50% plasticizer.

Phthalates are the most common plasticizers, and those with three to six carbon atoms (low-molecular-weight phthalates) are reproductive toxicants and have been associated with asthma, obesity, and other health problems. They are listed as “substances of very high concern” by REACH (the EU’s Registration, Evaluation, Authorization, and Restriction of Chemicals program) and are banned in Europe but not in the U.S. The most common of these, DEHP (di-2-ethylhexyl phthalate) is still in use in the U.S. in a wide range of products, including medical equipment.

Susan Walter, senior project architect at Wilmot Sanz Architecture + Planning, learned about phthalates in her work in healthcare. Studies showing DEHP leaching from tubing and IV bags used in hospitals were an epiphany for her. “For me, eliminating PVC from hospitals did not start with the PVC, but with DEHP.”

Lead in Global PVC

In Europe, lead was banned from use in pipe in 2005 and will be phased out of PVC production completely by 2015, but statistics on lead use in PVC in the rest of the world paint a bleaker picture.

According to Plastics News, lead is still used in 95% of PVC pipe in India, 86% in the Middle East and Africa, and 61% in South America. And although China passed regulations in 2006 banning lead in PVC, it is still used in an estimated 90% of pipe applications there. The Vinyl Institute’s Blakey doubts much PVC pipe is coming over from China due to the low relative cost of U.S. production and inefficient shipping (pipe shipments are mostly air), and any PVC pipe used for water in the U.S. has to meet the “lead-free” 2014 NSF/ANSI Standard 61 of 0.25 percent by weight.

Most U.S. manufacturers have moved to phthalates such as diisononyl phthalate (DiNP), said Blakey, but the full health impacts of these replacements are not clear. In December 2013, California added DiNP to its Proposition 65 list of cancer-causing agents, and the entire class of phthalate chemicals has been banned in children's toys in Europe and in many green building programs worldwide.

Non-phthalate plasticizers have been developed to fill the niche and are being used by InPro in its flexible wall and corner guards and by Tarkett in select PVC flooring. Upofloor uses a castor oil-based plasticizer in its vinyl flooring products but also offers PVC-free, phthalate-free resilient flooring.

End-of-life concerns

One of PVC's biggest problems is what we do with it at the end of its service life.

PVC can be placed in a landfill (many landfill liners are made from flexible PVC), and in theory, incinerating chlorine-containing materials such as PVC can be done safely in modern facilities under the proper temperature and other conditions—but many incinerators do not operate under ideal conditions, and many older PVC products coming out of service contain heavy metals and other hazardous materials.

PVC is a thermoplastic that can be easily melted down and re-formed (as opposed to a thermoset plastic, which cannot be re-melted), but recycling it gets complicated: it melts at a lower temperature than some other plastics and introduces chemicals that can break down PET during recycling, contaminating the resin. In the past, PVC products labeled #3 had to be hand sorted out of waste streams to prevent this issue, but automated optical scanners and x-ray technology that detect chlorine have simplified PVC removal. Still, there are more than 100 different varieties of PVC resin, and each finished product has its own blend of additives, so unlike standardized, disposable clear PET bottles, which are recycled in high volume and offer a clean end-product, most PVC products in the building industry are durable goods, and there is little infrastructure or economic incentive to recycle them in the U.S. In Europe, PVC recycling is more common.

Within individual industries, PVC take-back programs have had some success, however. PVC siding offcuts, carpet backing, resilient flooring, and even pipe are now recycled into new products. Still, manufacturers have to carefully vet the material so it meets quality and sustainability objectives, such DEHP avoidance, and use the materials wisely to avoid exposing occupants to older chemistry (such as encasing recycled PVC in new PVC in pipe systems).

Interface's sustainability roller-coaster

The standard-bearer for PVC recycling is the carpet industry—specifically Interface, whose founder, Ray Anderson, famously introduced sustainability initiatives that inspired similar efforts across the entire carpet industry.

For Interface, PVC-backed carpeting goes hand-in-hand with its recycling efforts, which has been a double-edged sword for the company. Mikhail Davis, director of restorative enterprise at Interface, acknowledges that perceptions from some in the green building industry have gone from industry thought leader to a company that "doesn't get it," but he offers a nuanced view of PVC and recycling.

"We understand there are significant issues with the life cycle of PVC," Davis said, "but materials with serious life-cycle and environmental impact issues are the rule, not the exception." Interface links recycling and sustainability and has sought materials that work in a closed-loop process with a focus on durability and performance. "You have to look at recyclability," he said. "Can we make safe use of the incredible amount of materials already in the waste stream, even if they are not perfect, and avoid the larger toxicity impacts of sourcing virgin materials from the oil and chemical industries?" he asked. "Is it 'one and done,' and your material still ends up in the landfill rather than solving the larger system problem?" Using recycled PVC is a challenge, though. Interface has tested and rejected more than 50 post-consumer vinyl streams due to their additives, according to Davis.

The company uses recycled PVC in its GlasBac RE-backed carpets, which boast 79% recycled content, including 25%–30% post-consumer vinyl backing, and can be recycled up to seven times with no loss in performance. He claims that other materials, such as lighter-weight polyolefins, break down after as few as two cycles and then have to be "down-cycled" or disposed of. Interface has a goal of using 100% recycled PVC by 2020 but is also looking for alternate materials. He claims the company worked on a PVC replacement (including PVB, which is used by other carpeting companies) but none met its performance require-

Photo: Interface

Interface uses recycled PVC because of the amount of this carpet backing still in the waste stream. PVC selected by Interface has been vetted for heavy metals and low-molecular-weight phthalates, and it can be recycled seven times without losing performance, according to the company.

ments, and the company deemed toxicity concerns with softeners in those plastics to be no improvement when compared with PVC.

Industry Initiatives and Transparency

The relationship between the vinyl industry and the green building movement has been contentious, with little, if anything, counting as dialogue between the two sides. Technical and substantive information on environmental challenges of PVC [don't appear anywhere on the Vinyl Institute's website](). Instead, its "Advocacy" section focuses primarily on political action to promote vinyl industry interests.

Compare this with Europe, whose major vinyl trade organization, PVC Europe, provides detailed information on ingredients and regulations and has a long-established voluntary program for reducing the impacts of PVC production and use. The organization's VinylPlus initiative has its own website and sets up "challenges" and deadlines for increasing recycled

PVC Building Products and Their Alternatives

Summing up the environmental and performance attributes of the many PVC alternatives in a few sentences is an impossible task, but we have attempted a summary of common PVC applications and alternatives here. For more detailed guidance, see GreenSpec and the related *EBN* feature articles linked from the main article.

Material	Environmental & Performance Attributes
WINDOWS	
Vinyl	Vinyl windows use un-plasticized PVC (uPVC) and are often less expensive than other frame materials. Vinyl expands and contracts more than other materials during temperature swings, but manufacturers claim this is not an issue, and fiber-reinforced PVC is used by many European manufacturers. Embodied energy of vinyl windows is significantly higher than that of wood and wood-clad alternatives.
Fiberglass	Fiberglass is typically polyester with glass-fiber reinforcement. It expands less than PVC and does not contain chlorine in the end product. Fiberglass curing at plants emits toxic chemicals.
Wood	Wood windows have low embodied energy and insulate well but need protection from the elements and may require more maintenance than other materials. Sustainably harvested wood is preferred.
ABS (Acrylonitrile butadiene styrene)	While manufactured using toxic chemicals and not readily recycled, ABS typically scores better than PVC in health and environmental impacts. ABS typically does not stand up well to weathering, but it can be engineered to do so.
Aluminum	Though less commonly used for residential windows, aluminum is the standard material for many commercial windows because of its workability and durability. Aluminum windows require robust thermal breaks to avoid heat loss. Although aluminum is recyclable, bauxite mining and aluminum processing (including recycling) are extremely energy-intensive, leading some to refer to this material as "embodied electricity."
CLADDING	
Vinyl	Vinyl siding uses un-plasticized PVC (uPVC) and is popular not for its aesthetics but due to its low cost and low maintenance, including no need for re-painting. Life-cycle impact studies give it mixed ratings—better than aluminum, worse than wood, and mixed against fiber cement.
Composite	Composites are typically made from wood or paper and a phenol-formaldehyde binder. They often have FSC-certified content but are energy-intensive to produce and not as durable as some other materials.
Wood	FSC-certified and reclaimed wood products are available. Cedar varieties provide natural resistance to weathering, fungi, and insects. The overall impact of wood siding is low, but it typically requires primer, paint, and/or stain as well as regular maintenance, all of which increase its environmental burden and cost.
Fiber Cement	Fiber cement is made from portland cement, wood, and other additives. It is very durable and holds paint well. The portland cement contributes to its life-cycle impact, which is moderate.
FLOORING	
Vinyl Composition Tile and Sheet Vinyl	Vinyl composition tiles (VCT, vinyl with a high percentage of limestone) and sheet goods use plasticized PVC, commonly with toxic phthalate plasticizers. Emissions from stripping and waxing add to health impacts. These products typically cost less than other flooring alternatives, although that is less true with more durable vinyl products.
Rubber	Rubber flooring uses recycled material. Though many rubber products are Floorscore-certified for low emissions, GreenSpec does not recommend them for enclosed indoor spaces.
Linoleum	Linoleum is made from renewable wood flour and rapidly renewable linseed oil and jute. It is durable and low-maintenance. It consistently scores favorably on life-cycle impacts.
Limestone with Ethylene Acrylic	Made primarily from limestone along with ethylene-methacrylic acid copolymer, a thermoplastic resin binder, this flooring has a lower overall life-cycle burden than PVC and requires little maintenance.
Limestone with Biobased Binder	Tiles are 85% recycled limestone by weight and use a corn-based polyester instead of PVC.
Cork	Harvested from the outer bark of the cork oak, cork flooring is resilient and rapidly renewable, and it scores consistently well in life-cycle impacts—though is not typically as durable as other options. It is available with FSC-certified content.

PVC Building Products and Their Alternatives, continued

Material	Environmental & Performance Attributes
CARPET BACKING	
PVC	Plasticized PVC carpet backing provides durability and ease of recycling. Most manufacturers offer high levels of recycled content. Life-cycle assessment shows generally low impacts.
Polyolefin	Polyolefin is considered a "cleaner" plastic than many. There is no chlorine in the end product, and it is recyclable, though its durability has been questioned.
PET (Polyethylene terephthalate)	Made from recycled bottles, PET carpet backing can be further recycled, but usually with a loss in performance. PET is considered a relatively "clean" plastic.
PVB (Polyvinyl butyral)	Made with recycled laminate from car windshields, PVB carpet backing is relatively low in toxicity.
Polyurethane with PVB (Polyvinyl butyral)	Some carpet backing combines PVB recycled from car windshields with polyurethane. Polyurethane is difficult to recycle and is implicated in many of the same impacts as PVC, such as dioxin emissions.
Proprietary Thermoplastics	Thermoplastic carpet backings whose ingredients are trade secrets have unknown toxicity risks and recyclability, but some products have earned NSF-140 Platinum.
Wool	Wool carpet and backing provide a natural material that is durable and naturally flame resistant. However, wool is not UV-resistant and can have significant life-cycle concerns due to agricultural impacts, including intensive water and carbon footprints, eutrophication, and pesticide use.
WALLCOVERING	
Vinyl	Vinyl wallcoverings use plasticized PVC. These products are known to contain high amounts of toxic phthalate plasticizers.
Polyolefin (TPO)	Though petroleum-based, polyolefin is considered a "cleaner" plastic, with no chlorine in the end product.
Polyurethane	Polyurethane is implicated in some of the same production impacts as PVC but does not contain chlorine in its end product, reducing end-of-life concerns.
Natural fibers	Natural materials such as flax, silk, sisal, and others are rapidly renewable but are not suitable for high-wear applications.
Woven glass	Woven glass is not made from plastics or associated toxic chemicals and is available at a price comparable to that of many vinyl products.
Polyethylene	Woven polyethylene is durable and contains no chlorine or plasticizers; a biobased version is available.
PIPING (Supply and Drain/Waste/Vent)	
PVC	PVC and CPVC (which has added chlorine for durability and stability) are ubiquitous due to their low cost, corrosion resistance, and durability. Made from unplasticized PVC (uPVC), they require toxic solvents for installation but have moderate life-cycle impacts.
Polypropylene	Polypropylene is considered a "cleaner" plastic, with no chlorine in the end product. It is recyclable and highly durable and has heat-fused joints.
PEX (cross-linked polyethylene)	Cross-linked polyethylene does not contain chlorine and has relatively low life-cycle impacts. It uses mechanical fastening rather than solvents for installation. It cannot be recycled.
Copper	Though it is recyclable, copper's environmentally intensive extraction and manufacturing process make it a worse performer in terms of life-cycle impacts than PVC.
Cast Iron	Though recyclable, cast iron piping has very high life-cycle impacts due to pollution during manufacturing.
ABS	While manufactured using toxic chemicals and not readily recycled, ABS typically scores better than PVC in health and environmental impacts.
WIRE INSULATION	
PVC	PVC is ubiquitous in wiring. Although heavy-metal stabilizers have been mostly eliminated from U.S. wire insulation, they are still used in specialty applications and in other countries.
Halogen-Free Alternatives	Halogen-free wire insulation may use metal, PEX, or other materials (depending on end use). These alternatives can be hard to find and much more expensive than PVC in most applications.
LOW-SLOPE ROOFING	
PVC **Asphalt and Built-Up Roofing (BUR)** **TPO (thermoplastic olefin)** **Metal**	Overall environmental and health impact of low-slope roofing is highly sensitive to the roof's service life—less replacement means less use of materials—and the possibility of recycling. With proper maintenance, any low-slope roofing can last decades, although in EBN's research, metal has the greatest potential life-span. Service life aside, BUR has substantially greater impact than other options, with PVC typically coming in second. EPDM and steel vie for the lowest impact in most life-cycle categories. There is little data on TPO, but it is considered a "cleaner" plastic than PVC. Additives and potential for leaching can vary within the same roofing material and can add to health concerns.

Source: BuildingGreen, Inc.

content and refining that process, reducing organochlorine emissions, and addressing additives such as stabilizers and plasticizers. Products in Europe have to meet REACH standards for numerous chemicals, whereas vinyl products in the U.S. have fewer restrictions and often rely on optional standards, such as NSF/ANSI 342: Sustainability Assessment for Wallcovering Products, that have a history of recognizing conventional vinyl products, apparently doing little to push companies to address environmental or material life-cycle safety concerns.

Though Blakey said there is little practical difference between the U.S. PVC industry and European manufacturing, the lack of meaningful dialogue between the Vinyl Institute and the green building community only worsens PVC's reputation.

The Vinyl industry acknowledges this tension exists. John Serrano, the Vinyl Institute's marketing and communications coordinator, told *EBN*, "One of the things we are trying to do is cut through some of the antagonistic relationships that have existed and allow people to understand that we are behind transparency and sustainable design and construction." Perhaps the industry is changing, but if so, recent actions suggest that not everyone has gotten the memo.

Along with the American Chemistry Council, the vinyl industry has fought changes in LEED v4 that address chemicals of concern (including spreading misinformation on LEED policy on multiple occasions) and has backed LEED competitors. And in response to Health Product Declarations, the Resilient Floor Covering Institute (RFCI), whose members are predominantly vinyl flooring manufacturers, came up with their own ingredient disclosure label, the Product Transparency Declaration (PTD) (see "Vinyl Group Launches Reporting Label for Toxic Chemicals"). Lobbying efforts and other initiatives typically downplay health and environmental impacts from the product's whole life cycle while also calling for life-cycle assessment (LCA) as the only "scientific" way to assess sustainability. Notably, LCA focuses on energy, water, and waste and does a very poor job of quantifying health hazards and environmental pollution from a material's life cycle. These programs' health focus is narrow, emphasizing VOCs and ignoring the semi-volatile phthalates that remain the major health drawback of many vinyl products.

Without better industry communication, regulations, and disclosure of chemical ingredients, end-users have taken matters into their own hands. When healthcare giant Kaiser Permanente first began compiling a list of chemicals of concern in the early 2000s, its priority was protecting public health, said John Kouletsis, the company's senior vice president of facilities design and planning. "We started out with the precautionary principle based on as much scientific evidence as we could find," he said, and at the time there was a lot of information coming out about PVC and dioxins. PVC was put on Kaiser's list, and the organization reached out to carpet and wallcovering manufacturers to ask for PVC-free alternatives with similar performance and price, which didn't exist at the time.

Instead of pushback, Kaiser discovered, "we were the first people to ask, and it turned out they [manufacturers] didn't want to be using products that had health concerns either." In the years that followed, major carpet and wallcovering manufacturers worked to provide these products, and healthcare competitors began asking Kaiser for its list of suppliers, which, in the spirit of health and transparency, it provided, according to Kouletsis.

Companies that use PVC, such as Interface and InPro, have piloted development of environmental product declarations (EPDs, which show life-cycle impacts from cradle to grave) and the Health Product Declarations (HPD, which provides material health data). "Transparency has been a big game changer by changing the tenor of the dialogue," Davis explained. Instead of having a confrontation, "People are able to have an in-depth, nuanced conversation because they (manufacturers) are putting ingredients and environmental impacts on the table, where you can talk about tradeoffs in a real way." (For more, see "The Product Transparency Movement: Peeking Behind the Corporate Veil.")

InPro has an EPD on its biobased PETG G2 rigid wall panels as well as on its vinyl offerings. "We were part of the pilot program back in 2012," according to InPro's sustainability expert Amanda Goetsch, "and since then, we have released 60 HPDs." The company has learned a lot about its PVC products through the HPD process. When residuals and colors and pigments showed up as carcinogens, "that opened our eyes as to what we can improve on."

HPDs required InPro to get product information from PVC manufacturers, and according to Goetsch, those companies have been very responsive to InPro's information requests and are willing to engage, contrary to industry perceptions. PVC supplier Axiall partnered with InPro to develop the company's PVC with a biobased plasticizer and organic, non-heavy-metal stabilizers, and "in May 2013, we are holding our first supplier transparency summit." The HPDs have been more of a challenge for the company's G2 product, however. The company is waiting for its patent before releasing the G2 HPD due to concerns about revealing proprietary ingredients (though HPDs can accommodate this).

The Tangled Web of PVC

Like the twisted network of pipes carrying oil, gas, and industrial chemicals for miles between and through plants in the American south and elsewhere, PVC itself is a labyrinthine tangle. Following one path can lead to snarl after snarl of complexity, from the direct impacts of PVC to those of its additives, and the impacts of other plastics and replacements.

Whether in reaction to the severity and persistence of PVC's impacts, the sheer volume of information on impacts, the denial and misinformation from the PVC industry, or other factors, many green building professionals are simply opting to ban or avoid PVC, and are trying to find safer alternatives. Others continue to specify PVC, particularly when it is perceived as the best fit for durability, cost, or other reasons. "There is definitely an interest (from building owners) in reducing PVC but not in eliminating it in all applications," said Wilmot Sanz's Walter. When she uses PVC, she prefers products without phthalate plasticizers that will be used in applications where the PVC will last the lifetime of the building. "In a plumbing product, it will last; in a flooring product, it will not."

Whatever path they're on, designers like Walter often have had to educate themselves. "Most designers don't have the time, energy, or inclination to keep up on green chemistry," she said, but she sees it as an important part of her job. "When you are trying to make better choices and a client only wants a PVC floor tile, you can start to have a conversation about plasticizers and other sustainability issues," she said. "It is a matter of keeping the conversation open and being open to pulling them along on a sustainability pathway."

What is the future of PVC?

Though PVC still has some significant life-cycle concerns, the industry in the U.S. has cleaned up its act over the last 20 years, and part of that success has to be attributed to public awareness generated by groups like Greenpeace, the Healthy Building Network, and programs like the Living Building Challenge. While a full phase-out of PVC, as proposed by Greenpeace more than 20 years ago, is nowhere close to being realized, the advocacy of these organizations has contributed to some projects going PVC-free, others to selectively finding alternatives, and to arguably safer products all around.

For those continuing the push to replace all PVC, there are no guarantees. "We have all talked about new chemicals that we don't think are tested well enough," said Kouletsis, "but it scares us to think that we got PVC out but might have put a new plasticizer in that might be just as bad." For the Living Building Challenge Red List, which tracks new chemical hazards, "When we are asked what material to red flag, almost any composite plastic material is going to be a challenge," Sturgeon said, adding that the point of the list is to drive development of and demand for safer materials. If PVC replacement materials show similar or worse environmental profiles, those too will be added to the list, she confirmed. LBC's red list is up for revision in the spring of 2014, and it would be a surprise if PVC weren't on it—but the goal is to encourage change. "Maybe a great result of us having PVC on the red list would be that PVC industry does transform," Sturgeon said. "That would be a great outcome."

NEWS

Report Warns of Asthma-Causing Chemicals in Building Products

The Healthy Building Network (HBN) is urging building product design and selection to account for asthmagens, but some question whether its precautionary approach is premature.

By Candace Pearson

The Healthy Building Network (HBN) has released a report that calls for new asthma prevention strategies after finding many chemicals associated with asthma are present in building materials and might have exposure pathways that are rarely considered.

The report is largely based on "logical arguments," in the words of a coauthor, and does not introduce new empirical evidence attributing chemicals in building materials to the rising rates of asthma—rates that are not completely understood by scientists but are generally linked with respiratory infections and exposure to airborne irritants.

The HBN report, "Full Disclosure Required: A Strategy to Prevent Asthma Through Building Product Selection," finds that materials like flooring, carpet, insulation, and paints commonly contain *asthmagens*, chemicals that can cause asthma to develop. The report outlines substance profiles for 50 asthmagens and identifies 28 as top priorities based on whether occupants have a reasonable chance of being exposed during product installation or use.

The report also points out weaknesses in emissions-based IAQ protocols and suggests that screening for material content in addition to emissions is the best way to prevent exposure.

High-priority chemicals

Researchers reviewed chemicals on three lists, heavily drawing from the Association of Occupational and Environmental Clinics' (AOEC) Exposure List, which names chemicals reported as asthmagens by asthma specialists and subsequently reviewed under AOEC criteria; most of these reports come from occupational case studies, where known exposures during construction or installation can be linked to asthma onset.

The researchers also examined emerging evidence from epidemiological studies that suggests bisphenol-A and phthalates may affect the development of children's lungs or immune systems (see "Toxic Chemicals Can Be Inherited in Utero"). After identifying 50 chemicals as common ingredients in building products, the researchers determined which ones building occupants are most likely exposed to, assuming that, in addition to VOCs, semi-volatile organic compounds (SVOCs) and non-volatile chemicals might be released from finishes by wear or by adsorption onto dust.

The researchers determined 28 chemicals call for "urgent attention," including eight phthalates that were listed as high-priority "suspected asthmagens" because of an indirect link to asthma through initial epigenetic studies. Some of the chemicals will look familiar to many designers, like formaldehyde and acrylates. Other compounds on the "urgent" list will likely be more controversial, as they are not associated with occupant exposure during the

Asthmagens Accounted for by Greenguard Program

Table 4. Asthmagens Covered by GreenGuard Gold Protocol Only

Substance	CAS No.	Formula	Vapor pressure (mm Hg @ 25°C)[a]	Boiling point (°C)[b]	1/100 TLV (µg/m³)[c]	½ Chronic REL (µg/m³)[d]	Authoritative lists that include these chemicals[e]	Content in building materials[f]
Acetic Acid, Glacial	64-19-7	$C_2H_4O_2$	15.7	118	250	none	AOEC (Rrs), Quebec CSST	Up to 5% in HPCs; also found in silicone caulking
Acrylic Acid	79-10-7	$C_3H_4O_2$	3.97	141	59	3	AOEC (Rs)	Up to 50% in paint; also found in composite wood binders
2- Aminoethanol	141-43-5	C_2H_7NO	0.404	171	75	none	AOEC (Rs), Quebec CSST, CHE (ethanol-amines; S- strong)	Up to 5% in adhesives
Butyl Benzyl Phthalate (BBP)	85-68-7	$C_{19}H_{20}O_4$	0.0000082	250	none	none	CHE (phthalates; S&I-limited)	Up to 4% in VCT, carpet backing, and adhesive
Dibutyl Phthal-ate (DBP)	84-74-2	$C_{16}H_{22}O_4$	0.0000201	340	none	none	CHE (I- limited)	up to 5% in flooring finishes, and lacquers
Di(2-ethyl-hexyl) Phthalate (DEHP)	117-81-7	$C_{24}H_{38}O_4$	0.000000142	384	none	none	CHE (phthalates; S&I -limited)	Up to 50% in roofing membrane; 16% in vinyl carpet backing; 4% in vinyl tile
Di-n-Octyl Phthalate (DNOP)	117-84-0	$C_{24}H_{38}O_4$	0.0000001	242	none	none	CHE (phthalates; S&I -limited)	Up to 10% in roofing membrane
Maleic Anhydride	108-31-6	$C_2H_2(CO)_2O$	0.25	202	4	0.035	AOEC (Rs), Quebec CSST, CHE (acid an-hydrides; S- strong)	Up to 50% in HPCs, paints, and adhesives; up to 1.5% in carpet backing
Methyl Methacrylate	80-62-6	$C_5H_8O_2$	38.5	100	2050	none	AOEC (Rs), Que-bec CSST (methyl methacrylate and cyanoacrylates), CHE (methacrylates; S- strong)	Up to 100% in solid surfaces, 70% in fluid-applied floors, 20% in insulation binder
Phthalic Anhydride	85-44-9	$C_6H_4(CO)_2O$	0.000517	295	61	10	AOEC (Rs), Quebec CSST, CHE (acid an-hydrides; S- strong)	Up to 50% in HPCs, paints, and adhesives; up to 1% in rubber flooring
Triethanolamine	102-71-6	$C_6H_{15}NO_3$	0.00000359	335	50	none	AOEC (Rs), Quebec CSST, CHE (ethanol-amines; S- strong)	Up to 17% in binder; also in HPCs

a. Data from the Hazardous Substances Data Bank (HSBD), available at: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
b. Data from Pharos Chemical and Materials Library (CML)
c. TLVs established by the American Conference of Governmental Industrial Hygienists (ACGIH). TLV data from GreenGuard Certification protocol, available for download at: https://www.comm-2000.com/productdetails.aspx?sendingPageType=BigBrowser&CatalogID=Standards&ProductID=ULE2821_1_G_20130402(ULEnvironment)
d. CRELs established by California Department of Public Health (CPDH). List of full CRELs available here: http://www.oehha.ca.gov/air/allrels.html. List of CRELs used in CA 01350 emissions testing protocol available here: http://www.cal-iaq.org/phocadownload/cdph-iaq_standardmethod_v1_1_2010%20new1110.pdf
e. Up-to-date asthmagen lists can be found here: http://www.aoecdata.org/ExpCodeLookup.aspx (AOEC), http://www.asthme.csst.qc.ca/document/Info_Gen/AgenProf/Bernstein/BernsteinAng.htm#N2_12 (CSST), and http://www.healthandenvironment.org/tddb (CHE)
f. As identified by cross-referencing asthmagen lists with over 1,250 products in the Pharos BPL.

Source: Healthy Building Network

The report contains valuable tables of asthmagens accounted for in IAQ programs, as well as many that are not.

use phase. Isocyanates, bisphenol-A diglycidl ether (BADGE), and styrene—chemicals in insulations, epoxy resins, and rubber products—are known to be a concern during manufacturing and installation but have been considered relatively stable once they react.

Raising the red flag

Jim Vallette, who coauthored the report, defends the idea that known asthmagens could slough off a polyurethane coating or epoxy resin, arguing, "The product wears. Predictably, that would be in the dust, available for exposure." Although he concedes that "it's a logical argument" rather than one based on empirical evidence, HBN's goal with this report, he said, is to "raise the red flag" and call for further research on "under-explored potential exposure."

But Scott Steady, product manager for Greenguard certifications at UL Environment, questioned this assertion, stating that isocyanates are highly reactive and dissipate quickly, adding, "We don't anticipate any de-polymerization" through wear from compounds that include isocyanates as an intermediary. Steady agrees, however, that the relationship between product wear and respiratory effects has been studied very little and bears further research.

Vallette also explains that the report relies heavily on occupational data because long-term occupant exposures have not been studied thoroughly, so case studies from occupational exposure "are all we have to go on." However, he contends there is more of a relationship between the two than has been assumed.

"These occupational exposures have no known thresholds," Vallette told *EBN*. In other words, we know they cause occupational asthma but haven't nailed down how much exposure over how long a period of time is safe. He echoes the recent stance that the U.S. National Institute for Occupational Safety and Health (NIOSH) took on the topic of spray polyurethane foam (SPF) insulation, asserting, "actual re-occupancy times are just kind of throwing a dart into mid-air without a known target." NIOSH has said the standard re-occupancy times after SPF installation are based on anecdote, not science (see "Research to Provide Deeper Look at Spray-Foam Health Risks"). The report takes a precautionary approach due to the paucity of data, Vallette said.

Can IAQ programs help?

According to the report, current indoor air quality (IAQ) testing and certification programs rarely address asthmagens, and when they do, thresholds for those chemicals are typically based on exposure levels known to cause other health issues, such as cancer, cardiovascular conditions, or nervous system problems and may not be adequate to prevent asthma. Any system using the CDHP Standard Method, for example, will account for respiratory toxicity from certain substances based on California's Chronic Reference Exposure Levels (CRELs), but those thresholds are not asthma-specific.

HBN's report calls for developing testing protocols for asthmagens and asthma triggers within IAQ certifications, and until those are established, incorporating protocols for screening product *content* rather than emissions—by using the group's own Pharos database or referencing Health

Product Declarations (HPDs) when specifying products. (This approach is characterized as hazard-based and is controversial; read more in "Vinyl Group Launches Reporting Label for Toxic Chemicals.")

Of current product certifications, the authors state that Greenguard from UL Environment covers the most high-priority asthmagens—11 of 50 identified in the report, including four phthalates. Addressing asthmagens has not been a specific focus of the Greenguard program, according to Steady, but the standard does measure "total VOCs as a catch-all for the volatile chemicals that might not have established health-based exposure levels."

Developing thresholds for semi-volatile compounds like phthalates has been more difficult because "in general, the exposure route for SVOCs from building products that are not heated cannot be well characterized by airborne measurements," said Steady. However, Greenguard may eventually incorporate SVOC protocols used in European standards—though he said the value of such metrics is limited. That's because, like VOC chamber testing, these methods measure levels in the air and don't currently account for transfer via non-airborne dust—even though dust is the most likely exposure route for SVOCs.

Limiting asthmagens in practice

Architects and designers who do decide to screen products using the subscription-based Pharos database may be in for some frustration.

According to Sarah Lott, coauthor of the HBN study, there are products in the Pharos database that do not contain asthmagens, but none pass the screening for all other categories of health risk. For some products—including most wet-applied products—there are no options on the market without asthmagen content, Lott told *EBN*. In those cases, she suggests focusing on avoiding other chemicals with health risks, like carcinogens or reproductive toxicants.

It's a difficult position, and one architects and designers are familiar with. "There are 60,000 materials in the world today for consumer use and consumer products," Chris Youssef, design associate at Perkins Eastman, told *EBN*. "If we address every single chemical through its life cycle, we'll literally be left with nothing." Youssef wants more research about long-term, use-phase exposures in order to make more educated trade-off decisions, but he says there are times in his current practice when he makes asthmagens a priority—usually in projects involving children's spaces.

The HBN report helped to validate that approach for Youssef by emphasizing exposure pathways associated with dust. "Children are always on the ground in their environments," he said. "Architects and designers can directly affect asthma triggers."

What's behind rising asthma rates?

The HBN report says asthmagens demand immediate attention because of the alarming increase of asthma cases in the last decade; it cites a Centers for Disease Control (CDC) figure estimating that the number of people diagnosed with asthma grew by 4.3 million from 2001 to 2009. "We were finding that there have already been a lot of ventilation and moisture-control measures put in place," Vallette told *EBN*. "But levels of asthma have continued to increase despite those measures. So that's what led us to look at chemicals in building materials."

However, Elliot Horner, Ph.D., principal scientist at UL Environment, argues that chemical asthmagens don't appear to be responsible for rising asthma rates among children. "The report talks about the dramatic increase in asthma over the last 25 years or so," Horner told *EBN*. "However, it's pretty well recognized that the major driver of that increase in asthma is childhood and juvenile allergic asthmas." According to the National Institutes of Health, while the cause of asthma is uncertain, it is most frequently linked with heritability; respiratory infections, particularly in childhood; and exposure to common environmental irritants and allergens such as pollen, dust mites, cockroach dust, and tobacco smoke.

That doesn't mean designers shouldn't be thinking about asthmagens or asthma triggers, especially for children's spaces, Horner says—avoiding any added stressors on the immune or respiratory systems is pragmatic—but it does suggest that building products are not primarily responsible for escalating asthma rates.

GSA Shares More "Green Proving Ground" Experience

With lessons learned from its own buildings, GSA reports conditions under which high-performance window panels, mag-lev compressors, and onsite PV are viable.

By Candace Pearson

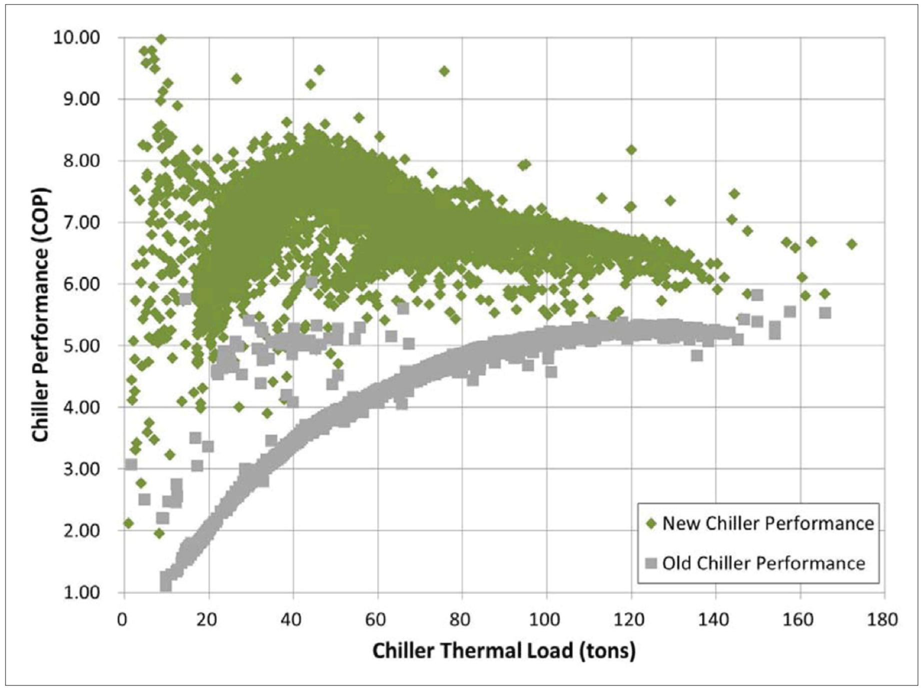
The U.S. General Services Administration (GSA) has shared results on three more technologies as part of its Green Proving Ground program. High-performance window panels and variable-speed chillers produced substantial efficiency gains in two of the latest case studies, and a comprehensive survey revealed some best practices for getting the most from solar photovoltaic (PV) installations.

These studies join six other published GSA evaluations of sustainable technology (see "Two Technologies Proven Effective in GSA Test Beds"), with 22 more selected to study next.

High-performance window panels

At a GSA federal office building in Provo, Utah, heating loads were reduced by 41% during the winter months when 21 single-pane windows were retrofitted with High-R panels in triple-pane configurations. Occupants reported increased comfort, and installation caused little workday disruption because the pre-manufactured units were mounted on the interior

Comparing Chiller Technologies



Source: Healthy Building Network

A variable-speed chiller with mag-lev compressors is just one of the technologies that GSA has tested through its Green Proving Ground Program. Researchers found the new technology performed better than a chiller with rotary-screw compressors, especially at partial loads.

side of the existing windows. According to GSA, the project cost a total of $7,500 for labor and materials—much less than what it would have taken to fully replace the windows.

GSA recommends this retrofit as a cost-effective measure but warns that the building's significant energy savings were likely due to the particularly cold climate; on average, high-performance window panels are estimated to reduce a building's heating and cooling demands by 11%. In addition, a more humid climate may cause unwanted condensation, so GSA concludes that a site-specific evaluation is necessary. (See "Making Windows Work Better.")

Variable-speed chiller with magnetic levitation compressors

In another case study, operators at the George Howard, Jr. Federal Building, a courthouse and office building in Pine Bluff, Arkansas, replaced one of two rotary-screw chillers with a chiller that had magnetic levitation compressors. This technology is designed to minimize noise and improve energy efficiency by eliminating metal-on-metal friction (see "Magnetic-Bearing Chillers: Cooling without Friction").

Because of its ability to operate more efficiently at partial loads, the new chiller achieved energy savings of 42% and is expected to have a payback period of 4.7 years. However, GSA notes that purchase and installation costs still vary widely, so the technology may be best suited as a compressor-only retrofit or as an end-of-life replacement for chillers with rotary-screw compressors.

Onsite PV

To evaluate onsite PV projects, GSA contracted with the National Renewable Energy Laboratory (NREL) to survey the teams responsible for 63 of GSA's latest solar energy projects and to summarize their experience in an On-site PV Guidance Report.

The survey found more challenges arose with project management, site, interconnection, technical, or economic issues than arose with net metering, state or local laws, or procurement. The report lists some recommendations aimed at helping teams streamline solar projects, including conducting a feasibility study early in the process, forming an integrated team of engineers, lawyers, and energy experts, and installing advanced metering to monitor performance. The report has some targeted recommendations for federal agencies, but many of the lessons learned and best practices apply broadly.

AIA Honor Awards To Be Judged on Sustainability

Many previous winners of AIA Institute Honor Awards have featured green attributes, but energy and water use data are now required submission criteria.

By Candace Pearson

After decades of effort within the American Institute of Architects (AIA), sustainability metrics have now become required submission criteria for what many consider to be one of the highest recognitions in architecture—the annual AIA Institute Honor Awards.

Submission guidelines for the 2015 awards will require projected energy and water use figures and a narrative describing the project's sustainable features—both of which were only "recommended" in 2013 and 2014. To ensure that this information is fully considered, at least one architect with recognized expertise in sustainability will sit on the jury panel.

A long time coming

According to William Leddy, FAIA, who had an instrumental role in passing the changes while serving as both 2013 Committee on the Environment (COTE) chair and member of the Awards Task Force, pressure to change the Honor Awards has actually been brewing for years. "Bob Berkebile pushed for incorporating sustainability into the Honor Awards back in the '80s," Leddy told *EBN*. Instead, COTE was formed, and a separate award, the COTE Top Ten Green Projects, was created to recognize excellence in sustainable design. According to Leddy, the topic was brought up again in 2008 under the leadership of Henry Siegel, FAIA, and years later, a task force charged with examining all AIA awards recommended that sustainability metrics become mandatory for the Honor Awards; however, the proposal was defeated by a two-thirds vote of the AIA board.

Then, when Leddy became 2013 COTE chair, he took up the challenge as a COTE priority and partnered with the AIA Awards Task Force to rally support. At least 100 firms responded by sending letters. Backing also came from former national firm award winners and 14 AIA knowledge communities, including the Technical Design for Building Performance community and the Housing Knowledge Community.

In a period of two years, the AIA board was swayed from its two-thirds opposition to unanimous support.

What to expect in 2015

There were worries that the mandatory criteria might preempt too many projects from applying, according to Rand Ekman, AIA, who was also on the 2013 COTE advisory committee. However, last year's submissions have put most of those concerns to rest. Of the 108 projects chosen for jury review in 2014, 81% submitted the sustainability narrative and metrics. Furthermore, the point of the awards is to identify the cream of the crop, according to Ekman. "We aren't talking about all projects. We are talking about those that deserve AIA awards."

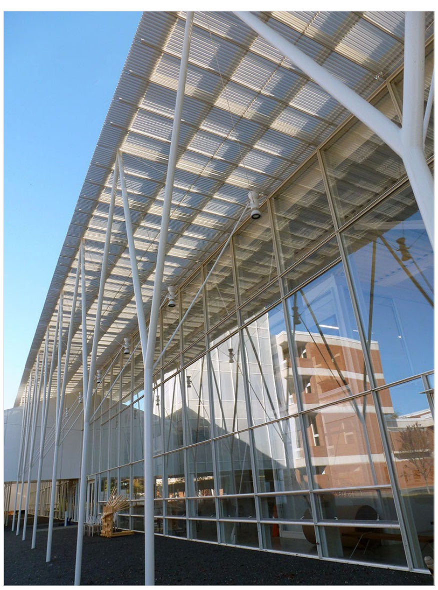


Photo: Nicobro. License: CC BY 3.0.

Energy models indicated that Clemson University's Lee Hall, an Honor Award recipient in 2013, would perform 50% better than a conventional building. Contestants submitting applications for 2015 will be required to provide similar energy use metrics for their projects.

Nevertheless, "there is still a lot of work that has to happen for this criteria to play out," Ekman told *EBN*. Juries have to be knowledgeable enough to interpret and compare energy performance, and local award programs have been encouraged to adopt similar criteria in order to feed competitive projects into the national program.

Good design is green design

For now, Leddy sees the victory as a way to push back against a history of differentiating sustainable design from good design: "Today sustainable design has its own separate awards, separate magazines, and separate following. We have to get to a place where sustainability is no longer a tack-on idea."

In addition, the Honor Awards are the "most potent expression of the values architects should aim for," said Leddy, and communicating the importance of sustainability brings the awards in line with the values already embraced by the AIA Repositioning Initiative, the Communities by Design's 10 Principles for Livable Communities, and the 2030 Commitment.

LEED Fellow Yudelson to Lead Rival Green Globes

Green building consultant Jerry Yudelson aims to "push the reset button" at the Green Building Initiative (GBI).

By Paula Melton

A new force will be making Green Globes go 'round.

Jerry Yudelson, P.E., a LEED Fellow and a prominent green building advocate, has joined the Green Building Initiative (GBI) as president. "It's a new beginning," Yudelson told *EBN*. "We pushed the reset button."

GBI's relationship with its former—and controversial—president, timber lobbyist Ward Hubbell, along with lobbying and public relations firm Hubbell Communications, "has been severed," Yudelson confirmed, and the group has moved from the Hubbell building to a new location in southwest Portland, Oregon.

Yudelson said he will be a much-needed "public face" for the organization, "kind of in the same way Rick Fedrizzi does for USGBC" (the U.S. Green Building Council, where Fedrizzi is president, CEO, and founding chairman). "I'll also set up a strategic planning process and take them to the next level of development," Yudelson added.

'Not anti-LEED'

Despite GBI's history of an adversarial relationship with LEED and USGBC, Yudelson asserts he's "not saying anything negative about LEED." Instead, he points out that "LEED does not meet everyone's needs" and says there's demand in the marketplace for a low-cost, user-friendly system that can make buildings greener than they would be without any certification at all.

"My goal is to be in the marketplace with a good product, a good approach, and to get more people to do green building," he explained. "I don't really see us getting engaged in anti-LEED activity as an organization."

Yudelson does fault LEED's bureaucracy for increasing the cost and slowing the uptake of green building, comparing credit interpretations to "religious fatwas" and arguing that LEED's complexity creates "the need for highly specialized consultants" who understand "the latest rulings from the 'mullahs.'" But he views GBI's role as that of "a friendly competitor" rather than a nemesis.

Competition, he argues, "forces you to continue to respond to the marketplace," and he points to the Living Building Challenge (LBC) as a model of friendly competition. "There's always an engine on the train and a caboose and a bunch of cars in the middle," he said (apparently hinting that LBC is the engine, LEED the cars, and Green Globes the caboose). "But everyone wants to go in the right direction."

Better, faster, or cheaper: Pick two

In an interview with *Building Design + Construction*, where he served as consulting editor until taking the helm at GBI, Yudelson claimed "better, faster, [and] cheaper" were the key selling points of Green Globes. *EBN* asked him to elaborate on how Green Globes is better.

"We can go with faster and cheaper and leave it at that," Yudelson joked. "In the building industry, we like to say you can have it faster, cheaper, or better: pick two."

The claims of lower cost and ease of use of Green Globes will be the core messages of GBI under Yudelson's leadership, he suggested, adding that he hopes to encourage LEED to move in a similar direction. "LEED is really out of touch with today's realities," he argued, citing requirements he views as outdated due to regulatory changes—such as sedimentation control, recycling space, and elimination of chlorofluorocarbons (CFCs).

"It doesn't need more credits," he contends, adding that any project team that hasn't already addressed the basics probably isn't realistically going to pursue LEED certification anyway. "It needs a wholesale revamp with a user-friendly approach as the paramount aspect." (Yudelson's examples of outdated requirements all refer to longstanding LEED prerequisites—SSp1, MRp1, and EAp3—that are generally considered easy to document on U.S. projects, where they are standard measures, but more of a push on non-U.S. projects.)

Maybe just faster?

Robert Phinney, AIA, director of sustainable design and energy services at HDR Architecture, challenged the idea that Green Globes is less expensive. "I am constantly hearing that one of the major benefits of Green Globes over LEED is the perception of lower costs. I find this to be misleading, and in many cases, simply incorrect," he told *EBN*. "On one recent project, we were asked to look at the cost of pursuing minimum LEED certification and minimum Green Globes certification," and the results surprised him. Phinney found that registration costs would be more than twice as much for Green Globes as for LEED ($17,000 vs. $8,150). This meant that although "the LEED process required more effort on the consulting side," that cost premium "about equalled the difference in admin costs, while the level of effort for the design disciplines throughout each process remained consistent." That said, continued Phinney, "From a technical standpoint, both LEED and Green Globes have their pros and cons, and this cost assessment does not reflect a judgment on the choice of one system or another. Each has their place in the industry."

"About time" or a betrayal?

On social media and in private exchanges, green building professionals expressed a variety of reactions to Yudelson's move, ranging from "It's about time LEED had some real competition" to surprise that a long-time LEED advocate would join an organization that has sought to undermine LEED.

Green pundit Eric Corey Freed stated simply, "This should be great for Green Globes," while LEED consultant and faculty member Rob Hink tweeted, "Why does Benedict Arnold come to mind?"

"Just picked myself up off the carpet after learning that Jerry Yudelson has become head of GBI/Green Globes," added Treehugger managing editor Lloyd Alter, who's been a scathing critic of Green Globes and Hubbell

Photo: Yudelson Associates

Jerry Yudelson is a sought-after conference speaker on topics ranging from Passive House to green building marketability.

Communications continually since the group's inception.

Beyond the wood wars

Asked whether GBI's close ties with the timber and chemical industries gave him pause, Yudelson said he planned to expand the reach of Green Globes to a much broader group of stakeholders.

"Clearly there was a history of wanting another form of wood certification," Yudelson concedes (see our investigative blog series on the "wood wars"). "I'm not going to look at the history and say it wasn't what it was."

But the membership base and board of directors—which currently have outsized representation from mainstream timber and plastics groups—are already diversifying, he claims, and he intends to build on that by doubling the number of members and "build[ing] a membership much more strongly in the area of users and the area of professional services. If you look at the board twelve months from now," he hopes, "you would say, 'Gee that looks a lot like USGBC.'" Another goal for the coming year, he told *EBN*, is to increase Green Globes' market share in the green building certification world to 10% (from an estimated 2%–4% currently).

And ANSI?

Yudelson was not prepared to address directly the recent controversy over discrepancies between the Green Globes tool and GBI's ANSI standard—a controversy that led to the resignation of longtime GBI board member Harvey Bryan, Ph.D., FAIA (see "Green Globes Board Member Quits Over ANSI Claims")—but he told *EBN* he planned to "find out what [Bryan's] critique is in some detail" and to address that critique, adding that "we're committed to being an ANSI standards organization, whatever that ends up meaning in practice."

Although claiming to build bridges, Yudelson took a dig at USGBC for not achieving unanimous support for LEED version 4 (LEED v4). "One in seven people voted against it," he pointed out. "Some people had genuine concerns about workability and so forth. That's a fact." In apparent contrast, GBI will "continue to go down the path" of a "consensus standards approach," he added.

Although GBI has often attempted to paint LEED as lacking full support and industry representation, consensus standards almost never require a unanimous vote. Like many consensus-based systems, USGBC's own rules require a two-thirds majority for approval of the standard, and the LEED v4 vote was a historic landslide, with 86% approval. (Contrary to Yudelson's statistics, only 1 in 10 voters voted against, with 4% abstaining. See "LEED v4 Overwhelmingly Approved by USGBC Members.")

More tools

Yudelson insists he's trying to fortify sustainability, however, rather than tear down LEED.

"Ultimately, most buildings are built without attention to any standards other than the building code," Yudelson told *EBN*. "Our goal has been to get every building to up its game in terms of environmental performance. We need more—rather than fewer—tools to do that. If this thing can work, it's going to help everybody."

[Disclaimer: BuildingGreen, Inc. owns LEEDuser, a virtual LEED help desk, and some BuildingGreen staff members have worked with USGBC as volunteers and contractors.]

NEWSBRIEFS

EPA to Tighten Pollution Rules for Wood Heaters

The new regulations will slash particulate emissions from woodstoves, wood hydronic heaters, pellet stoves, and masonry heaters.

By Paula Melton

For the first time in decades, the U.S. Environmental Protection Agency (EPA) has proposed updated emissions standards for new wood heaters. The new rules would reduce particulate emissions from wood heaters an estimated 80% and would also greatly expand the categories regulated by EPA.

Under the proposed regulations, new wood heaters would have to meet emissions standards in a two-step process, with a small reduction in emissions within 60 days after the final rule is published and a much larger reduction in emissions within five years.

Current EPA standards, issued in 1988, apply only to *adjustable-burn-rate* woodstoves (those designed to allow airflow changes) and woodstove inserts. The new standards would also apply to *single-burn-rate* woodstoves (which pollute more because they don't allow for airflow adjustments; these are commonly called "EPA-exempt" stoves) and to various new types of wood heaters—pellet stoves as well as wood-fired hydronic heaters, forced-air furnaces, and masonry heaters.

EPA is also seeking comment on regulation of emissions from new fireplaces, which are not considered heaters.

Once finalized, the rules will go into effect in 2015, with full compliance phased in over five years.

Proposed EPA Particulate Emissions Limits for Wood Heaters

<table>
<tr><th>WOOD HEATER TYPE</th><th>CURRENT PM EMISSIONS LIMIT</th><th>PM EMISSIONS LIMIT 60 DAYS AFTER FINAL RULE</th><th>PM EMISSIONS LIMIT 5 YEARS AFTER FINAL RULE</th></tr>
<tr><td>Single-burn-rate woodstoves and inserts</td><td>–</td><td rowspan="3">4.5 g/hr. (all stoves)</td><td rowspan="3">1.3 g/hr. (all stoves)</td></tr>
<tr><td>Adjustable-burn-rate woodstoves and inserts</td><td>7.5 g/hr. (non-catalytic)
4.1 g/hr. (catalytic)</td></tr>
<tr><td>Pellet stoves</td><td>–</td></tr>
<tr><td>Hydronic heaters (wood boilers)</td><td rowspan="3">–</td><td>0.32 lb./MMBtu</td><td>0.06 lb./MMBtu</td></tr>
<tr><td>Forced-air furnaces</td><td>0.9 lb./MMBtu</td><td>0.06 lb./MMBtu</td></tr>
<tr><td>Masonry heaters</td><td>0.32 lb./MMBtu (manufacturers who build more than 15 units per year)</td><td>0.32 lb./MMBtu (manufacturers who build fewer than 15 units per year)</td></tr>
</table>

Source: EPA

SCAQMD Sets First VOC Limits for Colorants

Precedent-setting regulations in Southern California now limit VOCs in colorants and toughen the requirements for certain specialty coatings.

By Candace Pearson

Tighter emissions restrictions on colorants and specialty coatings have taken effect in Southern California.

The South Coast Air Quality Management District (SCAQMD), which sets policy in Los Angeles, Orange, San Bernardino, and Riverside counties, will begin enforcing lower VOC limits for certain architectural and industrial maintenance coatings.

Previously unregulated colorants now have a VOC limit of 50 grams per liter (g/L). Although colorant added at the factory or sold for use on the jobsite is not subject to the limit, the rule regulates tints added at the point of sale, which can elevate VOC levels in a final product even when a low- or zero-VOC base coating is used. The VOC limit on primers, sealers, and undercoats remains at 100 g/L and was not lowered as had been proposed; however, lower limits were set for several specialty coatings, including concrete surface retarders, fire-proofing coatings, and mastic coatings. In addition, coatings sold in containers larger than two fluid ounces must include VOC content on the labeling.

Although the regulations apply only to four Southern California counties, and existing versions of LEED reference older versions of SCAQMD rules (and are not likely to be updated if precedent holds), the standard could be a potential model for future regulatory changes elsewhere in the U.S.

Updated Thermal Comfort Standard Could Save Energy

The 2013 version of ASHRAE's Standard 55 allows designers to reduce energy use by incorporating adaptive thermal comfort strategies.

By Candace Pearson

ASHRAE has published its latest update to Standard 55, Thermal Environmental Conditions for Human Occupancy, with some major revisions that make room for adaptive thermal comfort principles.

Especially notable are two new revisions that may provide for energy savings by giving designers more flexibility, according to Gwelen Paliaga, chair of the committee that wrote the standard. Older versions of the standard allowed a wider range of temperatures in naturally ventilated buildings, but the new version extends the comfort threshold even further if air movement is also utilized. This may make compliance to the standard more achievable for naturally ventilated buildings. In addition, the calculation tools are well established, according to Paliaga, because the standard already accounts for the cooling effect of air movement in mechanically conditioned spaces.

There is also an alternate procedure for estimating the amount of insulation occupants get from their clothing, which is based on updated field research that takes weather into account. A predictive model that estimates how much warm clothing occupants will wear throughout the seasons can be used to more accurately calculate the optimal thermostat setpoints for design calculations and annual simulations.

The standard incorporates 18 new addenda overall and has been reorganized so that calculation procedures appear sequentially. "The standard had been very theoretical, and now it's much more of a design procedure," Paliaga told *EBN*. "LEED users will find the difference to be night and day." Standard 55-2013 can be purchased through ASHRAE's online bookstore.

FDA: Antimicrobial Risks Outweigh Benefits

Common antibacterial chemicals, including triclosan, are the target of a proposed FDA rule.

By Paula Melton

Biocides used in antibacterial soaps and incorporated into many building materials and consumer products probably do more harm than good, says the U.S. Food and Drug Administration (FDA). The agency has released a new rule demanding that companies using triclosan, triclocarban, and similar biocides in "over-the-counter antiseptic drug products" prove that their products are not only safe and but also more effective than regular soap and water.

Mounting evidence suggests that triclosan, a chlorinated compound, affects the endocrine systems of animals, disrupts aquatic ecosystems, and may contribute to allergic sensitization in children. It also may cause antibiotic resistance and has shown potential for bioaccumulation.

Although the proposed FDA rule targets only "products intended for use with water" (i.e., soap), the resulting data could potentially halt the widespread use of triclosan, triclocarban, and similar antibacterial compounds in consumer products and interior building materials. Antimicrobials are commonly used in everything from door hardware to drywall to paint (see "Antimicrobials: Hygiene or Harm?").

The proprietary antimicrobial blend sold under the trade name Microban may or may not contain triclosan; the manufacturer lists an array of treated building products, from air filters to urinals, and claims the purpose of Microban is to protect building materials from mold, not to prevent disease.

The public comment period for the proposed rule will end June 16, 2014.

Phthalate Exposure Persists Despite Regulations

Plasticizers known to be highly toxic decreased in a nine-year study, but tests showed elevated levels of less-scrutinized substitutes.

By Paula Melton

People in the U.S. can rest a little easier about three toxic phthalates being phased out of consumer goods, reports Lindsey Konkel of *Environmental Health News*—but levels of other phthalates have gone up, in some cases dramatically. These chemicals

Phthalate Trends in U.S. People 2001–2010

PHTHALATE	COMMON SOURCES	TREND
DEP	Fragrance, cosmetics, medication	↓42%
DnBP	Cosmetics, medication, food packaging, PVC plastics	↓17%
BBzP	PVC flooring, food packaging	↓32%
DEHP	Toys, cosmetics, food packaging, PVC plastics	↓37%
DiBP	Cosmetics, food packaging	↑206%
DnOP	Food packaging, PVC plastics	↑25%
DiNP	Toys, flooring, wall coverings, PVC plastics	↑149%
DiDP	Toys, wire and cables, flooring, PVC plastics	↑15%

Source: Zota et al. via Environmental Health News

As reported in Environmental Health News, phthalate levels show ups and downs.

are used as plasticizers to make vinyl products flexible and also appear in personal care products such as shampoo and fingernail polish.

A research team led by Ami Zota, Sc.D., found that exposure to three phthalates banned in U.S. children's products in 2008 (BBzP, DnBP, and DEHP) had decreased among all age groups, but that exposure to substitutes had increased—more than doubling in the case of DiBP (Diisobutyl phthalate), a chemical used in cosmetics and food packaging that has not undergone scrutiny like many other phthalates. An assessment of DiBP by the U.S. Environmental Protection Agency in 2000 was inconclusive due to lack of data, while a hazard assessment seven years later by the Australian Department of Health and Ageing had little more information but noted possible reproductive and developmental effects in exposed rats.

Exposure to diisononyl phthalate (DiNP), a common substitute for toxic plasticizers used in vinyl wallcoverings and other PVC products, increased 149%. The State of California recently listed DiNP as a carcinogen (see "The PVC Debate: A Fresh Look").

"These findings are not as reassuring as they could be," epidemiologist Joe Braun, Ph.D., told Konkel, because widespread phthalate exposure continues despite regulatory action and public health campaigns.

"Temporal Trends in Phthalate Exposures: Findings from the National Health and Nutrition Examination Survey, 2001–2010" was published in *Environmental Health Perspectives* and is available online.

"Green Lease Leaders" Program to Recognize Brokers

Firms and brokers that offer leases meeting sustainability criteria will be recognized in an effort to get tenants and landlords collaborating to save energy.

By Candace Pearson

Applications are now open for Green Lease Leaders, a program that establishes a standard for green lease programs and honors firms and brokers that successfully implement it.

Developed by the Institute for Market Transformation (IMT) and the U.S. Department of Energy's (DOE) Better Buildings Alliance, the Green Lease Leaders program is designed to help tenants and landlords work together to save energy by encouraging them to set sustainability conditions in the lease. To be recognized as a Green Lease Leader, a landlord's or broker's lease agreement must include a tenant cost-recovery clause, which rewards the tenant for making energy-efficient capital improvements, and incorporate a minimum of three other provisions. Examples include requiring tenant disclosure of monthly utility data or setting sustainable operation and maintenance rules. Another set of requirements applies to a tenant lease.

"These requirements set a new standard for commercial leasing by providing a uniform definition for what characterizes a green lease, and each of the requirements aids in making a lease more equitable between landlord and tenant so that they share both the costs and benefits of improved energy performance," said Cliff Majersik, executive director for IMT.

Applications will be open until April 8, 2014, and the first group of recognized firms and brokers will be announced at DOE's Better Buildings Summit in Washington, D.C.

More Questions Than Answers in Report on Reflective Pavements

A report funded by the asphalt industry warns there could be consequences from solar radiation bounced off reflective pavements.

By Candace Pearson

A white paper funded by The National Asphalt Pavement Association and the State Asphalt Pavement Associations recently drew attention by asserting that reflective pavements, which are promoted in programs like LEED for mitigating the urban-heat-island effect, could be doing more harm than good. However, the conclusions drawn from limited field research are sketchy, raising questions about whether the asphalt industry introduced bias.

The report, titled "Unintended Consequences: A Research Synthesis Examining the Use of Reflective Pavements to Mitigate the Urban Heat Island Effect," argues that non-roof pavement with a high solar reflective index (SRI) may reflect solar radiation in a way that creates undesired ground-level impacts—chief among them increased cooling loads from reflected heat absorbed by adjacent buildings.

However, as co-author Zhihua Wang, Ph.D., himself told *EBN*, the report's literature review is "focused on one side of the story," and the research is preliminary. For example, to study how effectively reflective pavements reduce overlying air temperatures, the researchers monitored air temperatures just five feet above small, 12′ x 12′ sections of reflective and non-reflective surfaces. Unsurprisingly, they found little difference in air temperatures. "The [field research] is not very representative of the heat-island effect," according to Wang. "It is more representative of general physics."

That said, Wang supports the report's conclusion that porous asphalt and pervious concrete are likely better materials to mitigate the urban-heat-island effect because of their lower nighttime surface temperature, as observed in the same study. The authors plan to publish their research for peer review.

Lead Exposure Persists for Painters, Metal Workers

A large number of people are still exposed to unhealthy levels of lead through their jobs—most in construction and manufacturing.

By Candace Pearson

Workers in construction trades continue to account for a large percentage of those exposed to dangerous levels of lead, according to a federal report.

The Centers for Disease Control and Prevention (CDC) reports that from 2002 to 2011, occupational exposure caused 7,076 adults in the U.S. to have "very high" blood lead levels (BLL), defined as being at or above 40 μg/dL. Within this group, 49% were employed in battery manufacturing, nonferrous metal production, or painting and wallcovering contracting. Painting, renovation, and remodeling work were also prominent causes in the 6% of cases with a known exposure source that was not occupationally related, CDC noted.

In two case histories provided by the CDC, one worker was exposed to lead by recycling the grit and steel shot from his company's sandblasting operations, and another had been scraping paint without appropriate protections. These types of work-related exposures may result in such high lead levels in part because the Occupational Safety and Health Administration's (OSHA) lead standards do not require medical removal for construction workers until their BLL reaches 50 μg/dL, while CDC's reference level for a healthy adult is 10 μg/dL. In addition, workers may return to work as soon as their BLL falls below 40 μg/dL, leaving them vulnerable to chronic exposure.

CDC recommends that employers increase efforts to reduce exposure and that examining physicians exercise their authority to order leave or transfers for patients even if BLLs are lower than current OSHA standards.

LEED Ban Lifted in New Military Spending Bill

A two-year halt on spending for LEED Gold and Platinum was called off in the 2014 federal defense authorization act.

By Paula Melton

Congress has lifted its restriction on LEED spending by the U.S. military.

The National Defense Authorization Act (NDAA) signed by President Obama on December 26, 2013, does not renew a two-year prohibition on use of Department of Defense (DoD) funds to achieve LEED Gold or Platinum (see "Two New Laws Restrict Use of LEED").

Although there had been an exception for projects that could achieve Gold or Platinum at no additional cost (see "Army to Congress: LEED Doesn't Cost More"), the provision was just the tip of a political iceberg involving the timber industry; statements by Roger Wicker (R–Mississippi), who introduced the restrictions, suggested the ban stemmed from "the wood

The Community Emergency Services Station at Fort Bragg achieved LEED Platinum certification not long after Congress began restricting funding for buildings certified above the Silver level. (The building was completed before the law went into effect.) Those restrictions have now been lifted.

wars." LEED recognizes only the strict Forest Stewardship Council (FSC) standard for certified wood, a sore point with the mainstream timber industry.

According to Stuart Kaplow, who reported on the change in Green Building Law Update, such a targeted restriction on LEED may no longer be necessary. That's because Green Globes, which recognizes the Sustainable Forestry Initiative (SFI) certification favored by vocal forestry lobbyists, now shares equal status with LEED for the federal government.

Additionally, "this is a big deal because the act includes $527 billion in base defense spending for the current fiscal year," according to Kaplow. Most major renovations and new construction funded by those billions will have to adhere to DoD's internal regulations, the United Facilities Criteria (UFC), which require third-party verification of sustainable design and construction through an approved rating system. Current UFC wording designates "LEED Silver or equivalent" as the minimum standard, and DoD has historically left the word "equivalent" open to interpretation within each military department (see "4 Reasons Battles Over LEED in the Military Are a Distraction").

EPA Crowd-Sources Toxicity Analysis of 1,800 Chemicals

Hoping to accelerate chemical assessments, the Environmental Protection Agency calls on the public to help decode new screening data on hundreds of chemicals.

By Candace Pearson

The U.S. Environmental Protection Agency (EPA) recently made toxicity data for 1,800 chemicals publicly available on its interactive Chemical Safety for Sustainability Dashboard (iCSS dashboard) and solicited the help of the scientific community to interpret the data.

The chemicals were screened as a part of the Toxicity Testing in the 21st Century (Tox21) program—a federal collaboration between EPA, the National Institutes of Environmental Health Sciences (NIEHS), the National Center for Advancing Translational Sciences (NCATS), and the U.S. Food and Drug Administration (FDA). The Tox21 program uses robotics and high-throughput screening to discover the proteins, pathways, and cellular processes that chemicals interact with when used in industrial and consumer products, food additives, or drugs. Nearly 2,000 chemicals were analyzed in 700 *in vitro assays*, a type of test that measures the activity of a chemical on a sample of organic tissue.

"Making these data publicly available will help researchers across disciplines to better identify hazardous chemicals," according to Raymond Tice, Ph.D., who heads the Biomolecular Screening Branch at NIEHS. EPA is hoping to encourage that research by announcing two ToxCast challenges, which will reward teams for accurately predicting the lowest dose of a chemical that causes an adverse reaction in animals. The competitions are meant to generate solutions for how the data can be used to predict health effects; given those solutions, EPA would be better able to prioritize chemicals needed for testing under the Toxic Substance Control Act, the Safe Drinking Water Act, and its Endocrine Disruption Screening Program.

ASHRAE Develops World Climate Zone Maps

Standard 169-2013 expands its dataset globally and adds a new zone for extremely hot climates.

By Candace Pearson

ASHRAE's updated Standard 169 for Climate Data now offers climatic information for 5,564 locations throughout the world and adds an "extremely hot" climate zone.

"With this major revision, Standard 169 now includes climate zone maps for the entire world, as opposed to the 2006 standard, which only included a U.S. climate zone map," according to Dru Crawley, chair of the committee that wrote the standard. "This allows users outside the U.S. to more easily determine which climate zone their location is in."

Information provided for each location includes enthalpy, humidity ration, wind conditions, solar irradiation, elevation, and dry-bulb, wet-bulb, and dew point temperatures. The reference standard also includes statistical data, such as mean temperatures, daily ranges, degree hours, and seasonal percentages within ranges of temperatures.

In addition, Climate Zone 0 is newly incorporated into the standard for "extremely hot" settings. Humid and dry zones are separated into 0A and 0B, respectively. Updated climate data in Standard 169-2013 is a result of the data-gathering efforts from ASHRAE Research project 1453.

PRODUCT NEWS & REVIEWS

Can TimberSIL Manufacturer 'Make It Right'?

Timber Treatment Technologies and its innovative non-toxic treated decking product are in the news again—this time over durability and performance in post-Katrina homes.

By Tristan Roberts

Rotting TimberSIL at the high-profile "Make It Right" green building projects in New Orleans—along with other consumer complaints—have Timber Treatment Technologies (TTT), the maker of the innovative glass-impregnated wood product, on the defensive.

TimberSIL is designed to resist decay, insect damage, and fire without the pesticides and heavy metals commonly used in treated wood, but it has had its share of trouble over the roughly 10

Photo: Mike Guertin

Fungal decay is visible on a TimberSIL deck installed by Mike Guertin in 2008. One board under a door mat experienced severe rot, but as shown here, the entire installation is weathering poorly, and Guertin expects it to require replacement within a year or two.

years it has been around. Most of that has had to do with navigating regulations and building distribution channels, and the company had appeared to put the worst of that behind it.

However, a recent spate of news stories is potentially more damaging—questioning the quality and durability of the product itself, as well as TTT's responsiveness to warranty claims. Having been excited by TimberSIL's promise as early as 2004 due to it nontoxic sodium-silicate treatment process, *EBN* tried to get to the bottom of the recent complaints.

Mt. Holyoke Summit House

The bad press started in 2013 when the *Daily Hampshire Gazette* started reporting that the Summit House atop Massachusetts' Mount Holyoke, a tourist destination within a state park, would remain closed for a third consecutive summer, even as the price tag on its renovations ballooned by $100,000. A key factor in the delay and cost overruns was TimberSIL wood used in the project's extensive decking and deck railings, which reportedly wouldn't hold paint, leading the Massachusetts Department of Conservation and Recreation to remove and replace the installed product.

According to the *Gazette*, an expert hired by the Commonwealth pegged the coating problems on moisture content in TimberSIL being higher than 20%. Storing the wood indoors over the winter and even attempting to "bake" the moisture out it did not help, according to Joe Orfant, chief of the Bureau of Planning and Resource Protection at the state Department of Conservation and Recreation, as quoted in the *Gazette*. Unfortunately, Orfant did not respond to *EBN*'s repeated requests for comment, so we were unable to clarify whether the "baking" reduced the moisture content below 20% or to ask what coating the company used.

Joel Embry, executive vice president at TimberSIL, told *EBN* that the moisture content in the wood leaving TimberSIL's factory was "not that high," and company literature states that it will be no higher than 19%. "How it gained that content is a mystery," he says, although storage and handling onsite are obviously suspects. "At this point, we have not determined which of the parts of this installation have the most effect," says Embry, "but it's a combination of the sanding, cleaning, sealing, and the choice of paint."

TimberSIL's installation guidelines call for using "30–40 grit sand paper, and sand[ing] thoroughly prior to sealing, staining, or painting in order to provide proper adherence." Embry suggested that the wood may have been sanded with higher-grit (finer) sandpaper, which might be standard on other products, but which could reduce paint adhesion on TimberSIL. TTT recommends Keim silicate-based paints for TimberSIL, which can be applied without sanding, or Seal-Once sealers and tints.

According to the *Gazette*, TTT was not responsive to inquiries from the Summit House project; a TTT representative was sent for one site visit with no follow-up, which was called an "empty gesture" by Orfant. Embry said that TTT has a sample of the Summit House wood in its lab and is examining it, but he told *EBN* that "our updates to them probably have not been as frequent as we would like;" however, TimberSIL has "offered to work with them" and has "not had a claim."

TTT president Karen Slimak, TimberSIL's inventor, questions whether the Commonwealth used the right expertise to address the problems. "They went with someone who was expert in painting wood but who knew nothing about TimberSIL," she told *EBN*.

Making it wrong at Make It Right?

While the problems at Summit House could be seen as a project-specific issue, reports of problems on Make It Right homes in New Orleans have raised questions about the durability of TimberSIL, and the high profile of Make It Right and its actor founder, Brad Pitt, have attracted attention to the problems.

According to Embry, who toured the Make It Right homes in January 2014, about 100 homes used TimberSIL in decking applications, and, he said, "Make It Right indicated that 30 had problems, and of the 30, about half

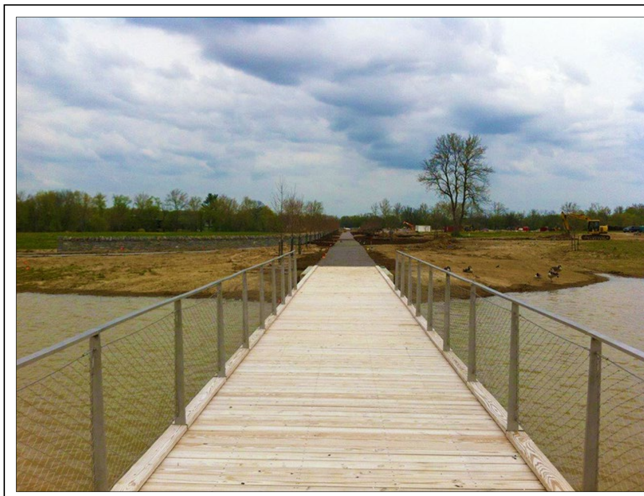


Photo: Timber Treatment Technologies

The Louisville Parkland Project uses TimberSIL in walkways, bridges, and boardwalks to connect several park areas over water and wetlands.

have already had the TimberSIL wood replaced by other wood." As reported in *The Advocate* of New Orleans, Embry says that the TimberSIL generally has a gray, weathered appearance. The wood was not sealed, says Embry, who contends that "any wood that has been in the weather would gray" in a similar fashion.

In addition to graying, there is some rot, acknowledges Embry. He says that in cases where wetting of the wood has been concentrated, such as under eaves, "the aging or weathering is more pronounced, and in some cases there is rot." He added, "The moisture content of the wood indicates that at those points, some aspect of the treatment has broken down." However, Embry said that news reports suggesting widespread rotting are incorrect, with rotting concentrated in those locations. Neither a Make It Right spokesperson nor the group's head of construction responded to *EBN*'s requests for comment.

TTT argues that the key issue at Make It Right is a lack of sealer. Says Embry, the Make It Right homes were done in 2008–10, and "we did have installation guidelines in that period that recommended sealing." He also said, "Since 2010, we have made a stronger case with all of our customers that a sealer is highly recommended, and it is now a part of our warranty program." Embry says that TTT would honor its warranty with Make It Right but that the terms had not yet been discussed.

In the meantime, TTT is studying samples from Make It Right to determine whether there was a defect in the TimberSIL treatment. Even with the lack of sealer and the exposure to wetting, the rot is a surprise, says Embry. TTT has continued to improve TimberSIL since 2008, he says, but "we wouldn't expect any of our products to have this problem"—even the older ones.

Make It Right is currently removing and replacing all TimberSIL on its homes, whether rot is evident or not, at a reported cost of $150,000. That's an overreaction, says Embry. "There are remedies that could be taken well before replacement would be required," he said, such as selective replacement, sanding and sealing boards that remain sound, and even use of fungicides to kill accumulated mold and mildew (though this latter approach would take away from one of the major attractions of the product).

Photo: Mike Guertin

This mysterious fuzz "comes and goes" on his TimberSIL installation, says Mike Guertin.

Echoing the experience of Summit House, TTT was called "unresponsive" in the press by a Make It Right spokesperson, a charge disputed by TTT. "We were not consulted. We were not invited to solve this," said Embry. He continued that between 2008 and 2010, TTT had some conversations with Make It Right about weathering, and since 2010 Make It Right has used conventional treated southern yellow pine on its homes. "We did not realize they were having this problem until November" of 2013, said Embry, when TTT received a letter threatening legal action.

Is TimberSIL under attack?

Both Embry and TTT founder Slimak suggested that TimberSIL was the victim of a campaign to discredit it by conventional treated-wood interests.

"We have competitors, and the wood that is replacing TimberSIL now is a competitive material," said Embry. He speculated that replacing TimberSIL rather than seeking remedies through TTT could be the result of a competitor getting between the two parties. "If they went to our competitors to get advice for a remedy, the remedy from the salesman was to take that out and buy some new."

While Embry said he was speculating in the case of Make It Right, Slimak says that pattern has played out before. "Every single building where they go public with having used TimberSIL, they get called" by treated wood competitors, she told *EBN*. "If they couldn't talk them out of it [TimberSIL] before the fact, they would come in and say all kinds of negative things and then be there if there was a question, to tell them the only thing to do is to replace it." While Slimak did not provide concrete evidence of such actions, there is precedent for chemical industry attacks on TimberSIL (see "Chemical Industry Challenging TimberSIL").

Slimak said that any warranty claims would not harm the overall standing of the company, either in the marketplace or in financial terms. To the contrary, she referred to "massive" contracts TimberSIL has in the railroad industry both domestically and globally, and she professes confidence in the product. "TimberSIL outperforms the treated wood products on their best days," she says.

Disputed studies abound

Whether or not TimberSIL bests conventional copper-treated wood and lives up to its 40-year warranty should be a matter of science, not opinion, but studies examining the question are mired in dispute. A 2009 study, "Decay Resistance of TimberSIL Treated Wood," conducted at Oregon State University, has been withdrawn due to a suit filed by TTT.

Nonetheless, one of the authors, James Morrell, a professor at Oregon State, told *EBN* that in the study, "we saw no difference between TimberSIL and untreated wood." The methodology was an accelerated aging test that exposed ¾" cubes of wood to decay organisms.

According to Slimak, the study was "discredited" for not following industry protocol for testing treated wood. In any board of treated wood, TimberSIL or otherwise, treatment solutions do not reach the heart of boards. In normal installations, any cuts into the treated wood should be coated for protection, with a copper solution in the case of treated wood. In the case of TimberSIL, TTT recommends sealant on end cuts that will be in ground contact. Slimak contends that this aging test, with five cut, untreated sides of the wood exposed, not only was inappropriate for testing the efficacy of the product but also was designed to fail.

Morrell told *EBN* that he would be willing to repeat the test with fully coated product anytime TTT wanted to cooperate, and in fact, "we just put out a test where we coated everything we got," he said, noting the test was in Hawaii and would take two years to net results, because it is using full dimensional wood. Regarding Slimak's complaint, he acknowledged the limits of the lab test but said, "Even if the barrier were compromised, some part of the treatment should have been protective," but he reports no evidence of protection afforded by the TimberSIL treatment as measured by reduced weight loss from decay in the treated samples.

So is there any valid lab data on TimberSIL? Slimak shared with *EBN*

Photo: Alex Wilson

EBN *founder Alex Wilson had TimberSIL installed on his Vermont farmhouse in 2013 but says it is too early to judge its performance.*

the unpublished results of a 2011 test commissioned by TTT and performed by Louisiana State University. That test, done according to a common standard for the treated wood industry, measured the resistance of TimberSIL—cut into ¾" cubes—to three brown rot decay fungi, with untreated southern yellow pine as a control. The test spanned 12 weeks, and TimberSIL fared well, suffering less than 5% weight loss, while the untreated samples lost as much as 50% of their weight.

Asked by *EBN* for his opinion on the testing, Morrell said that it appeared to follow standard procedures and to produce favorable results. His one quibble was that the study does not report the level of treatment in the TimberSIL product, in contrast with studies like the one just discussed, which details the levels of copper treatments retained in the wood samples. In response, Slimak told *EBN* that the samples were typical of TimberSIL products sold at the time.

Something rotten in copper?

Slimak also went on the offensive, arguing that all is not well with conventional copper wood treatments. As evidence, she points to "A Comprehensive Review of Copper-Based Wood Preservatives," published in the *Forest Products Journal* in 2008. That study looked at the efficacy of micronized copper formulations, which were relatively new at the time, and concluded that they were just as effective as conventional solution-based formulations.

However, Slimak finds a different conclusion in the study's data: that *none* of the copper-based products perform well. The study shows that even wood with the highest concentrations of copper preservative retains only 73% of its structural soundness after 30 months in conditions ideal for decay, while some samples had less than 50% of their soundness. This is no surprise, Slimak says, claiming, "Large commercial projects tell us that the new treated wood products do not last six months."

Morrell, who was not involved in that study, says that Slimak is missing the point. Like the accelerated aging test of TimberSIL, this study used small sticks of wood: for that particular test, 3mm x 14mm x 150mm samples of wood were used. "In small-scale testing, you tend to fail things much sooner than in real life," says Morrell, arguing that the test only reveals relative, not absolute, durability. But Slimak contends that the fully treated sticks should have held up better.

While clarifying the results of that study, Morrell acknowledged that the treated wood industry hadn't fully resolved the durability of current copper-based treatments in the last decade of industry transition (see "Treated Wood in Transition"), with conflicting studies and claims abounding.

Reports from builders

EBN asked TTT for contact information of customers similar to Make It Right—large customers who have used TimberSIL on multiple projects, going back a few years. TTT was not able to provide that, instead offering contacts that had either installed the product within the last six months, or had worked only on isolated projects.

Representatives of several of the recent projects, which included a deck for an architectural office in Texas, and a fence at a rail station in Florida, were optimistic about the product, with nothing unfavorable to report.

Mixed reviews came from Kevin McLemore, the project manager on the HGTV "Toolz" Project House in Phoenixville, Pennsylvania, where TimberSIL decking was installed in June 2013. "It's a great product," he said, adding, "I would use it on any other project." While enthusiastic, McLemore reported issues that might have frustrated other builders: sanding the wood to meet TimberSIL guidelines was intensive due to the wood's hardness, burning through two sanders before it was done with a commercial-grade unit. He used Seal-Once according to company specifications, but reports that it came off when the decking got wet. "If I had to do it over again, I would suggest the company have it either pre-sanded for the stain, or figure out another stain option," he told *EBN.*

One project, dating to 2004 and reportedly the first major installation of TimberSIL, uses TimberSIL as the support structure for a 5,000 ft2 education center in Venice, Florida, in which part of the structure is built over a retention pond. Al Bavry of Kimal Lumber, who built and owns the building, says, "We check it from time to time, and I would have to grade it pretty much bulletproof. We haven't seen any deterioration," he said.

One builder we reached, author [Mike Guertin](), said, "I don't plan on using TimberSIL on any clients' decks." He explained, "I had high hopes for TimberSIL" in using it on a 900 ft2 deck at a rental house where he could keep an eye on it. One board rotted, he said. "It was under a door mat so likely had a lot of trapped moisture. Still, it should not have rotted in just five years," he said, complaining, "TTT didn't reply to my inquiries about the problem." Guertin had faint praise for the rest of the installation, comparing it to regular pressure-treated wood, with "end checking, splitting, splintering" and adding, "There's an unusual fuzz [that] comes and goes."

More issues with sealants

BuildingGreen's Web designer, Andrea Lemon, who installed TimberSIL as decking in 2012 on her [Vermont Passive House](), reported problems with coloration and sealants. Following TTT's recommendation, she contacted Keim for an appropriate sealant but was told that the company didn't yet have a product suitable for TimberSIL. Turning to Seal-Once, Lemon reported that the "colors were inconsistent and did not resemble the samples particularly well. Our deck came out quite yellow in spots." Within a year, she reported, "the yellow mostly faded, and now the deck is just a bland, grayish wood color."

Asked for clarification on Keim's offerings, Michael Maloon, a product specialist for the company, told *EBN* that Keim does not offer a product for horizontal wood surfaces such as decking. "Keim has never done any testing on their [TimberSIL's] product," Maloon admitted. "Theoretically, it should work fine," but he also noted that "15% to 18% is ideal for Keim" in terms of moisture levels—lower than what TimberSIL guarantees.

EBN also spoke with Seal-Once president and owner Hank Croteau, who said there is "no question" that Seal-Once should hold up well on TimberSIL decking. However, Croteau repeated the advice to sand the product first, and he also recommended another step not mentioned by TTT—pressure-washing the product after sanding, to clear out dust that would prevent the sealer from penetrating. Croteau said that Seal-Once can be applied even on wood with moisture levels over 20%.

Asked why TTT requires customers to sand a hardened wood product and apply a stain reported to be problematic, and whether this could be done more successfully in the factory, Slimak told *EBN*, "We are looking at options to do exactly that." Croteau said that he had discussed with Slimak applying Seal-Once at TTT's factory three years ago but that Slimak had not followed through on the idea.

Other reviews are mixed

Based on testing, *Consumer Reports* [gives TimberSIL decking]() a score of 67 (out of 100) based on "resistance to color change, staining, slips, flexing, sagging, mildew after one year outdoors." That may not sound like a great score, but it's the publication's highest-rated wood decking product, and *Consumer Reports* calls it "recommended" while reserving its "best buy" recommendation for copper-treated southern yellow pine, which received a 63 rating. *Consumer Reports* rated the product well in all categories it tested except resistance to color change and resistance to staining—categories in which all wood decking products were weak. *Consumer Reports'* review of plastic, composite, and aluminum decking turned up several products rated higher than TimberSIL—all of which were significantly more expensive.

However, user reviews on *Consumer Reports* trended toward the negative, with only three out of 11 saying they would recommend it. Complaints mentioned inconsistent handling directions, premature aging and weathering, rotting, sealant failure, and poor responsiveness on TTT's part. The legal profession has taken note: more than one law firm has posted notices online gathering customer complaints for potential class-action lawsuits.

TimberSIL is different

While opinions on TimberSIL appear polarized, everyone who has been involved with the product would probably agree that it is different—a point emphasized by Embry, who said, "We're an innovative material."

"There is a tendency to want to treat us like other wood products, and we have properties that are different, and that's what makes us great," Embry said, adding, "When something doesn't go right, we would like to know about it."

Given TimberSIL's pluses—no toxic chemicals, use of renewable resources, and relative affordability, to name a few—we can only hope that TTT is able to prove its critics wrong by addressing complaints adequately, proving the durability of its product in the field, and helping scientists deliver more data on its effectiveness in different applications.

Passive House Windows and Doors Continue to Wow

Exciting new doors and windows featuring cork, composites, and low U-factors have come to U.S. markets.

By Candace Pearson

For evidence of the growing influence of the Passive House standard, look no further than the North American market for efficient windows and doors, where new and innovative products engineered to meet the standard seem to appear all the time. Case in point: an entire "Passive House Zone" at the 2013 Greenbuild conference was dedicated to featuring Passive House manufacturers and service providers.

Among the new wave of highly efficient windows and doors, some are going beyond the strict energy criteria set by the Passivhaus Institute (PHI) to offer additional green features and innovations designed to reduce overall environmental impact. Most frontrunner products are imported, suggesting European manufactures continue to lead in quality (see "European Windows for Passive House Buildings"). However, U.S. manufacturers have begun to certify windows through the international standard and may soon offer products with competitive performance and lower embodied transportation energy.

European Architectural Supply

European Architectural Supply (EAS) offers two lines of Passivhaus-certified windows and doors. The Schüco ThermoPlus line with PVC frames (also called the Schüco Alu Inside) is offered in several configurations based on the amount of insulation used, but only the most insulated is PHI-certified. Advertised as "uPVC," or unplasticized PVC, this material is equivalent to the PVC used in most vinyl windows. The system has seven chambers that can be left "naked," according to to Patrik Muzila from EAS, or filled with polystyrene insulation inserts—a material that carries health concerns because of the chemical HBCD (see "Polystyrene Insulation: Does It Belong in a Green Building?"). However, the inserts significantly increase the energy efficiency of the frame, lowering the U-factor from U-0.16 (R-6.3) to U-0.14 (R-7.1), and if an additional multiple-chamber insert is also added, the frame achieves U-0.13 (R-7.7) and is PHI certified, according to Muzila. The system achieves a whole-window U-value of 0.11 (R-8.7). This system is EAS's less-expensive Passive House option, starting at $36 per square foot.

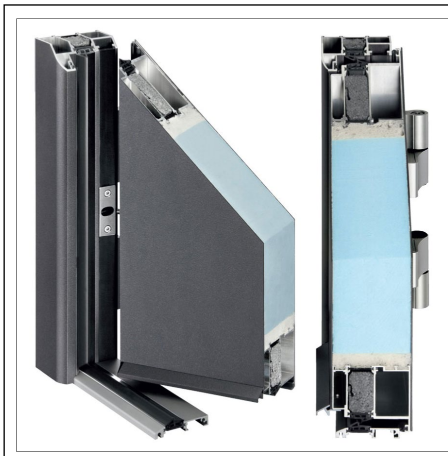


Image: Groke

Three-latch multipoint locking improves both airtightness and security, according to Groke, which is currently seeking Passivhaus certification for its doors.

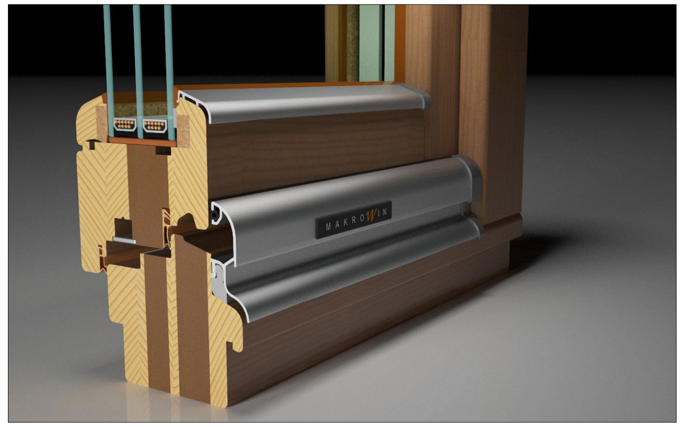


Photo: European Architectural Supply

The Makrowin MW88G2 line is foam-free and uses cork to insulate the frame.

EAS also offers the Makrowin MW88G2 line, which is foam-free and uses cork to insulate the frame. As a biobased, sustainably managed, and rapidly renewable material, expanded cork avoids the hazardous chemicals of foam and offers structural stability that could increase the windows' durability. The wood windows and doors of the Makrowin MW88G2 line incorporate sustainably harvested cork from Portugal and can be built using wood certified by the Forest Stewardship Council (FSC). "The cork maintains rigidity so that we are not compromising the structural integrity of the window," according to Muzila.

Its insulating properties also allow for a slimmer profile. The company claims Makrowin windows are the thinnest PHI-certified wood windows, achieving a whole-window U-value of 0.12 (R-8.6) at 3.46 inches thick (88mm). Extruded aluminum cladding is offered for the exterior, and triple glazing from Saint-Gobain provides a solar heat-gain coefficient (SHGC) up to 0.62. The company works with Passive House designers to adjust SHGC values for different sides of the building. Makrowin windows start at $52 per square foot.

Klearwall Windows and Doors

Klearwall offers EcoClad, a line of aluminum-clad wood windows and doors that are manufactured in Ireland. These windows have an aluminum exterior, a PVC-encased polyurethane insulating core, and a wood frame interior. These composite windows, offering the interior aesthetics of wood with the exterior durability of aluminum, can achieve a whole-unit U-factor down to 0.13 (R-7.7).

Ewen Utting used EcoClad for the Equilibrium House, a San Francisco home certified to the Passive House Institute U.S. (PHIUS) building standard. "A wood window needs maintenance and doesn't stand up in ten years," Utting told *EBN*. "The aluminum will last, the vinyl performs, and the wood cladding creates the feel of wood."

Utting also found the price was less than that of German equivalents. According to Klearwall sales director Brendan Harte, these windows are a comparatively affordable option starting at $35–$40 per square foot. Utting was convinced to "go with a company no one has ever heard of" because of added perks: FSC-certified wood for the interior pane comes standard, and the Klearwall factory harnesses energy from two onsite wind turbines and a co-generation plant.

Groke Aluminum Entry Doors

Groke entry doors are currently pursuing PHI certification, but they are worth keeping in mind because, unlike many companies that only offer Passive House doors when you buy a large number of windows, Groke sells high-performance entry doors individually.

Groke doors are available in three thicknesses based on how much extruded polystyrene insulation they contain—0.94" (24mm), 2.52" (64mm), or 3.70" (94mm)—with triple glazing that comes standard on the upper two thicknesses. Doors with 64mm of insulation have an overlay panel on the outer skin of the door, and the 90mm doors have overlay panels on both sides. These all-aluminum doors achieve a whole-unit U-factor that ranges from U-0.257 (R-3.9) down to U-0.13 (R-7.7), and they are powder coated.

According to Allen Nelson, product manager at Groke, people are usually interested in Groke doors either for energy efficiency or security, but in reality, the features overlap. Three-latch multipoint locking is more secure and better seals the door against the gaskets, which prevents air leakage, he claims. Most Groke doors are rated class 4 in the air permeability test DIN 12207—exceeding the requirement for PHI certification.

Groke doors are expensive, typically ranging from $3,000 to $8,000; costs for the custom-made shipping crate alone can amount to $500. However, "there is a real lack of doors that meet Passive House criteria," Nelson told *EBN*. "We are finding that, in a lot of cases, our customers are willing to pay for a high-end residential entry door."

More in GreenSpec

These products are welcome additions to the roughly half-dozen Passivhaus-certified or near-certified windows already listed in our GreenSpec directory; see all the options here.

Carnegie Renews Wallcovering Options with Biobased Xorel

PVC-free wallcoverings have gotten greener with a new high-performance, sugar-cane-based textile from Carnegie Fabrics.

By Paula Melton

Carnegie Fabrics has introduced Biobased Xorel—an updated version of its high-performance wallcovering textile made from polyethylene yarn. The company uses sugar-cane-derived ethanol for 60%–85% of the material, and three of the most popular Xorel patterns are no longer available in the original fossil-fuel-based version, according to Cliff Goldman, president of Carnegie, who told *EBN* that there is no cost premium for the biobased version of the product and that the product performs exactly the same way as the traditional fabric.

Durability

Wallcovering innovations have been rare in the last decade.

Once ubiquitous in healthcare, hospitality, and higher education, this design choice has fallen out of favor somewhat in many building types. That's due both to the first cost and to durability issues, especially with PVC-based (vinyl) products, says Scott McFadden, vice president and design director at HKS in Indianapolis. Although vinyl wallcovering was originally billed as easier to care for than a painted surface, nowadays "from a maintenance perspective, a lot of facilities people don't want to use it," according to McFadden, because it's "very difficult to repair or patch if it is damaged."

Not all wallcoverings have this problem, says McFadden, reporting that Xorel—along with some similar woven products from Designtex and Knoll—is "almost indestructible." Although his division of HKS uses little wallcovering now in comparison to a few years ago, "Xorel is one that we do use quite a bit—especially in healthcare." That's because it can take a licking in an area like a hospital corridor, where it might be banged and scuffed frequently by stretchers and wheelchairs. And it can be scrubbed down or even cleaned with diluted bleach, McFadden said, a cleaning practice used in some hospitals.

Lorraine Francis, director of hospitality interiors at Gensler LA, concurred about the durability of Xorel and additionally praised its suitability for hotels and resorts; for a Grand Canyon National Park Lodges project, she specified the product for headboards "because it is as strong as 'leather vinyl' but greener."

Material health

Some design teams focused on occupant health have also shied away from wallcoverings in recent years. As interior paints and other coatings have improved their environmental and health profiles, multiple issues remain with wallcoverings. Xorel and Biobased Xorel are halogen-free and inherently flame resistant (meeting Class A or Class 1 under ASTM E84 without added flame retardants), Goldman says, but that's not the case with most wallcovering products. Independent testing has also shown the material doesn't support the growth of microbes, even when backed with paper.

The overwhelming majority of wallcoverings are flexible vinyl, laden with all the concerns that come with PVC and certain phthalate plasticizers (see "The PVC Debate: A Fresh Look"). Thermoplastic polyolefin (TPO) is gradually replacing vinyl, says Goldman, because "we're able to create products very similar in performance and look to PVC without chlorine or plasticizers." Yet, unlike vinyl, TPO wallcoverings and some woven products typically incorporate a flame retardant. (Carnegie uses a non-halogenated, clay-based flame retardant for its TPO wallcoverings, Goldman says.)

Many woven products, including the original Xorel, are also made from fossil fuels, a drawback for many de-

Photo: Carnegie Fabrics

The embroidered Topiary wallcovering from Carnegie fabrics is now available with biobased polyethylene content.

sign teams. However, the natural-fiber options offered by the wallcoverings industry rarely have the performance required for heavy-duty applications like healthcare. In addition, antimicrobial coatings may be applied to textiles, and stain-resistant coatings with brand names like Teflon, Crypton, and Nanotex, all of which contain perfluorocarbons (PFCs), may be added to linen, polyester, silk, and other fabrics used as wallcoverings—just as they are applied to fabrics used for furniture (see "The Chemicals on Our Carpets and Textiles.") When specifying non-vinyl wallcoverings, designers should ask manufacturers about flame retardants, antimicrobials, and stain repellants to ensure they're not introducing potential health hazards into the project.

Finally, adhesives used throughout the building industry may contain any number of potentially hazardous substances—as well as chemicals whose health profile is unknown, which can be more problematic. Low- and zero-VOC adhesives for wallcoverings should be readily available, but full ingredient listings will probably not be. Goldman says Carnegie typically recommends a clear, vegetable-starch-based adhesive for hanging its products; these can be used for vinyl wallcoverings as well. "Most adhesives today contain a bactericide and mildewcide to prevent mold growth," he cautions. (Biocides have become ubiquitous in interior products; see "FDA: Antimicrobial Risks Outweigh Benefits.")

Moisture concerns

With few exceptions, high-performance wallcoverings are not vapor-permeable.

Poor planning regarding the vapor profile of exterior assemblies has led to moisture issues in some climates—particularly in the hospitality industry, which still makes frequent use of wallcoverings—as warm, humid air infiltrates exterior walls that are unable to dry to the interior because of the non-permeable wallcovering. Mold and rot can result. "Some architects have banned wallcoverings on exterior walls" to avoid this problem, says Goldman, but he argues that's unnecessary because most products can be *micro-vented*, or perforated with thousands of tiny holes.

These holes make the material vapor-permeable, but liquid water can't penetrate due to the small size of the openings. "Almost any wallcovering can be made 'breathable' through venting," he said. "There are some naturally breathable wallcoverings, but a lot of those products are not high-performance. They work for an office, maybe, but not in an area that takes a lot of abuse, like healthcare." Micro-vented wallcoverings can still be wiped with water and whatever cleaning agents the manufacturer says are appropriate.

Certifications & sourcing

Biobased Xorel has achieved the Cradle to Cradle multi-attribute certification at the Gold level (the non-biobased version is Cradle to Cradle Silver), Indoor Advantage Gold for indoor air quality, and a four-star rating (indicating a very high percentage of biobased content) through the OK Biobased program, an international certification that provides independent testing of biobased content according to ASTM D6866. Carnegie has also released a Health Product Declaration (HPD) for Xorel.

What about the rainforests?

Carnegie has claimed the material used to make Biobased Xorel is carbon-negative: the sugar cane itself sequesters carbon, and sugar cane waste is used to generate electricity. But land use and field management are equally important in judging the sustainability of biobased plastics (see "Biobased Materials: Not Always Greener").

Goldman told *EBN* Carnegie's suppliers had likely not been through the certification process for the Sustainable Agriculture Standard (SAN), which is referenced in LEED v4—and that LEED would not likely be a driver for this certification, since the building industry is such a miniscule part of Brazil's sugar cane production—but "we have a lot of information about how the sugar cane is grown and how the fields are managed." Although some sugar cane plantations have been implicated in rainforest destruction, Goldman said, "Fields used to grow sugar cane for ethanol are 2,500 kilometers from the Amazon and therefore have no land-use effect on the rainforest." Additionally, burning sugar cane fields before harvest has been a common practice that emits particulates and other pollutants and may have localized environmental impacts. Goldman said this practice is being phased out in Brazil and will end by 2017.

Among biobased materials, Goldman contends, corn is a far more controversial feedstock than sugar cane, which "packs way more energy in every ton, uses much less land, and is much more carbon efficient," he says, adding that one ton of processed sugar cane produces 9.3 tons of renewable energy—in contrast with corn's 1.4 tons. (That said, corn was not even an option for Biobased Xorel because Carnegie was seeking an exact performance match for its regular polyethylene fibers.)

Gensler's Francis said she's looking at Biobased Xorel for two projects right now. "We still use vinyl," she said, but "I try to get away from it," though she added that cost is almost always the biggest issue. Xorel has a sheen that's not suitable for every project, she explained, but when she wants to use a high-performance wallcovering, she feels she has a story to tell because Carnegie reps actually know where their products come from, exactly what's in them, and why they're made the way they are. She also thinks her clients are ready to hear that story.

"We are a global hospitality firm, and we have to look at the next generation—and that next generation has different values for where they choose to stay," Francis believes. "It's not just about the bottom line."

BACKPAGE PRIMER

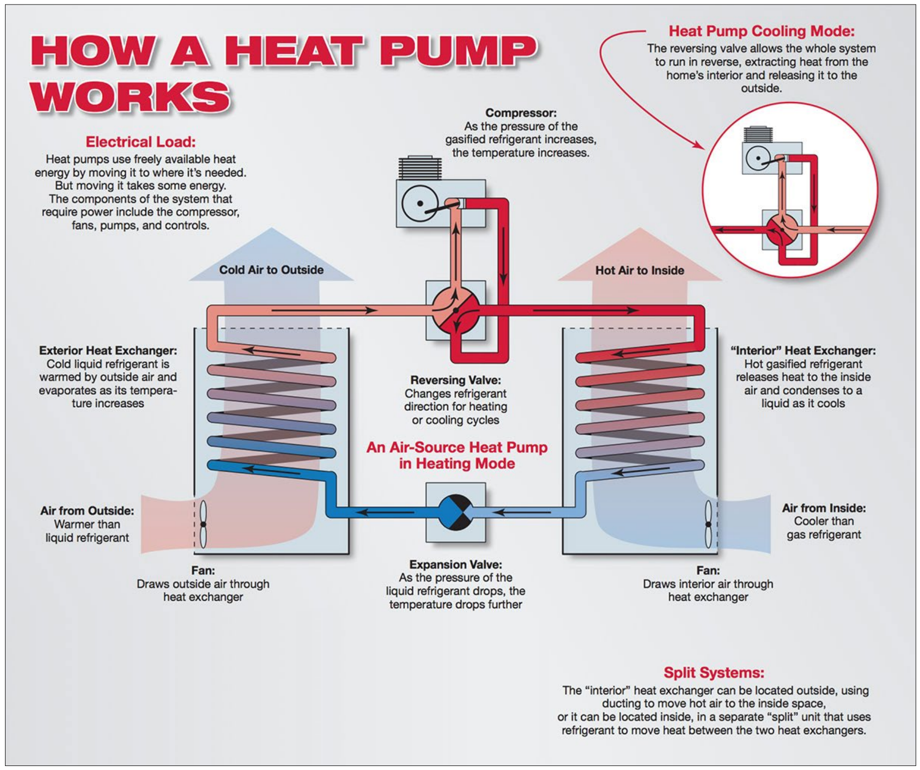
How Air-Source Heat Pumps Work

Heating with cold air? Cooling off with hot air? Heat pumps performing these feats (especially mini-splits and VRF systems) have taken off, but how do they work?

Air-source heat pumps have been growing rapidly in popularity over the past decade. In many regions, simple point-source *mini-split* systems are now the leading choice for designers and builders of high-performance green homes, and more sophisticated variable-refrigerant-flow (VRF) multi-split systems are popular in multifamily and commercial buildings.

All heat pumps perform the same basic function: they move heat from one place to another, using electricity. In heating mode, *air-source* heat pumps move heat from the outside air into a building; in cooling mode, they take heat from the inside air of the building and dump it outdoors, cooling the indoor space in the process.

Keeping an indoor space at 70°F using 0°F outdoor air is a bit counterintuitive; we're used to heat flowing from warmer to colder, as the second law of thermodynamics says it should. The key to heat pumps—used for decades by our refrigerators—is the *refrigerant cycle* or *vapor-compression cycle*, driven by electricity.



This schematic is reprinted here courtesy of Home Power Magazine, homepower.com.

With the vapor-compression cycle, a specialized refrigerant fluid alternately evaporates and condenses—absorbing and releasing heat in the process. All this takes place in a closed loop that is typically split, with part of it outside the building and part of it inside.

The operation of a heat pump varies depending on whether it is used in heating or cooling mode. In the heating mode, evaporation takes place in the outdoor coils and condensation in the indoor coils. In the cooling mode, the opposite occurs, with the outdoor coils becoming the condenser and the indoor coils becoming the evaporator.

In heating mode, very cold liquid refrigerant is pumped through heat-exchange coils exposed to the outside air. This outside air—even at 0°F in winter—is *warmer* than the sub-zero refrigerant, and it warms the refrigerant enough to evaporate it (change its phase from liquid to gas).

Still outside the building, that refrigerant gas is then mechanically compressed using a compressor (the loudest part of the heat pump), which raises its temperature. As a hot gas, this refrigerant then flows into the house through insulated piping to the interior heat-exchange coils. Indoor air is blown across these coils, warming that air. As this happens, the refrigerant cools and condenses back into liquid.

Finally, to complete this loop, the refrigerant (mostly liquid at this point) flows through an expansion valve, where the pressure is suddenly reduced, causing the refrigerant to cool off further.

In cooling season, the process is reversed. What had been a heat source (the outside air) becomes a heat sink, and what had been a heat sink (the inside air) becomes a heat source. The same indoor and outdoor heat-exchange coils are used, but their function reverses.

The technical wizardry inside these heat pumps allows for impressive coefficient of performance (COP) numbers, often 3 or more. That means that for every one unit of energy used by the system (as electricity), three units of heating or cooling energy are provided.