Take Control of Your Materials: Four Empowering Lessons from Teams That Beat the Red List

Need to streamline your product vetting process? These LBC project teams have it down to a science, and anyone can apply their methods.

By Paula Melton

It was a Living Building Challenge project team’s worst nightmare.

After months of vetting—most LBC teams report eight or more hours of research per product—to achieve the stringent rating system’s requirements, the team for the Bechtel Environmental Classroom at Smith College discovered a forbidden substance in the completed project.

“The forbidden substance. There is one 2-foot-long piece of PVC in our Living Building,” confesses Reid Bertone-Johnson, a lecturer in landscape studies at Smith and manager of the college’s MacLeish Field Station, where the Bechtel Classroom is located. “It turns out the supplier of our composting toilet sent us a version that was not compliant.”

Kicking up such a fuss about 24 inches of pipe may sound absurd to anyone who hasn’t worked with LBC. Yet the results speak for themselves: LBC is making rapid headway in the marketplace, convincing major manufacturers to eliminate common but problematic substances like PVC (Phoenix), phthalates (Prosoco), formaldehyde (Smith & Fong), and halogenated flame retardants (Knauf). And it doesn’t need to stop there. Embedded in this tale are at least four clear lessons that project teams can apply to any project—not just Living Buildings.

“I agree that that was better than changing out this one piece of PVC,”

Bechtel kept its pipe, and ultimately, Bertone-Johnson points out, the choice to remove PVC from its supply chain paid off for Phoenix when its products were used in Seattle’s six-story Bullitt Center—possibly the largest building in the world to be served exclusively by composting toilets.

“The end game is to create products that have closed-loop life cycles with no carbon footprint and are free of known [toxic substances],” argues Chris Lee of Philadelphia-based Re:Vision Architecture. Although the industry is a long way from this goal, he believes current trends are moving the marketplace in the direction of net-zero impact. “If manufacturers use and learn from environmental product declarations and Declare, designers create conceptual life-cycle and energy models while paying attention to material toxicity, and contractors...
consider materials transportation decisions, I think we can get to net-zero-impact products.” Lee adds, “If we can share lessons along the way, having a net-positive impact … this will not seem so far out of our reach.”

1. Limitations Are Just Innovations You Haven’t Met Yet

LBC is known as the world’s most stringent green building rating system for a reason: requiring net-positive energy, water, and waste in its latest version (3.0), it sets a bar that can look almost ridiculously high. Yet people succeed in part because the program’s rigidity and specificity can actually simplify things, project teams report.

In its Materials Petal—“petal” is the name for a category of requirements, or “imperatives”—LBC 3.0 has five distinct requirements:

- Avoid toxic compounds from the LBC Red List (see the table below for the complete list).
- Purchase a one-time offset for the embodied carbon of the building.
- Choose products from the Declare database and materials meeting third-party sustainability standards.
- Use regionally sourced materials.
- Design for net-negative waste from construction, operations, and demolition.

Although all these imperatives have parallels in LEED and other rating systems, LBC is different because all the elements are required: unlike in LEED, for example, you can’t foreground occupant health while letting embodied carbon fade into the background. Bruce Coldham, FAIA, of Amherst, Massachusetts-based Coldham&Hartman Architects, puts it this way: “It’s not a menu; it’s a table d’hôte. There’s a meal served, and you take the dinner that’s being served.”

“It changes how you design”

“You talk to designers who’ve been through this process, and they say, ‘Yep, it’s changed how I think about materials,’” says Jim Newman, owner and managing partner at Linnean Solutions. “It has this effect where you simplify what you’re using because otherwise it drives you nuts. It changes how you design.”

Corey Squire of Lake|Flato Architects concurs that having to stand firm on specific rules for the firm’s first LBC project, the Josey Pavilion, has transformed how they look at materials for all their projects. “There are two ways of dealing with this petal: one is you really design the building based on the materials available. The other way to do it is you design the building you want and then go out looking for materials that comply.” Designing with a limited palette makes material selection easier but design harder, he says, which is why his team did it the other way around, focusing on design first and then doing extra work looking for materials they could use. Having done that work once, he says, “if we did a building in the same area, we would go to the material matrix [for Josey] and try to use the exact same building materials.”

The process will have cascading effects on other projects as well, Squire says. “I think that because we did this once, it’s really changed the way we see materials as an office and will hopefully influence our non-Living Building Challenge projects.” For example, they discovered that high-density polyethylene pipe has about the same price and performance characteristics as PVC, he explains. “We can eliminate PVC in the future, and we were only able to do it because of what we were forced to learn on this one project.”

At the Bullitt Center, Margaret Sprug, AIA, a principal with Miller-Hull Partnership and the project architect, says the team went with the materials-first option since, as she pointed out, every material you don’t use is a material you don’t have to research. “Our approach was to try to make the building structure be the finish material,” she explained, because “the fewer materials we needed to put into the building, the better.”

That was one factor in the project’s choice of wood for 80% of the structure, which doubles as finish, along with unfinished concrete and simple white metal panels on the exterior. “Most pigments other than white either have bad stuff in them or unknown stuff in them,” she says. Solar panels are prominently featured, their wires visible from the street. Bullitt’s aesthetic has been criticized, Sprug acknowledges, but she’s happy with it: “we wanted it to be raw, flexible, a little bit gritty, and be true to what it was.”

Writing your own rules

Many clients would prefer healthier materials, but most aren’t ready for the full LBC material vetting process. LBC project successes have demonstrated that laying out some absolutes for manufacturers can be a good way to get what you really want—but if you’re not pursuing LBC certification, how do you decide what to ask for?

Lessons: Create Product Rules

- Don’t be wishy-washy: know exactly what you want, and ask for it from manufacturers.
- Base your “product rules” on multiple considerations, such as long-term performance, occupant health, sustainable and ethical sourcing, carbon impact, and reuse or recycling options.
- To simplify the vetting process, simplify your palette of materials.
- Suit the design to the available materials rather than the other way around.
That was the question underlying a Living Future Conference workshop on “product rules” led by Tom Lent, policy director at the Healthy Building Network, and Robin Guenther, FAIA, sustainable healthcare design leader at Perkins+Will, in 2011 (see Materials Rules for Going Beyond the Red List). Inspired by food writer Michael Pollan’s list of pithy “food rules,” the group tried to come up with similar guidelines for choosing building products, such as “Pay more; use less” and “Use materials made from substances you can imagine in their raw or natural state.”

How to translate such guidelines into something you can present to manufacturers? A good first step is to request data about energy, carbon, sourcing, and ingredients, suggests Lee. It’s hard to start advocating for improvements if you don’t know what you’re working with in the first place. “Third-party life-cycle assessments and ingredient certification tools are providing manufacturers, contractors, and designers with metrics to evaluate manufacturing process and products,” he says. Once the information is available, “pushing manufacturers to look into and use more naturally derived ingredients that have the same performance and durability as existing products is essential.”

Project teams who have the lay of the land will be better able to decide on some practical rules—perhaps avoiding LBC Red List chemicals in interior products, or choosing envelope materials with low carbon impacts. (We discuss at length how to evaluate products by category in What Makes a Product Green?) But no matter what else you ask for, argues Lent, it’s important to put some focus on what you do want from products, not just what you don’t want—that is, avoiding “regrettable substitutions” (see The Problem with Red Lists). “I think one of the single most important things to throw into your materials framework as a product selector is to raise the issue of getting all the ingredients fully assessed,” he says. “Make sure you’re substituting better stuff for the bad stuff you know you want to avoid.” Lent recommends “asking manufacturers not only ‘Are you Red List-free?’ but ‘Do you understand what you’re using instead?’”

2. Bend, Don’t Break

As important as it is to begin with clear ideals, LBC project teams say, it’s equally important to recognize that exceptions are inevitable. What happens when you can’t get an attractive, ergonomic, regionally sourced task chair that contains no halogenated flame retardants? LBC has its own ways of resolving such conflicts, but if that system doesn’t make sense for your project, it is good to have a custom framework in place. Consider discussing material-related priorities explicitly with the owner: if you find a beautiful, comfortable, halogen-free task chair, but it comes from China instead of Chicago, is that acceptable? What if you can get the flame retardants out but the design choices become more constrained, or it costs 20% more? Asking questions like this up front will save time and simplify complex decisions later.

And all for want of a lead-free screw

The Red List looks deceptively simple. Once designers start choosing products, they can quickly get lost in rabbit holes that turn out to be dead ends. “There’s an exception for everything, and you need to know all the exceptions,” says Squire. “The Materials Handbook is incredibly complicated.” Adds Greg Mella, FAIA, vice president at SmithGroupJJR and project lead for the Chesapeake Bay Foundation’s Brock Environmental Center (pursuing LBC certification), “On one level, the all-prerequisite system is great; you’re never point-chasing. At the same time … it’s impossible.” He readily admits that his team relied heavily on exceptions, but even that wasn’t easy. LBC is “living” in more ways than one: “New clarifications are emerging; it’s

Lessons: Accept Exceptions

• To simplify decision-making, develop an explicit list of material-related priorities for the project.
• Don’t let the perfect be the enemy of the best you can do.
• Be aware that a red-list approach sets clear requirements for chemical avoidance but can also result in toxic substitutions.
• When a manufacturer can’t meet your criteria, advocate for changes that might help others in the future.
constantly changing,” notes Mella, and ILFI updates the system through the LBC “Dialogue,” an online forum. “A good chunk of what you’re doing is finding published exceptions,” continues Mella, who jokes that he and his team are ordering t-shirts that say, “I survived the Red List.”

This quest for purity can feel like a waste of time: many early adopters report conducting hundreds or thousands of hours of material vetting not reflected in their fees. Sometimes it’s hard to see the point. Squire notes that brass almost always contains lead, and his team had spent hours looking for lead-free brass door hardware for the Josey Pavilion, only to discover later that ILFI offers a temporary exception the team had overlooked.

One’s sense of the absurd may increase when scrutinizing the ingredient list of certain Red List-free products in the Declare database. Carpet backing can’t have PVC, but it may incorporate coal fly ash (which can contain heavy metals) or polyurethane (which, among other issues, uses a lot of chlorine during its production, one of the main complaints with PVC). Engineered wood should have no added formaldehyde but can use a polyurethane binder. These anomalies result from LBC’s choice to ban certain substances without providing an agile way of preventing substitutions that may also be questionable, or providing a clear pathway for optimization. Black-listing or red-listing certain chemicals is always going to be an imperfect exercise (see The Problem with Red Lists for more on red-listing versus hazard screening).

In addition to highlighting certain limitations of a red-list approach, LBC could be seen as an argument for the 80/20 rule—the idea that 80% of a goal can be achieved by doing 20% of the work, while the remaining 20% requires 80% of the work. Rather than seeking to remove every potentially hazardous substance from every last bit and bob in the entire building, doesn’t it make more sense to save time and money and get rid of the worst stuff in the majority of building products?

Not every project team will fully commit to the LBC approach, but someone has to, argues Scott Kelly, AIA, principal at Re:Vision Architecture, which (in addition to its architecture practice) provides training to other firms on the LBC Materials Petal. Asked about how silly it might look to an outsider to be fretting over a tiny amount of lead in door hardware, Kelly said, “Absolutely it’s absurd, until you look beyond the boundaries of your project and you realize how much door hardware is out there—and if you do the math on the lead content, you realize quickly it’s a football field every year. You have to look at the global scale.”

Eventually, pioneers in avoiding certain hazards have a way of pushing the marketplace toward elimination of those hazards (see our graphic look at this—the Hazard Avoidance Curve). James Connelly, Declare manager at ILFI, says this “network effect” is already making it easier for project teams to find products and materials that meet LBC criteria.

What’s more, despite its limitations, a red-list approach can make the task of chemical avoidance manageable; even with its current, relatively short Red List (which represents thousands of individual chemicals), the task is hard enough. “We don’t have every Green-Screen chemical on the Red List,” acknowledges Connelly. “That would literally make it impossible to build a Living Building Challenge project.” (The GreenScreen List Translator is actually a list of red lists that have been developed by governments and non-government organizations around the world and thus identifies and classifies almost every problematic chemical in commercial use.) The takeaway for non-LBC project teams? Set a high bar, but don’t let perfection become the enemy of the best you can do.

The “Now what?” moment

Although the process can get into the nitty gritty quickly, plenty of products and materials meet the stringent LBC requirements without even trying, notes Charley Stevenson, principal at Integrated Eco Strategy and a consultant on multiple LBC projects. These requirements go beyond the Red List and into the other imperatives like regional sourcing and reducing embodied carbon (not a requirement, but incentivized by the one-time carbon offset).
What’s Your Hazard Avoidance Profile?

Find yourself and your project on BuildingGreen’s hazard avoidance curve.

**PIONEERS**
What’s in this product?

**EARLY ADOPTERS**
That’s a hazard? Yikes! Avoid it.

**MAIN-STREAMERS**
Is there a good alternative?

**LATE ADOPTERS**
Is it easy and inexpensive?

**CLEANUP CREW**
It’s still here, people!

Over time, the concerns of the Pioneers tend to migrate to the rest of the market. Look to the group before yous to see what might be next.

Their Role in the Market

- When most of us haven’t heard of these hazards, their research and advocacy create awareness and leave a path of disclosure.
- Once alerted, they make avoidance a priority, providing support for market development of alternatives.
- When both hazards and alternatives are clearly identified, they provide critical mass to push prices down and bring alternatives within reach.
- Their broad base of demand helps complete market transformation away from a known hazard.
- They work to remove chemicals from existing building stock and in specialty products, while also providing advocacy in weakly regulated markets.

When They’ll Choose Alternatives

- If they’re doing a Living Building Challenge project or if the project type or client demands it.
- If hazards are well documented—even if there is a cost premium and choices are limited.
- When a hazard has become very well defined and alternatives are available—especially if the alternatives are higher-performing.
- When the “alternative” has become the obvious choice with little or no cost premium or inconvenience.
- They’ll help enact bans on hazards to bring alternatives even to the laggards.

Examples of Chemicals They Avoid

- alkylphenols
- chlorinated polyethylene
- chlorosulfonated polyethylene
- chlorobenzenes
- chloroprene
- chromium-6
- lead (in fixtures)
- phthalates (wet-applied products)
- PCBs (in pigments)
- PVC in wiring
- PVDC (polyvinylidene chloride)
- short-chain chlorinated paraffins
- bisphenol-A (in building products)
- CPVC
- hydrofluorocarbons (HFCs)
- perfluorinated compounds (PFCs)
- PVC piping
- halogenated flame retardants
- mercury (in lighting)
- phthalates (in flexible plastics)
- PVC interior finishes and cladding
- PVC windows
- bisphenol-A (in consumer goods)
- cadmium
- added formaldehyde
- hydrochlorofluorocarbons (HCFCs)
- VOCs
- wood treatments containing creosote, arsenic, or pentachlorophenol
- asbestos
- chlorofluorocarbons (CFCs)
- lead (paint)
- mercury (in thermostats)
- PCBs

To read more about how building project teams are using the Living Building Challenge and similar frameworks to choose greener materials and transform the marketplace, see www.BuildingGreen.com/redlist
“If we’re talking about gravel for the sub-base, there’s really no change from the gravel you would get for a non-LBC project,” he explains. “At the other end of the spectrum is something like plywood.” For LBC, it has to be free of added formaldehyde, certified to Forest Stewardship Council (FSC) standards, and extracted and manufactured within a certain distance of the project site. “That’s just completely impossible,” Stevenson asserts. “You get to the ‘Now what?’ moment,” he says.

This isn’t exclusive to LBC—most teams find there are tradeoffs when pursuing multiple goals at once—but the way LBC deals with the issue is instructive. The system has several built-in temporary exceptions as well as case-by-case exceptions. ILFI may make at its discretion when a project team demonstrates it did its best to meet all the requirements.

According to Stevenson, with the Materials Petal, there is an invisible hierarchy of imperatives. In the plywood example, the Red List and FSC certification are non-negotiable, he explains, so you may have to give up on regional sourcing for that particular project. Though exceptions are common, they aren’t taken lightly: even for pre-established exceptions, the project team must document all its failed attempts to meet the requirements, and the team also must advocate for change by writing letters to manufacturers who could not meet their needs.

A balance between rigid ideals and flexible practices helps because once practitioners have exhausted all their options for finding the perfect material, they can still move forward in a way that is positive instead of feeling defeated. Even a “failure” in LBC (like an accidental piece of PVC pipe) can transform the market—and there’s nothing keeping other programs from employing similar tactics. We are seeing broader versions of this type of advocacy in efforts like Google’s Healthy Materials program and the Center for Environmental Health Purchasers’ Pledge, and when manufacturers get the same message from multiple people and programs, they are more likely to listen, says Connelly.

### 3. Build Relationships, Not Just Buildings

Project teams are not working alone to achieve the network effect required for market transformation: they report the greatest success when collaborating with manufacturers to achieve reasonable goals.

**Conversations, not demands**

When LBC project teams come calling, their Red List in hand, “Plenty of manufacturers will say ‘Talk to my lawyer,’ or ‘We’re not interested,’” says Stevenson. “The goal is to find those that will engage in the conversation.”

When Stevenson says “conversation,” he means it. He emphasizes “how much collaboration this requires among owners, design team, engineers, contractor, subcontractors, and material manufacturers. I think that’s where the power of the system comes from because there’s no choice but to engage in these deep conversations.”

Practitioners requesting ingredient disclosure through the Health Product Declaration (HPD), whether independently or because of LEED v4 incentives, can achieve a similar level of engagement, as Rand Ekman, AIA, director of sustainability at CannonDesign, can attest. His firm is among more than 30 that in early 2014 began requesting HPDs for products they specify—documentation that eventually will become a standard requirement for these firms.

**Lessons: Work Together**

- Treat manufacturers as partners rather than adversaries.
- Reward change, even if it’s incremental.
- Streamline how you request the data you need.

Ekman sees the value in the absolutes inherent in LBC: “If we were doing a Living Building, it would be very easy: the client wants it delivered in this particular manner, and you have to do that or you can’t be on the project.” But since most projects aren’t working with LBC and most clients are not quite so choosy about their materials, he also sees the value in wading in more gradually.

“Really what we’re looking for right now is the information. People need to feel as though there’s room for them to make changes and make decisions and do what their design or manufacturing work is without being shut down right away.”

Ekman says his conversations with manufacturers have been humbling at times. “I personally was probably a little naive when I started down this path because the complexity of making things was something that I was just not really that familiar with,” he admits. “I needed to be open and learn from the manufacturer to communicate back into my firm what they reasonably can and can’t do.”

Although asking for a list of ingredients is quite different from showing up with a list of banned chemicals, this back-and-forth “is making an impact,” Ekman says. “I’ve been very happy that certain companies have really responded to the request; I think it’s taken them time to sort of gear up, hire people, and build the knowledge. From one of them, I heard they understand that well enough now to go back into their supply chain and ask the same kinds of questions.”

Kelly and his Re:Vision Architecture colleague Chris Lee report similar transformations under way after they have approached manufacturers through the lens of LBC and its Declare ingredient disclosure program (see Transparency Is the Secret Ingredient in “Declare” Products).

“We have had so much luck after talking to manufacturers and helping them understand what’s in their products,” claims Kelly. Instead of saying, ‘We will not use your product,’ we say,
‘Here’s some things that could be a problem for you; what can you do in the future to get them out?’

One insulation manufacturer listed both a halogenated flame retardant and a formaldehyde binder on its Red List form; at the time, those could not be changed for the project. A couple years later, the manufacturer decided to eliminate both of the problematic substances and join the Declare program—a choice initiated by that one attempt by an LBC team. (Note that although they usually do, manufacturers don’t need to avoid Red List substances to participate in Declare, but the label identifies Red List chemicals in red and other problematic substances in orange.)

As ILFI’s Connelly notes, initiatives like the HPD campaign and incentives for disclosure in LEED v4—supported by intentional harmonization efforts by various programs—are making life easier for everyone. “The materials transparency credit within LEED v4 has caused a real change in the tone of the conversation in the market,” he remarks. “Manufacturers are much more willing to engage on these issues now. It’s really a sea change, I would say.”

Companies, not just products

Once you’ve had the necessary conversations, Ekman emphasizes, it’s important to reward manufacturers that have responded positively. “Two years ago, this was a completely wide open and unfamiliar landscape,” he recalls. “I think it’s pretty remarkable how quickly they’ve taken to this set of issues and geared up. It’s laudable. It’s a good thing.”

CannonDesign has responded to this in part by preferring products from manufacturers that have begun publishing HPDs—even if the specific product doesn’t have one yet. “It’s a relationship question. We are looking at them as a company, not just products, looking in the context of other manufacturers.”

Systems, not random requests

Part of that relationship involves how you ask for information—not just how you use it. Many professionals who’ve worked on multiple LBC projects have their information requests and material vetting down to a science.

“We were inventing it as we went along” at first, recalls Kelly. “After the first project, we got much smarter and much faster,” and that continued as the firm was hired as material consultiants on other LBC projects and began training other firms on the details.

Lee took the lead on developing ways of asking manufacturers for data, and after several assays, he thinks the firm has finally settled on something that works: “We’re on our third version of the Red List letter,” he notes. Here is some of the advice he offers about communicating with manufacturers:

- Be friendly. Your first contact might not even mention the Red List (or HPDs or other disclosure requests). Lee said his first call to a manufacturer is typically to ask where their raw materials come from and where the product of interest is manufactured—since this information is lower-key but is also required for LBC. (It could also be relevant for LEED or other rating systems, so the advice translates to other projects.)

- Ask for material safety data sheets and other product data to get an initial sense of whether certain ingredients might be a problem.

- Send a standard Red List form for a technical professional to fill out. This is “the best way to get information back,” Lee stresses. Also, “when you give someone something to fill out, include instructions on how to fill it out. We’ve gotten it back ten different ways.”

- Be patient. Lee notes that manufacturers make mistakes: this is not business as usual. Sometimes they even send back an ingredient list that includes Red List chemicals while also signing a form saying the product contains no Red List chemicals. This is an opportunity to call back and explain what will be needed in order for the project to include the manufacturer’s product. But Lee says that before launching into his “Red List pitch,” he starts with small talk, setting the tone for an amicable conversation rather than a confrontation.

Internal communication can be just as important, notes Mella. The vetting process “takes a lot of time; staying one step ahead of construction becomes a huge challenge for projects. We were documenting stuff that we knew was going to have to be procured in the next week.” Mella says...
<table>
<thead>
<tr>
<th>Version 2.1 Substances</th>
<th>Version 3.0 Substances</th>
<th>Where Might They Be Found?</th>
<th>How Hard Are They To Avoid?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkylphenols</td>
<td>Coatings, epoxies, and other wet-applied products</td>
<td>Very difficult to get information on product ingredients</td>
<td></td>
</tr>
<tr>
<td>Asbestos</td>
<td>Old building materials, such as flooring, insulation, etc.</td>
<td>Easy in new construction</td>
<td></td>
</tr>
<tr>
<td>Bisphenol-A</td>
<td>Epoxies; polycarbonate plastic</td>
<td>Doable, but reduces product options</td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>Pigments</td>
<td>Easy for some materials; very difficult to get information on textile pigments and dyes</td>
<td></td>
</tr>
<tr>
<td>Chlorinated polyethylene and chlorosulfonated polyethylene</td>
<td>Roofing membranes; wire and cable jacketing</td>
<td>Very difficult to get information on product ingredients</td>
<td></td>
</tr>
<tr>
<td>Chlorobenzenes</td>
<td>Many plastics</td>
<td>Very difficult to get information on product ingredients</td>
<td></td>
</tr>
<tr>
<td>Chlorofluorocarbons and hydrochlorofluorocarbons</td>
<td>Cooling and refrigeration systems; foam insulation</td>
<td>Easy, but could add cost</td>
<td></td>
</tr>
<tr>
<td>Chloroprene</td>
<td>Window and door gaskets</td>
<td>Difficult, but exceptions possible</td>
<td></td>
</tr>
<tr>
<td>Chromium-6</td>
<td>Chrome-plated fixtures</td>
<td>Easy, but could add cost</td>
<td></td>
</tr>
<tr>
<td>Chlorinated PVC (CPVC)</td>
<td>Plumbing pipe</td>
<td>Getting easier due to greater availability of alternatives</td>
<td></td>
</tr>
<tr>
<td>Formaldehyde (added)</td>
<td>Plywood, OSB, some engineered timber products, some insulation</td>
<td>Generally easy; some complications for specialty products</td>
<td></td>
</tr>
<tr>
<td>Halogenated flame retardants</td>
<td>Foam insulation; textiles and carpets; furniture foam</td>
<td>Very difficult with LBC 3.0 scope expanded to include furnishings</td>
<td></td>
</tr>
<tr>
<td>Lead (added)</td>
<td>Brass; pipe solder</td>
<td>Very difficult (brass common in hardware and plumbing), but exceptions possible</td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>Fluorescent lighting</td>
<td>Easier as LEDs become more common, but could add first cost</td>
<td></td>
</tr>
<tr>
<td>Perfluorinated compounds</td>
<td>Carpet and textile coatings</td>
<td>Very difficult if using carpet, and with LBC 3.0 scope expanded to include furnishings</td>
<td></td>
</tr>
<tr>
<td>Petrochemical fertilizers and pesticides</td>
<td>—</td>
<td>Landscaping products</td>
<td>Easy</td>
</tr>
<tr>
<td>Phthalates</td>
<td>Vinyl flooring, wallcoverings, upholstery; some wet-applied products</td>
<td>Easy for finished products if avoiding flexible PVC; very difficult to get information on ingredients in wet-applied products</td>
<td></td>
</tr>
<tr>
<td>Polychlorinated biphenyls</td>
<td>Some pigments and textile dyes; old caulk and light ballasts</td>
<td>Very difficult to get information on pigments and dyes; easy to avoid legacy PCBs in new construction</td>
<td></td>
</tr>
<tr>
<td>PVC</td>
<td>Plumbing pipe, windows and doors, cladding, resilient flooring, carpets, wallcoverings, and many other products</td>
<td>Easy for many categories, but may add cost; difficult in multi-component products</td>
<td></td>
</tr>
<tr>
<td>PVDC (polyvinylidene chloride)</td>
<td>Water-based coatings</td>
<td>Very difficult to get information on product ingredients</td>
<td></td>
</tr>
<tr>
<td>Short-chain chlorinated paraffins</td>
<td>Adhesives, sealants, coatings; in plastics as a plasticizer or flame retardant</td>
<td>Very difficult to get information on product ingredients</td>
<td></td>
</tr>
<tr>
<td>VOCs in wet-applied products*</td>
<td>Most adhesives, sealants, and coatings</td>
<td>Easy for most materials</td>
<td></td>
</tr>
<tr>
<td>Wood treatments containing creosote, arsenic, or pentachlorophenol</td>
<td>Treated wood sold for commercial applications</td>
<td>Easy, but could add cost; difficult for specialized applications</td>
<td></td>
</tr>
</tbody>
</table>

* Unlike most substances on the Red List, VOCs are not prohibited. All wet-applied products must comply with South Coast Air Quality Management District (SCAQMD) rules for their product category. The Health & Happiness petal in LBC Version 3.0 also includes a new requirement that all finished products meet CDPH Standard Method for indoor VOC emissions. These rules align with those in LEED. Source: BuildingGreen, Inc.
if he does another LBC project, he will try to set aside a month-long period between the bid and breaking ground for designer/contractor meetings devoted purely to materials. “That way you’re not chasing your tail or struggling to stay one step ahead.”

And as time goes on, many project teams say, the process will get easier and easier because ILFI’s own systems are developing rapidly. “The Declare program is gaining products every day,” says Kelly. “Instead of us spending six months to vet something, we just go to the website.” And since Declare is public, anyone can consult the database for product information.

4. Sharing Is Caring

Vetting materials for LBC is intense and time-consuming; the learning curve is steep. Projects teams pursuing new LEED v4 credits with similar aims may also find that the process requires a similarly steep learning curve. Project teams report that they would prefer not to push that rock up the hill twice, so in addition to refining how they acquire data, some have also developed systems to manage the data for the project that can be used to inform future projects as well.

**Better together**

Many professionals are accustomed to the material tracking required for LEED projects, but for LBC it may be orders of magnitude more difficult since every ingredient of every component of every product must be accounted for. “Essentially you have to document every material that goes into the property,” explains Jim Newman, “not just recycled content for 20% of the cost.” The intensity of that exercise has taught LBC experts to be meticulous about how they track and share product and material information, using processes any project team can learn from.

Mella says his team—including contractors, subcontractors, architects, owners, and others—shared access to a highly detailed “smart” spreadsheet through Web-based collaboration software. The project architect kept the spreadsheet up to date throughout the process.

In addition, “every week we had a Red List meeting,” he notes. “We started before construction. We’re still having them even though it is substantially complete.” These one-hour calls continue as the team dots its i’s and crosses its t’s for items like air handlers. “We’ll stop once we’ve documented the last piece of equipment on the job,” he says.

Lee concurs that keeping the whole team on the same page (literally) is essential.

“We have a couple interns to help support the process,” says Lee. “They catch on fast.” When they join the team, they are required to read the Materials Petal Handbook published by ILFI as well as internally developed research guides that explain a standardized workflow and teach team members what to watch out for based on product categories or other features. “We break the product down and list all the potential components of the product,” explains Lee, who adds that the guide also points to “manufacturing processes that might introduce Red List chemicals along the way, like galvanization” (where lead may be used).

**“Pre-certifying” materials**

Building on project-specific communication and training such as this, some firms are now working on more permanent ways to keep up.

Lee has begun shifting the firm’s entire library over to LBC-eligible materials. “I have a product evaluation form I send to [product] reps,” and he’s been sending that out to manufacturers to align with the new LBC 3.0 Red List. “What chemicals are in our library already, maybe we can get them out of our library.” Product reps “have to fill out the form before they come in the door. If you develop that system as part of your regular system, then the LEED and LBC work isn’t an additive: it’s just the standard.”

Mella reports that the Brock Center team began by seeking to “pre-certify” materials during design to save work later—with mixed success. “Like you’d expect, a manufacturer is...
willing to help you, but if you can’t guarantee they’ll get the job, they won’t be as helpful with that information,” Mella cautions.

It may be simpler, though, if the project team is asking for less than full LBC compliance. CannonDesign is now in a process similar to that of Re:Vision, refining its library to reflect which manufacturers have committed to HPDs as well as environmental product declarations (EPDs). Working by product category, the librarian will “go into our stacks and pick our standard manufacturers, and we’re going to ask them” about the declarations, explains Rand Ekman. It will not be documented by product at first; to speed the process, initially the library will be based on statistics. For example, it will show that 10% of a manufacturer’s products have HPDs.

This information will be used in two ways. It will steer designers toward products from those manufacturers; they’ll know “if I pull this binder off the shelf, I’ll have a higher likelihood of getting what I want than if I pull that one off,” says Ekman. The data will also provide an advocacy opportunity: it will be made into a chart and sent to all the manufacturers listed with a simple question: “Is this right?” Seeing themselves compared with other companies in that format could spur action.

A Golden Rule for the Red List

A few LBC teams are trying to spur action in other ways. Although some hold their material lists close to their chests—reasoning that they represent thousands of hours of unbillable work that gives them a competitive advantage—others have chosen to publish their lists.

“We didn’t expect to make money on the project, but we never really conceived how much time it was going to take to do the materials,” recalls Tom Hartman, AIA, of Coldham&Hartman. “I hope no one ever has to have the experience we did.” Anyone can download the Red List tracking sheet for the Bechtel Classroom on Coldham&Hartman’s website. It includes materials not used on the project, Hartman notes. “One of the reasons we distributed that list was to show who said no to us.”

With the new LBC 3.0, ILFI will now require teams to share their tracking lists—though only with other registered projects, not publicly.

After consulting on so many projects, Re:Vision is taking a “teach-a-man-to-fish” approach—offering training to other LBC teams—rather than directly sharing lists. “You really don’t get compensated to do this kind of work in the architecture field,” points out Kelly. “We’re still investing a heck of a lot of unpaid time in the office to unpack and prepare because it’s what we believe in. We took the knowledge that we learned and started to share with other people to make their process faster and smoother.”

ILFI’s Connelly claims that the time spent on vetting products for LBC has dropped off dramatically in the last year. He states that the Bullitt Center team estimated about 20 hours of research per product, but “the difficulty curve is really coming down for meeting the materials requirements. It is now five hours and declining.” Connelly adds, “We have some multi-hundred-thousand-square-foot projects [registered for LBC] looking at developing and innovating new pathways to allow a scale that was seemingly not possible a year-and-a-half ago. With the growth of programs like HPD, and the growth in the number of Cradle to Cradle products, Declare products, and publicly available lists, the difficulty is really decreasing rapidly.”

This Is the First Day PVC-Free Composting Toilet of the Rest of Your Life

It’s not difficult to find the flaws in the LBC approach to material vetting: the process is still disruptive and time-intensive, yet it goes virtually unpaid for and can feel like a meaningless exercise. A red-list approach doesn’t ensure that alternatives are better than what they replace. And while the network effect and the decreasing time commitment sound encouraging, there are fewer than ten certified LBC projects. The program has a lot of scaling up to do (a topic we examined in Can the Living Building Challenge Scale Up?).

But those working with LBC projects or asking for similar changes from manufacturers see the seeds of long-term market transformation in their small, everyday successes.

“The enthusiasm of people coming to work has changed,” claims Kelly. “We all love what we do and are so excited
Muscoe left Susan Maxman and Associates in 2002, spent three years with Wallace, Roberts & Todd, LLC, and then in 2006 started his own firm, M2 Architecture, where he continued to focus on cutting-edge green design. Most recently, he had been involved with a Living Building Challenge project for the Alice Ferguson Foundation in Maryland, an addition and bio-pond for a Philadelphia residence, and the Water Research Education Center in Pennsylvania.

Although we first became acquainted with Muscoe because of his design work with Susan Maxman, it was through his extensive committee work with the U.S. Green Building Council and the AIA Committee on the Environment that we—and many others in the green building world—really got to know him and benefit from his brilliance as a collaborator. Muscoe and I overlapped on the USGBC National Board from 2003 to 2006. In addition, he served on the board of the Delaware Valley Green Building Council from 2006 to 2008; he co-chaired the program committees for the first three Greenbuild conferences; he served on the LEED for New Construction Core Committee from 2004 to 2006; he chaired the LEED Market Advisory Committee for 4 ½ years (2007–2011); he served on the LEED Steering Committee from 2006 to 2011; and he served for seven years (2003–2010) with my colleague Nadav Malin as a LEED Faculty member. Muscoe was recognized as a LEED Fellow in the class of 2013.

With AIA, Muscoe served as co-chair of the Philadelphia Committee on the Environment (COTE) from 1994 to 1999 and then served on the national steering committee of the AIA COTE from 1997 to 2002, including a term as chair in 1999. In this role, he organized the Mainstreaming Green conference in Chattanooga, Tennessee, which could be considered one of the defining events of the emerging green building movement. It was here that many of us were first introduced to biomimicry.

Throughout this period, he also taught the next generation of architects as a lecturer for the University of Pennsylvania’s Department of Architecture.

When I think of Muscoe, what comes to mind is his ever-cheery, unflappable demeanor and his facility with the latest gadgets. It was with him that I first witnessed someone finding a restaurant with a cell phone, getting directed to it, and calling to make a reservation—all while strolling down the street. Being something of a Luddite in the technology arena, I was amazed. I don’t think I had even graduated to a flip phone at that point.

In a letter of recommendation of Muscoe for his LEED Fellow application, Joel Ann Todd noted that “Muscoe is a quiet leader—his ego doesn’t get in the way of his leadership. He leads by example, by his expertise, and by his commitment. He believes in collaboration and processes that bring out the best in all team or committee members.”

I speak for Nadav and others at BuildingGreen, as well as many others...
in the green building world, in saying how much we will miss Muscoe and his calm, disarming wisdom. He left us way too soon!

A memorial service was held January 10 at St. Peter’s Church in Philadelphia. Muscoe’s wife, Jennifer Pinto-Martin, asks that donations in Muscoe’s name be made to Breakthrough Bike Challenge, the research fundraising organization that she co-founded in Philadelphia.

NEWS

Huge Carbon Savings from Transit Could Dwarf Building Efficiency

LEED-EBOM project data confirm that how people get to the office has a greater impact than other green building efforts.

By Paula Melton and Tristan Roberts

Slight reductions in transportation energy can have massive carbon benefits for existing buildings, according to new research—much greater than similar reductions in building energy use.

The study, “Quantifying the Comprehensive Greenhouse Gas Co-Benefits of Green Buildings,” conducted by researchers at the Center for the Built Environment (CBE) at the University of California–Berkeley, calculated the carbon savings from reducing water consumption, waste production, and transportation associated with existing LEED-certified office buildings.

LEED–EBOM measured performance

The study examined the actual performance of more than 200 California buildings certified under version 2009 of LEED for Existing Buildings: Operations & Maintenance (LEED–EBOM).

In cooperation with the U.S. Green Building Council (USGBC), researchers accessed performance data submitted to USGBC. Based on demonstrated reductions in conventional commuting trips to and from LEED buildings, the researchers found the buildings averaged a modest reduction of 5% (compared with a typical building) in carbon emissions from transportation. But even that reduction had a significant impact on greenhouse gas emissions, reducing carbon by an estimated 8 megatons per year for an average 13,000 ft² California office building. By contrast, a 5% reduction in carbon emissions from building operations would save 3.4 megatons per year—leading the researchers to recommend that California building standards be updated to take transportation into account in addition to building energy use.

Water and waste also add up

The study also examined the greenhouse gas (GHG) intensity of water and waste in addition to transportation, concluding that widespread reductions can add up to large savings in the state.

Although the GHG impacts of water vary regionally, the study found that the LEED-EBOM buildings on average achieved 50% savings in carbon emissions connected with water use. On waste, the study found that the LEED-EBOM buildings achieve a diversions rate of 52%, which translates to a 48% savings in carbon emissions.

However, those big savings pale in comparison with the actual tons of carbon saved by transportation—with transportation saving about eight times as much as waste diversion, and about 16 times as much as water-saving strategies (see chart, above).

Yet the cumulative effects of all three could be huge: if all California office buildings met the level of carbon savings achieved by the LEED-EBOM buildings studied, the state would see an overall reduction in annual GHG emissions of more than 830,000 megatons of CO₂ (with more than 700,000 coming from a 5% reduction in transportation carbon alone).
No surprise: Transportation trumps other impacts

“Commercial office buildings stimulate more than twice as much GHG emission through induced transportation than they do through their own operational energy consumption,” the researchers conclude. “Locating buildings in transit-accessible areas … may be worth more to GHG control efforts (from commercial office buildings) than all other foreseeable improvements to green building standards combined.”

The quantification is striking, but the overall point should not come as a surprise: energy use from transportation associated with an average building in the U.S. is significantly higher than the energy use of the building itself, as EBN reported in Driving to Green Buildings: The Transportation Energy Intensity of Buildings (see also Homes Save More Energy from Location Than Efficiency).

Healthcare Giants Boycott Furniture Containing Flame Retardants

Sixteen major buyers, including tech firms, retailers, and U.S. cities, have pledged to purchase furniture containing no chemical flame retardants.

By Paula Melton

Facebook, Kaiser Permanente, and Autodesk are among major buyers that have pledged to purchase furniture that contains no chemical flame retardants. HDR Architecture and Perkins+Will have also signed the pledge.

Initiated by the Center for Environmental Health (CEH), the purchasers’ pledge currently represents $520 million in annual furniture purchases. The announcement follows on the heels of a similar pledge among large healthcare networks in four U.S states.

Avoiding flame retardants in certain furniture types is now feasible because of changes to California law, which formerly required the use of chemical flame retardants in upholstered furniture, effectively forcing the standards onto furniture manufacturers nationwide (see Flame Retardant Rules Result of Deception, Says Investigation).

The updated regulations require a different testing method and can now be met without use of toxic additives that were once ubiquitous.

HDR has also worked with CEH to publish a list of furniture suppliers that have totally eliminated flame retardants from their products as well as those that offer some products without these chemicals. According to the list, those that have eliminated flame retardants are:

- Andreu World
- Arcadia Contract
- Bretford
- David Edward Company
- Global/GLOBALcare
- Humanscale
- Izzy+
- Neutral Posture
- OFS Brands
- Teknion
- Wieland

Though not listed by HDR, Ekla also makes commercial contract furniture containing no chemical flame retardants. Manufacturers

Teknion has eliminated chemical flame retardants from all its products, including these Sabrina task chairs.
Ibuprofen Side Effects May Include Stunted Produce, Infertile Otters

From our bodies into wastewater, and back into our water supplies, pharmaceuticals are disrupting biological processes in plants and animals.

By Candace Pearson

All that Advil we take for small aches and pains is adding up in our wastewater, says new research, and it’s affecting wildlife, the plants we eat, and even the water we drink.

Levels of ibuprofen currently found in the environment significantly hamper early root development of lettuce plants, according to research led by the University of Exeter Medical School and Plymouth University in the U.K., and another common anti-inflammatory drug, diclofenac, affects the growth of radish roots. Our food is exposed to these drugs in the largest doses when sewage sludge is used as fertilizer or when wastewater is used for irrigation, but even when wastewater is treated, antibacterial drugs and anti-inflammatory drugs typically have low rates of removal.

That means these pharmaceuticals build up in our waterways, and otters, for one, may be suffering as a result.

Researchers suspect that pharmaceuticals building up in otters’ fur are to blame for their recent low reproductive rates.

California Questions Whether Low VOCs Make Artificial Turf Safe

Smell no evil, see no evil: low counts of toxic fumes have been cited to argue turf fields with crumb rubber are safe, but a new bill calls for more study.

By Candace Pearson

California Senator Jerry Hill is calling for crumb rubber—the ground pieces of old tire that are used for artificial turf fields—to again be put under the microscope amidst concerns that the material emits harmful compounds or acts as a carcinogen.

So far, the few risk evaluations that have been conducted have found crumb rubber to be safe for sport fields and playground surfaces. One oft-referenced 2010 study prepared by California’s Office of Environmental Health Hazard Assessment, while identifying nine different VOCs and fine particulates emanating from samples of four artificial turf fields, determined that the level of exposure via inhalation did not present a health hazard.

Groups Avoiding Furniture with Flame Retardants

- Advocate Healthcare
- Autodesk
- Beaumont Health System
- Blue Cross Blue Shield of Massachusetts
- Dignity Health
- Facebook
- Genentech
- Hackensack University Medical Center
- HDR Architecture
- Healthy Building Science
- Kaiser Permanente
- Kay Chesterfield
- Multnomah County
- One Workplace
- Perkins + Will
- City of Portland
- San Francisco Department of Environment
- Staples
- University Hospitals

that have removed the chemicals from certain product lines are Haworth, Herman Miller, Leland International/Freshcoast, and Martin Brattrud.

“Manufacturers of course can continue to use flame retardants if they choose,” notes Jean Hansen, sustainable interiors manager at HDR, “but many have said they are excited to move away from flame retardant use.”
But tires also contain other potentially dangerous substances, such as polycyclic aromatic hydrocarbons and heavy metals that might be harmful if they touch people’s skin or get into abrasions—exposure pathways that seem especially likely on sports fields and playgrounds. Tires also contain several known carcinogens, including benzene, butadiene, and arsenic, and the lack of a long-term exposure study has been made more glaring by recent anecdotal reports of high instances of cancer among soccer goalies aired by NBC News.

Referencing concerns that young athletes might increasingly be developing cancer, Hill’s bill calls for a more extensive evaluation of these alternate exposure pathways with a more robust study sample. If it passes, public and private schools and local governments in California would be unable to install new synthetic-turf fields and playground surfaces until the results of the study are published.

Artificial turf is sometimes preferred because it averts the need for the water and fertilizer used for grass fields (see Which Grass is Greener? Comparing Natural and Artificial Turf), but alternatives to crumb rubber exist, including coconut fibers, rice husks, cork, and recycled shoes.

PRODUCT NEWS & REVIEWS

Spray Foam with Minimal Global Warming Impact Now Available

U.S. production of next-generation HFO blowing agents signals a positive shift in the spray polyurethane foam (SPF) market.

By Brent Ehrlich

Spray polyurethane foam (SPF) is a widely preferred high-performance product due to its impressive insulating value and air-sealing properties—yet the high global warming potential (GWP) of the standard SPF blowing agent (HFC-245fa) has seriously compromised its environmental performance. Now SPF manufacturers are adopting newly developed blowing agents known as HFOs (hydrofluoroolefins) that have minimal GWP—and they even claim a boost in R-value.

Honeywell announced it has started production of both its low-GWP Solstice blowing agents at its Baton Rouge, Louisiana facility. HFOs are considered the “fourth-generation” blowing agents, with a 100-year GWP of only 1 (equal to that of carbon dioxide). Its availability signals a shift in the industry away from third-generation HFCs (see Avoiding the Global Warming Impact of Insulation), which have GWPs over 1,000 and are currently used in closed-cell SPF. (HFCs continue to be used in extruded polystyrene for now.)

Already available in Europe, Solstice is now being used in the U.S. by Whirlpool in its appliances, by Lapolla in its Foam-Lok 2000 4G SPF wall insulation, and by Henry-West Development Group (a Henry subsidiary) in its 3012-EB-3 SPF roof insulation. According to Lapolla’s vice president of sales, Mike Kontranowski, the cost of substituting Solstice for HCF-245fa in SPF is minimal, but he claims the new blowing agent provides a significant performance benefit, with a 10% to 12% increase in foam yield and a 10% increase in R-value.

Having a widely available source of HFOs in the U.S. could have a significant impact on the insulation industry and the environment. Further progress for the industry would include reducing worker exposure to isocyanates and getting potentially toxic flame retardants out of SPF.
Ten Green Products That Could Transform the Building Industry: An Updated Wish List

We’ve been pleasantly surprised with recent green building innovations, but we can always dream of more. Here’s what’s on our wish list now.

By Alex Wilson

About a year ago, I posted my green building products wish list. One of those wishes came true: introduction in June 2014 of a polyisocyanurate boardstock insulation containing no halogenated flame retardants from Johns Manville.

So what’s on my list now? Can concrete that sequesters carbon go to scale this year? Will manufacturers stop putting flame retardants in foam furniture cushions and insulation? Here are a few things we’d like to see.

1. Carbon-negative concrete

In EBN last year (see Can Concrete Save Us? Locking Up Carbon in Building Materials), we explored various efforts under way to achieve this goal, and I’m hoping that one of those companies—or another one that comes along—really comes through with such a product. Blue Planet’s focus not only on the cement component of concrete but also on the aggregate is intriguing.

Synthesizing calcium carbonate (limestone) as an aggregate in concrete using carbon dioxide captured from power plants might be a lot less expensive than other carbon-sequestering strategies proposed by “clean coal” advocates. Plus, the Blue Planet approach would allow synergistic industries to co-locate (a coal- or gas-fired power plant generating CO₂ and a desalination plant producing calcium as raw materials to the cement plant and a concrete aggregate plant).

2. Safer spray-foam insulation

Spray polyurethane foam (SPF) is an amazing product in terms of adherence to uneven surfaces, insulating value, and air-sealing of cavities. But the isocyanate chemistry is troubling from a health standpoint, and a halogenated flame retardant (TCPP) is added to impart the required fire resistance. I’d love to see a silicone foam insulation or some other chemistry that is inherently fire resistant. Such a product (called HybridSil) has been under development, but we regularly check with the company and have not seen any indication that it will be ready any time soon.

3. Even better LEDs

Three years ago, we asserted that “the future is here” in terms of LEDs achieving acceptable quality and efficiency. The industry has come a long way since then, and a year ago, I was looking at 100 lumen-per-watt (lpw) LED lights that delivered light with a color rendering index (CRI) of 90 or higher. But why stop there?

Now we know that 150 lpw is possible (a few products already achieve it). Given the tremendous advances that have been made with LED technology, I’d like to see 150 lpw, 90 CRI drop-in LED replacements for F40 fluorescent lamps and screw-in CFLs.

4. Green polystyrene

Extruded polystyrene (XPS) in the U.S. still includes the flame retardant HBCD (a persistent organic pollutant) and an HFC blowing agent, which has massive global warming potential (see Avoiding the Global Warming Impact of Insulation).

But XPS without these harmful chemicals—which would be safer for human health and the environment—has been in testing for a couple years now by major manufacturers, and it’s time for them to bring it to market. If there is a problem with the HFO (hydrofluoroolefin) blowing agents that the U.S. industry has focused on most actively (to maintain R-5 per inch), I would be happy with a lower-R-value product (as is available in Europe); architects would simply need to specify greater thicknesses.

5. Truly clean carpets

Perfluorocarbons (PFCs) are great at resisting staining and allowing easy clean-up (see The Chemicals on Our Carpets and Textiles), but this class of compounds, made with the element fluorine, doesn’t break down...
readily in nature, and there is growing evidence that it is hazardous to humans and the environment. Yet PFCs—which are the main ingredient in familiar brands like Scotchgard and Teflon—are added as a standard coating on most carpets and textiles, even though the coating wears away surprisingly fast with cleaning and enters the environment.

It's now possible to make carpet fibers that are inherently stain-resistant and dirt-repellant. I'd like to see PFC-free carpeting and upholstery fabric, with good cleaning properties and durability, become standard practice in the industry.

6. Furniture that won't poison you

More than ten years ago, EBN helped bring concern about halogenated flame retardants to the attention of the design community with our report Flame Retardants Under Fire. Progress is being made, but the vast majority of upholstered office and home furniture is still treated with halogenated flame retardants. With recent changes in California’s flammability standard, TB117, manufacturers can now manufacture upholstered furniture without toxic flame retardants.

I'd like to see a top manufacturer take the lead and eliminate all halogenated flame retardants from all of its furniture (some smaller companies are already removing the chemicals entirely, while some of the largest companies are introducing product lines that contain none of these chemicals). Let's hope this transition won’t take long: those flame retardants aren’t helping much anyway, and evidence is mounting about their harm.

7. Cars as backup generators

In keeping with the growing focus on resilient design, I’d like to see robust, affordable, and fully supported systems for allowing electric vehicles (EVs) and plug-in hybrid-electric vehicles to serve emergency power needs in homes.

There have been third-party kits for modifying cars to play this role, and tinkerers have been creating their own interfaces for several years; let’s see auto manufacturers embrace this trend and provide warranty-supported solutions that will help us create more resilient buildings and even lay the groundwork for a more distributed smart grid in which the battery systems in cars can help to shave peaks and feed additional power into the grid when brownout conditions or production shortfalls occur.

8. Insulating sheathing any building scientist can love

There are several low-density insulative sheathing products made from wood fiber now imported from Europe, including the German products Gutex Multitherm and Agepan. Why isn’t anyone making this in the U.S.?

We have the wood resource here to create our own products, and I believe we could build demand for such a product, given its structural properties and very high vapor permeability, which makes the product great for building assemblies that aren’t vulnerable to moisture problems. Let’s see a U.S. company set up a manufacturing facility here.

9. An affordable, highly insulating exterior door

When we built our house in 2012–13, one of the challenges was finding exterior doors that satisfied our energy targets and budget. We never found what I had hoped for.

I’d like to see an attractive front entrance door—achieving at least R-10 (center-of-panel) in thermally broken fiberglass or FSC-certified wood surrounding an insulation core, and with long-life, replaceable weatherstripping and durable construction that won’t warp—with a price tag in the $1,500 to $2,000 range. And I’d like to see a more utilitarian version for under $1,000.

10. Heat pumps that don’t contribute to global warming

Nearly all of today’s heat pumps use climate-unfriendly HFC refrigerants, (such as R-410a, which is a 50-50 blend of HFC-32 and HFC-125 and has a global warming potential of 1,725), and most can only deliver temperatures of around 130°F. Heat pumps using carbon dioxide as the refrigerants can deliver higher output temperatures—temperatures hot enough to be used for hydronic heating.

While using CO₂ as a refrigerant requires much higher operating pressures, such systems would help to speed the transition from fossil-fuel heating to renewably powered electric heating, particularly in the coldest climates. A commercial-scale CO₂-based heat pump made by Mayekawa is available in the U.S., and smaller heat pumps relying on CO₂ exist in Japan, Europe, and Australia. We need those smaller heat pumps in the U.S.

A New Place to Store Rainwater: The Fence

Created by a 14-year-old student for a science fair, Water Fence provides an innovative solution for storing large volumes of water.

By Brent Ehrlich

With the local science fair coming up, 14-year-old high school freshman Steven McDowell told his teacher he planned to solve California’s current...
water crisis—one of the worst in the state’s history. The incredulous teacher had his doubts, but McDowell set out to prove him wrong and began tinkering with a system that combines rainwater storage and fencing. His idea won the science fair (and several other regional awards), he applied for a patent, and the aptly named Water Fence was born. Interest in McDowell’s concept has continued to grow, and Water Fence has gone from a science fair project to a rainwater storage system that solves two major problems: size and aesthetics.

**How do you make a large tank look good?**

From a one-inch rainfall event, you can capture 620 gallons for every 1,000 ft² of roof area: that’s a lot of water. Yet most rainwater systems are either too small to capture large volumes of water or too bulky (and ugly) to be practical for most uses. *(Rainwater Hog, which earned a Top-10 award from us in 2008, is an exception, with a tank system that fits between studs in walls or decking.)*

But Water Fence is unique, according to Ken McDowell, president of the company and father of the inventor, because it combines modular water storage with a fence system that can store almost 10,000 gallons of water for a 70’ x 80’ x 70’ Water Fence system (the fence boundary of the inventor’s yard).

Appropriate for commercial or residential use, this rainwater storage system could be valuable for storm-water mitigation in business parks, housing developments, or anywhere else fencing or outdoor walls are common—potentially reducing the size of containment ponds or lowering overall costs for alternative methods. And, according to the company, in areas where there is wildfire danger, Water Fence could also serve as a firebreak and provide a water source for keeping roofs wet.

**A modular system**

Each Water Fence section is 6’ tall, 7” wide, 12” thick virgin high-density polyethylene (HDPE) and holds approximately 320 gallons of water. (Recycled-content products may become available, but recycled HDPE is typically only available in black, and finding enough material could be a challenge, according to McDowell.) The company plans to make smaller sections available to fit specific lengths, and all sections connect to one another via a flexible hose and a ball valve located at the base. As one section fills, water spills into the next so the system fills evenly, but the sections can also be isolated in case there are special irrigation needs or one needs to be cleaned, repaired, or replaced. The tanks are sealed, said McDowell, but there is a breather vent on top that vents air but not water. “We have smart phone apps, so with sensors you can tell how much water you have or if there are leaks in the system,” claimed McDowell, “and eventually we will have one that works with weather satellites” to maximize irrigation efficiency.

McDowell said that installation is similar to putting up a regular fence. Holes are augured into the ground for cement footings, “and in the cement there are four lag bolts,” he said. Four-foot-high galvanized steel posts are then bolted to the footings, and the 230-pound tanks slide into the posts. The system can be installed quickly by two people *(see this demo video provided by the company)* and is engineered to survive wind speeds up to 80 miles per hour and meet California’s seismic codes, claims McDowell. Because of the unique way each section fills, Water Fence can be installed on uneven terrain, although hillier lots may not be an ideal fit.

**Not just a giant plastic fence**

Once the tanks are up, there is one more step: “You don’t want a plastic tank around the yard,” McDowell acknowledges. Water Fence includes inserts to add façades to the fence via bolts. This proprietary system will be available in several rock façades to match a style or local stone, as well as redwood and other options. McDowell notes that the fence can accommodate different façades on each side, allowing aesthetic choices that match different settings. McDowell says the company is also working on a living wall system.

**Availability and costs**

Water Fence was initially slated for release in California, intended primarily for use with irrigation or gray-water. *(The company is not offering separate leaf filtration, pumps or irrigation equipment, or other gray-water components, instead relying on existing products for those needs.)* But according to McDowell, interest in the product has grown in areas with harsher climates, such as Canada and the U.S. Southwest, and the company redesigned the system to handle these temperature extremes—though
Until recently, mercury in lamps was difficult—maybe impossible—and isn't even always appropriate. Completely avoiding these substances in the environment (PBTs and POPs) is known to persist and bioaccumulate in the environment (PBTs and POPs).

Some red lists used in the building industry include the Living Building Challenge Red List, the Perkins+Will Precautionary List, and the Cradle to Cradle Banned Lists.

Simple, memorable rules are great tools, but everyone knows they don't apply in every situation: real life is confounding, complex, and context-bound. The cardinal rule of thumb is that there's an exception to every rule.

Some project teams have opted to follow simple rules in the form of a red list—a set of potentially hazardous substances they would prefer to avoid. Some red lists used in the building industry include the Living Building Challenge Red List, the Perkins+Will Precautionary List, and the Cradle to Cradle Banned Lists.

The bad news is that a red-list approach can replace the devil we know with the one that we don’t. For example, polychlorinated biphenyls (PCBs) were some of the first halogenated flame retardants. U.S. regulations in the 1970s required these to be phased out, but they and other halogenated substances have been replaced repeatedly over the decades with new chemicals that eventually have turned out to have similar toxic effects on both humans and wildlife (see New Flame Retardant for Polystyrene: Too Much Like the Old?).

One way to avoid replacing toxic substances with similarly problematic ones is to conduct a hazard screening of proposed alternatives. A full GreenScreen assessment of a chemical includes a thorough toxicological review of its entire life cycle, including analysis of any available hazard data and expert evaluations of how the chemical is produced and how it is likely to break down. The chemical is assigned a “benchmark,” with Benchmark 1 indicating the highest potential for toxicity (see NSF Offers GreenScreen to Promote Safer Chemicals).

The Cradle to Cradle program uses a similar system of hazard screening (while also taking exposure risk into account—see Building Products and Health: A Look at Risk versus Hazard), applying the screening to a finished product—not just individual chemicals. Instead of benchmarks, Cradle to Cradle uses an ABC-X system, where “A” denotes a preferred chemical and “X” denotes a highly toxic one (see table).

Simpler ways of doing hazard screenings exist, though they are not as accurate and can suffer from the same “devil-you-don’t-know” problem as red lists. The GreenScreen List Translator benchmarks already-known hazards by referencing red lists from around the world; the Health Product Declaration (HPD) is a way of using GreenScreen assessments to disclose all the chemicals, along with their GreenScreen or List Translator benchmark, in a finished product. Neither can characterize chemicals whose hazard level hasn’t already been identified through a full assessment.

If hazard screenings give us better information, why don’t we all use them?

Conducting them is well beyond the scope of building professionals, so red lists are a practical “cheat sheet” for avoiding some of the worst substances.

But projects can require product ingredients to be screened for potential hazards. LEED v4 offers incentives for HPD screening and Cradle to Cradle assessment in a new credit that rewards the disclosure of known hazards. The same credit offers further

---

**Cradle to Cradle Screening**

<table>
<thead>
<tr>
<th>Benchmarks</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Preferred: Ideal substance from a Cradle to Cradle perspective. No known hazards associated with this substance.</td>
</tr>
<tr>
<td>B</td>
<td>Preferred: Little to no risk to human health and/or environmental health.</td>
</tr>
<tr>
<td>C</td>
<td>Acceptable: One or more moderate risks to human health and/or environmental health. Suitable for continued use until a better alternative is found.</td>
</tr>
<tr>
<td>X</td>
<td>Problematic: One or more significant risks to human and/or environmental health; should be phased out as quickly as possible.</td>
</tr>
<tr>
<td>BANNED</td>
<td>Banned: This ingredient (or a chemical in this component) poses a serious risk to human and environmental health and is not allowed in the Cradle to Cradle Certified™ program.</td>
</tr>
</tbody>
</table>

The Cradle to Cradle program classifies chemical ingredients on an ABC-X scale, with manufacturers gradually moving toward having all ingredients on the A-list.

---

By Paula Melton

When two vowels go walking, the first one does the talking. Build tight; ventilate right. Thou shalt not steal.

Some project teams have opted to follow simple rules in the form of a red list—a set of potentially hazardous substances they would prefer to avoid. Some red lists used in the building industry include the Living Building Challenge Red List, the Perkins+Will Precautionary List, and the Cradle to Cradle Banned Lists.

Red lists often identify only the worst ingredients—known carcinogens, known reproductive and development­mental toxicants, and toxic substances known to persist and bioaccumulate in the environment (PBTs and POPs). Completely avoiding these substances is difficult—maybe impossible—and it isn’t even always appropriate. Until recently, mercury in lamps was a sensible tradeoff because the only alternative (incandescent lamps) indirectly added more mercury to the environment. Teams that have met Living Building Challenge (LBC) requirements, which include many temporary Red List exceptions, can at least know their materials were thoroughly vetted.

McDowell still recommends draining Water Fence during cold periods. Water Fence will be available by the end of February 2015, and though the cost has not been finalized, the company expects the system to be around $2.00–2.50 per gallon, or $640–$800 per seven-foot section.

**For more information**

Water Fence
www.waterfence.com

**BACKPAGE PRIMER**

**The Problem with Red Lists**

Having a short list of toxic chemicals to avoid is convenient, but nasty “alternatives” can sneak in the back door. Hazard screenings help solve this problem.

By Paula Melton

When two vowels go walking, the first one does the talking. Build tight; ventilate right. Thou shalt not steal.

Simple, memorable rules are great tools, but everyone knows they don’t apply in every situation: real life is confounding, complex, and context-bound. The cardinal rule of thumb is that there’s an exception to every rule.

Some project teams have opted to follow simple rules in the form of a red list—a set of potentially hazardous substances they would prefer to avoid. Some red lists used in the building industry include the Living Building Challenge Red List, the Perkins+Will Precautionary List, and the Cradle to Cradle Banned Lists.

Red lists often identify only the worst ingredients—known carcinogens, known reproductive and development­mental toxicants, and toxic substances known to persist and bioaccumulate in the environment (PBTs and POPs). Completely avoiding these substances is difficult—maybe impossible—and it isn’t even always appropriate. Until recently, mercury in lamps was a sensible tradeoff because the only alternative (incandescent lamps) indirectly added more mercury to the environment. Teams that have met Living Building Challenge (LBC) requirements, which include many temporary Red List exceptions, can at least know their materials were thoroughly vetted.

The bad news is that a red-list approach can replace the devil we know with the one that we don’t. For example, polychlorinated biphenyls (PCBs) were some of the first halogenated flame retardants. U.S. regulations in the 1970s required these to be phased out, but they and other halogenated substances have been replaced repeatedly over the decades with new chemicals that eventually have turned out to have similar toxic effects on both humans and wildlife (see New Flame Retardant for Polystyrene: Too Much Like the Old?).

One way to avoid replacing toxic substances with similarly problematic ones is to conduct a hazard screening of proposed alternatives. A full GreenScreen assessment of a chemical includes a thorough toxicological review of its entire life cycle, including analysis of any available hazard data and expert evaluations of how the chemical is produced and how it is likely to break down. The chemical is assigned a “benchmark,” with Benchmark 1 indicating the highest potential for toxicity (see NSF Offers GreenScreen to Promote Safer Chemicals).

The Cradle to Cradle program uses a similar system of hazard screening (while also taking exposure risk into account—see Building Products and Health: A Look at Risk versus Hazard), applying the screening to a finished product—not just individual chemicals. Instead of benchmarks, Cradle to Cradle uses an ABC-X system, where “A” denotes a preferred chemical and “X” denotes a highly toxic one (see table).

Simpler ways of doing hazard screenings exist, though they are not as accurate and can suffer from the same “devil-you-don’t-know” problem as red lists. The GreenScreen List Translator benchmarks already-known hazards by referencing red lists from around the world; the Health Product Declaration (HPD) is a way of using GreenScreen assessments to disclose all the chemicals, along with their GreenScreen or List Translator benchmark, in a finished product. Neither can characterize chemicals whose hazard level hasn’t already been identified through a full assessment.

If hazard screenings give us better information, why don’t we all use them?

Conducting them is well beyond the scope of building professionals, so red lists are a practical “cheat sheet” for avoiding some of the worst substances.

But projects can require product ingredients to be screened for potential hazards. LEED v4 offers incentives for HPD screening and Cradle to Cradle assessment in a new credit that rewards the disclosure of known hazards. The same credit offers further
incentives for preferring “optimized” products with favorable GreenScreen assessments or higher levels of Cradle to Cradle certification.

For more information

Clean Production Action
greenscreenchemicals.org