



Building Materials: What Makes a Product Green?

QUITE A BIT OF ATTENTION HAS been focused on the issue of green building materials. What makes a given product “green”? How do you evaluate the relative greenness of different products? How do you find green products? More important, perhaps, manufacturers are asking, “How can we make our products greener?”

There are several directories of green building products available, some national in focus, some regional. In compiling any directory of green building products, the authors have to figure out what qualifies a product for inclusion. That was an exercise the *EBN* editorial staff went through when we began developing the *GreenSpec*®

directory, our own entry into the products directory field, in the late 1990s. This article is an attempt to lay out for public examination and discussion our standards for what makes a building product green. Our standards and thresholds have evolved over time, and this article lays out for public examination and discussion our current standards for “what makes a product green.” These criteria will continue to change, and as they do, the products included in future editions of *GreenSpec* will also change. We welcome input in this process of determining just what is green.

The Challenges in Defining What is Green

The Holy Grail of the green building movement would be a database in which the life-cycle environmental impacts of different materials were fully quantified and the impacts weighted so that a designer could easily see which material was better from an environmental standpoint. Though efforts are afoot along these lines we are not even close to realizing that goal. Very often, we are comparing apples to oranges. We are trying to weigh, for example, the resource-extraction impacts of one product with the manufacturing impacts of another, and the indoor-air-quality impacts of a third.

These issues were addressed in an earlier article on material selection (see *EBN* Vol. 6, No. 1), but in that article we were addressing the broader issue of material selection for a given project—not determining which

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The *GreenSpec*® *Directory* includes more than 1,850 listings of green building products and materials carefully selected by the editors of *Environmental Building News*. Organized in CSI format, *GreenSpec* includes descriptions of each product, along with environmental considerations and manufacturer contact information. It also features specification guideline language that can be selectively integrated into a project's specifications. The *GreenSpec Directory* is \$89.

The *BuildingGreen Suite* of online tools (at www.BuildingGreen.com) offers integrated access to the current and all past issues of *Environmental Building News*, the *GreenSpec* product database, and a database of high-performance building case studies. Subscriptions are \$199/person per year, plus \$45/person annually for additional users at the same location.

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Source: BuildingGreen, Inc.

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materials should be considered green in general. This distinction is subtle but important. In building a house or office building, a great many materials and products will be used. Even in the greenest of projects it is likely that many products will be used that are not themselves green—but they are used in a manner that helps reduce the overall environmental impacts of the building. A particular window may not be green, but the way it is used maximizes collection of low winter sunlight and blocks the summer sun. So even a relatively conventional window can help make a house green. Creating a green building means matching the products and materials to the specific design and site to minimize the overall environmental impact.

This article examines products in isolation—not how to use a product to make a building green, rather what makes a certain product green. Green products, including virtually all of those found in *GreenSpec*, could be used in dumb ways that result in buildings that are far from environmentally responsible. In a well-thought-out building design, however, substituting green products for conventional products can make the difference between a good building and a great one.

Defining Standards When Feasible

Our tactic with the *GreenSpec* directory is to identify quantifiable, easily verifiable, standards where those could be defined, then base other decisions about what should be included on the collective wisdom of our editorial staff. In a few product categories, such as energy-consuming appliances and VOC-emitting paints, specific thresholds can be established relatively easily. But for many criteria, the lines are much fuzzier and judgment calls are required.

It is important also to note that multiple criteria often apply—in other words, a product may be considered green for more than one reason. Take

recycled plastic lumber, for example: it's made from recycled waste, it's highly durable, and it can obviate the need for pesticide treatments. Straw particleboard products are made from agricultural waste materials, and they are free from formaldehyde offgassing. A product with multiple benefits could qualify for *GreenSpec* on the basis of its overall environmental performance, even if it doesn't meet a threshold in any one category alone. Conversely, a product with one or more green attributes might not qualify if it also carries significant environmental burdens. For example, wood treated with toxic preservatives has advantages in terms of durability, but it would not be listed in *GreenSpec* due the health and environmental hazards it represents.

This article reviews the criteria—not listed in any order of priority—used to designate building products as green and therefore suitable for inclusion in our *GreenSpec* directory.

1. Products Made with Salvaged, Recycled, or Agricultural Waste Content

The materials used to produce a building product—and where those materials came from—is a key determinant of green.

1a. Salvaged products — Whenever we can reuse a product instead of producing a new one from raw materials—even if those raw materials are recycled—we save on resource use and energy. Many salvaged materials used in buildings (bricks, millwork, framing lumber, plumbing fixtures, and period hardware) are sold on a local or regional basis by salvage yards. Fewer salvaged materials are marketed widely, and it is generally only these that are profiled in a national directory such as *GreenSpec*. Local and regional green product directories can really shine when it comes to finding salvaged materials.

1b. Products with post-consumer recycled content — Recycled content is an important feature of many green products. From an environmental standpoint, post-consumer is preferable to pre-consumer recycled content, because post-consumer recycled materials are more likely to be diverted from landfills. For most product categories, there is currently no set standard for the percentage of recycled content required to qualify for inclusion in *GreenSpec*, but such standards will increasingly be developed in the future.

In some cases, products with recycled content are included with caveats regarding where they should be used. Rubber flooring made from recycled automobile tires is a good example—the caveat is that these products should not be used in most fully enclosed indoor spaces due to offgassing concerns.

In certain situations, from a life-cycle perspective, recycling has downsides. For example, energy consumption or pollution may be a concern with some collection programs or recycling processes. Also, closed-loop recycling is generally preferable to downcycling, in which a lower-grade material is produced. As more complete life-cycle information on recycled materials—and the process of recycling—becomes available, we intend to scrutinize recycled products more carefully.

1c. Products with pre-consumer recycled content — Pre-consumer (also called “post-industrial”) recycling refers to the use of industrial by-products, as distinguished from material that has been in consumer use. Iron-ore slag used to make mineral wool insulation, fly ash used to make concrete, and PVC scrap from pipe manufacture used to make shingles are examples of post-industrial recycled materials. Usually excluded from this category is the use of scrap within the same manufacturing process from which it was generated—material that would typically have gone back into the manufacturing

process anyway. While post-consumer recycled content is better than pre-consumer recycled content, the latter can still qualify a product for inclusion in *GreenSpec* in many product categories—especially those where there are no products available with post-consumer recycled content.

1d. Products made from agricultural waste material

— A number of products are included in *GreenSpec* because they are derived from agricultural waste products. Most of these are made from straw—the stems left after harvesting cereal grains. Citrus oil, a waste product from orange and lemon juice extraction, is also used in some green products, but such products usually include other agricultural oils as well and are lumped under 2d – Rapidly renewable products.

2. Products That Conserve Natural Resources

Aside from salvaged or recycled content, there are a number of other ways that products can contribute to the conservation of natural resources. These include products that serve a function using less material than the standard solution, products that are especially durable and therefore won't need replacement as often, products made from FSC-certified wood, and products made from rapidly renewable resources.

2a. Products that reduce material use — Products meeting this criteria may not be distinctly green on their own but are included in *GreenSpec* because of resource efficiency benefits that they make possible. For example, drywall clips allow the elimination of corner studs, engineered stair stringers reduce lumber waste, pier foundation systems minimize

concrete use, and concrete pigments can turn concrete slabs into attractive finished floors, eliminating the need for conventional finish flooring.



Source: BuildingGreen, Inc.

2b. Products with exceptional durability or low maintenance requirements

— These products are environmentally attractive because they need to be replaced less frequently, or their maintenance has very low impact. Sometimes, durability is a contributing factor to the green designation but not enough to distinguish the product as green on its own. This criterion is highly variable by product type. Included in this category are such products as fiber-cement siding, fiberglass windows, slate shingles, and vitrified-clay waste pipe.

2c. Certified wood products — Third-party forest certification, based on standards developed by the Forest Stewardship Council (FSC), is the best way to ensure that wood products come from well-managed forests. Wood products must go through a chain-of-custody certification process to carry an FSC stamp. Manufactured wood products can meet the FSC certification requirements with less than 100% certified wood content through percentage-based claims. With a few special-case exceptions, any nonsalvaged solid-wood product and most other

wood products must be FSC-certified to be included in *GreenSpec*. A few manufactured wood products, including engineered lumber and particleboard or MDF, can be included if they have other environmental advantages—such as absence of formaldehyde binders. Engineered wood products in *GreenSpec* do not qualify by virtue of their resource efficiency benefits alone (for more on this, see *EBN* Vol. 8, No. 11).

2d. Rapidly renewable products

— Rapidly renewable materials are distinguished from wood by the shorter harvest rotation—typically 10 years or less. They are biodegradable, often (but not always)

low in VOC emissions, and generally produced from agricultural crops. Because sunlight is generally the primary energy input (via photosynthesis), these products may be less energy-intensive to produce—though transportation and processing energy use must be considered. Examples include linoleum, form-release agents made from plant oils, natural paints, geotextile fabrics from coir and jute, cork, and such textiles as organic cotton, wool, and sisal. Note that not all rapidly renewable materials are included in *GreenSpec*—non-organic cotton, for example, is highly pesticide-intensive. In some cases, even though a product qualifies for *GreenSpec* by virtue of its natural raw materials, it may have negatives that render it inappropriate for certain uses—such as high VOC levels that cause problems for people with chemical sensitivities.

3. Products That Avoid Toxic or Other Emissions

Some building products are considered green because they have low

manufacturing impacts, because they are alternatives to conventional products made from chemicals considered problematic, or because they facilitate a reduction in polluting emissions from building maintenance. In the *GreenSpec* criteria, a few product components were singled out for avoidance in most cases: substances that deplete stratospheric ozone, and those associated with ecological or health hazards including mercury and halogenated compounds. In a few cases, these substances may be included in a “green” product if that product has significant environmental benefits (for example, low energy or water use).

These substitutes for products made with environmentally hazardous components may not, in themselves, be particularly green (i.e., they may be petrochemical-based or relatively high in VOCs), but relative to the products being replaced they can be considered green. Most of the products satisfying this criterion are in categories that are dominated by the more harmful products—such as foam insulation categories in which most products contain HCFCs. We have created several subcategories here for green products:

3a. Natural or minimally processed products — Products that are natural or minimally processed can be green because of low energy use and low risk of chemical releases during manufacture. These can include wood products, agricultural or nonagricultural plant products, and mineral products such as natural stone and slate shingles.

3b. Alternatives to ozone-depleting substances — Included here are categories where the majority of products still contain or use HCFCs: rigid foam insulation and compression-cycle HVAC equipment.

3c. Alternatives to hazardous products — Some materials provide a better alternative in an application dominated by products for which there are concerns about toxic constituents, intermediaries, or by-prod-

ucts. Fluorescent lamps with low mercury levels are included here, along with form release agents that won’t contaminate water or soils with toxicants. Also included here are alternatives to products made with chlorinated hydrocarbons such as polyvinyl chloride (PVC) and brominated fire retardants.

3d. Products that reduce or eliminate pesticide treatments — Periodic pesticide treatment around buildings can be a significant health and environmental hazard. The use of certain products can obviate the need for pesticide treatments, and such products are therefore considered green. Examples include physical termite barriers, borate-treated building products, and bait systems that eliminate the need for broad-based pesticide application.

3e. Products that reduce stormwater pollution — Porous paving products and green (vegetated) roofing systems result in less stormwater runoff and thereby reduce surface water pollution. Stormwater treatment systems reduce pollutant levels in any water that is released.

3f. Products that reduce impacts from construction or demolition activities — Included here are various erosion-control products, foundation products that eliminate the need for excavation, and exterior stains that result in lower VOC emissions into the atmosphere. Fluorescent lamp and ballast recyclers and low-mercury fluorescent lamps reduce environmental impacts during demolition (as well as renovation).

3g. Products that reduce pollution or waste from operations — Alternative wastewater disposal systems reduce groundwater pollution by decomposing organic wastes or removing nutrients more effectively. Masonry fireplaces burn fuel-wood more completely with fewer emissions than conventional fireplaces and wood stoves. Recycling bins and compost systems enable occupants to reduce their solid waste generation.

4. Products That Save Energy or Water

The ongoing environmental impacts that result from energy and water used in operating a building often far outweigh the impacts associated with building it. Many products are included in *GreenSpec* for these benefits. There are several quite distinct subcategories:

4a. Building components that reduce heating and cooling loads — Examples include structural insulated panels (SIPs), insulated concrete forms (ICFs), autoclaved aerated concrete (AAC) blocks, and high-performance windows and glazings. As these energy-saving products gain market acceptance, our threshold for inclusion in *GreenSpec* may become more stringent. For example, we may begin including only SIPs and ICFs with steady-state R-values above a certain threshold or with other environmental features, such as recycled-content foam insulation. Some products, such as insulation, clearly offer environmental benefits but are so common that they need other environmental features to qualify for *GreenSpec*.

In the case of windows, the base standard for energy performance of windows is an NFRC-rated unit U-factor of 0.25 or lower for at least one product in a listed product line. If the windows are made from an environmentally attractive material (e.g., high recycled content or superb durability), the energy standard is less stringent: U-factor of 0.30 or lower. If the frame material is nongreen, such as PVC (vinyl), the energy standard is more stringent: U-factor of 0.20 or lower. There are a few exceptions to these standards, such as high-recycled-content windows made for unheated buildings.

4b. Equipment that conserves energy and manages loads — With energy-consuming equipment, such as water heaters and refrigerators, we have good data on energy consumption and can set clear standards accordingly. In most product catego-

Sample *GreenSpec* Standards for Selected Equipment

Product Type	<i>GreenSpec</i> Standard
Domestic water heaters	Energy Factor = 0.80 or higher
Residential clothes washers	Minimum modified Energy Factor of 1.8 and maximum Water Factor of 5.5 (as defined by the Consortium for Energy Efficiency)
Residential refrigerators	Exceed 2004 National Energy Standard by 20% (full size) or 25% (compact)
Residential dishwashers	Energy Factor = 0.67 or higher
Central AC and heat pumps	Product line must have at least one model with a SEER rating of 16 or greater.

ries—e.g., refrigerators, dishwashers, and clothes washers—we set higher thresholds than ENERGY STAR®: for example, exceeding those standards by 10% or 20%. With lighting and lighting control equipment, certain generic products qualify, such as compact fluorescent lamps and occupancy/daylighting controls, while in other categories only a subset of products qualify. (See table for *GreenSpec* standards for certain types of equipment.) In some cases, products that meet the energy efficiency requirements are excluded, because of evidence of poor performance or durability. Microturbines are included here because of the potential for cogeneration (combined heat and power) that they offer. Ice- or chilled-water thermal energy storage (TES) equipment is also included because it helps reduce peak loads, which in turn can reduce energy costs and lower the impact of electricity generation.

4c. Renewable energy and fuel cell equipment — Equipment and products that enable us to use renewable energy instead of fossil fuels and conventional electricity are highly beneficial from an environmental standpoint. Examples include solar water heaters, photovoltaic systems, and wind turbines. Fuel cells are also included here, even though fuel cells today nearly always use natural gas

or another fossil fuel as the hydrogen source—they are considered green because emissions are lower than combustion-based equipment and because the use of fuel cells will help us eventually move beyond fossil fuel dependence.

4d. Fixtures and equipment that conserve water — All toilets and most showerheads today meet the federal water efficiency standards, but not all of these products perform satisfactorily. With toilets and showerheads we include products that meet the federal standards and have dependably good performance. We include in *GreenSpec* only toilets that offer at least 20% water savings, compared with the federal standard of 1.6 gallons per flush (gpf), and we have adopted the Maximum Performance (MaP) standard for the performance of most toilets—requiring a minimum rating of 65 grams of test media removal per liter of flush volume. Some other products, such as rainwater catchment systems, are also included.

5. Products That Contribute to a Safe, Healthy Built Environment

Buildings should be healthy to live or work in and around, and product

selection is a significant determinant of indoor environment quality. Green building products that help to ensure a healthy built environment can be separated into several categories:

5a. Products that do not release significant pollutants into the building

— Included here are zero- and low-VOC paints, caulks, and adhesives, as well as products with very low emissions, such as nonformaldehyde manufactured wood products. Just how low the VOC level needs to be for a given product to qualify for inclusion in *GreenSpec* depends on the product category. Ideally those standards should be based not on simple VOC content, but on resultant VOC concentrations in the space after a given period of time—EPA is working on such data for paints (including a way to factor in higher impacts for more toxic VOCs), but this information is not yet available.

5b. Products that block the introduction, development, or spread of indoor contaminants

— Certain materials and products are green because they prevent the generation or introduction of pollutants—especially biological contaminants—into occupied space. Duct mastic, for example, can block the entry of mold-laden air or insulation fibers into a duct system. “Track-off” systems for entryways help to remove pollutants from the shoes of people entering. Coated ductboard—compared with standard rigid fiberglass ductboard—prevents fiber shedding and helps control mold growth. And linoleum helps to control microbial growth because of the ongoing process of linoleic acid oxidation.

5c. Products that remove indoor pollutants

— Qualifying for inclusion here are certain ventilation products, filters, radon mitigation equipment, and other equipment and devices that help to remove pollutants or introduce fresh air. Because ventilation equipment is now fairly standard, only products that are particularly efficient or quiet, or that have other environmental benefits are included.

5d. Products that warn occupants of health hazards in the building — Included here are carbon monoxide (CO) detectors, lead paint test kits, and other IAQ test kits. Because CO detectors are so common, other features are needed to qualify such products for *GreenSpec*, such as evidence of superb performance.

5e. Products that improve light quality — There is a growing body of evidence that natural daylight is beneficial to our health and productivity (see *EBN* Vol. 8, No. 9). Products that enable us to bring daylight into a building, including tubular skylights, specialized commercial skylights, and fiber-optic daylighting systems, are included in *GreenSpec*. Some other products, such as full-spectrum lighting systems and highly reflective ceiling panels, could also be included in *GreenSpec* under this criterion.

5f. Products that help control noise — Noise, both from indoor and outside sources, adds to stress and discomfort. A wide range of products are available to help absorb noise, prevent it from spreading, masking it, and even reducing it with sound-cancellation technologies.

5g. Products that enhance community well-being — Looking beyond the walls of a building, many products can contribute to safer neighborhoods, increasing walkability and making high-density communities appealing.

Final Thoughts

The primary intent with any green building products directory is to simplify the product selection process. Such directories, including *GreenSpec*, are designed to save you time. For a directory to properly serve your needs, you must be able to trust it—you must have confidence that the process used to select products for inclusion is logical and based on good information and careful analysis. In this article, we have attempted to lay out our process for selecting products for the *GreenSpec* directory.

We are also providing this information so that you can critique it. We print updated copies of *GreenSpec* periodically, and we update the online version every week. That means not just ensuring that we have up-to-date contact information and product descriptions, but also regularly reexamining our standards for what should (and should not) be included. In the next edition of *GreenSpec* certain products will be kicked out—not because they have gotten worse from an environmental standpoint, but because we have reevaluated our standards for inclusion. As more low-VOC paints reach the market, we will likely tighten our standards because we want to include only the very best products. As we consider modifying our standards, we'd like to hear

from users of this information. Are our standards too tight in a given area? Are they too lax? What other criteria should we consider adding to our product-evaluation process? We welcome your suggestions and comments by e-mail at: greenspec@BuildingGreen.com.

Finally, we have laid out our standards for *GreenSpec* to advance the development of new, greener products. We want to make it as easy as possible for manufacturers to understand what we consider to be green—so that they can strive to meet those criteria. Doing so will make more green building products available to us all and help to reduce the overall impacts of construction.

— Alex Wilson

Summary of Product Standards for *GreenSpec*

1. Products Made with Salvaged, Recycled, or Agricultural Waste Content

- 1a. Salvaged products
- 1b. Products with post-consumer recycled content
- 1c. Products with pre-consumer recycled content
- 1d. Products made with agricultural waste material

2. Products That Conserve Natural Resources

- 2a. Products that reduce material use
- 2b. Products with exceptional durability or low maintenance requirements
- 2c. Certified wood products
- 2d. Rapidly renewable products

3. Products That Avoid Toxic or Other Emissions

- 3a. Natural or minimally processed products
- 3b. Alternatives to ozone-depleting substances
- 3c. Alternatives to hazardous products
- 3d. Products that reduce or eliminate pesticide treatments
- 3e. Products that reduce stormwater pollution
- 3f. Products that reduce impacts from construction or demolition activities
- 3g. Products that reduce pollution or waste from operations

4. Products That Save Energy or Water

- 4a. Building components that reduce heating and cooling loads
- 4b. Equipment that conserves energy and manages loads
- 4c. Renewable energy and fuel cell equipment
- 4d. Fixtures and equipment that conserve water

5. Products That Contribute to a Safe, Healthy Built Environment

- 5a. Products that do not release significant pollutants into the building
- 5b. Products that block the introduction, development, or spread of indoor contaminants
- 5c. Products that remove indoor pollutants
- 5d. Products that warn occupants of health hazards in the building
- 5e. Products that improve light quality
- 5f. Products that help noise control
- 5g. Products that enhance community well-being