

GREEN BUILDING SECTION

Seven Steps To Green Building



Green Building promotes equipment, design methods, landscapes, and building materials that save energy, water, solid waste, and natural resources.

One of the more misunderstood aspects of green building is that it is just about "gadgets." Some assume that advanced appliances and materials are all that are needed to make an environmentally-sound building. While these go a long way towards this goal, they are not the only things that are needed. For example, most air conditioning systems are oversized and have ducts that leak, so even the most energy-efficient system can waste much of its energy. And the right green material in the wrong location can be counterproductive, such as using sustainably-harvested wood in areas heavily infested with termites.

This section includes an abbreviated version of the City of Austin Green Building Program publication *Green By Design*. It discusses 7 steps to consider in a green building project. A complete version is available on CD-ROM for \$15 from the Program Web site (www.ci.austintx.us/greenbuilder) or by calling (512) 482-5200.

Once you understand the basic issues raised in these 7 steps, you'll see that green building is a process of fully considering the end use of your home. The goal is a building that meets your deepest wants and needs without compromising the environment of future generations.

Step 1: Assess Your Needs & Priorities

"Our house is in need of some major repairs and feels pretty cramped. It seemed like some remodeling would solve our problems. We called in a designer, who gave us a ballpark figure. Then she asked if we had considered a different furniture arrangement. We tried it, and realized we didn't really need the addition, just the repairs. We sent the designer a gift certificate for a gourmet dinner, and figure we saved about \$39,900."

First of all, think about how you and the other members of your household need and want to live, and any changes in lifestyle that might occur over the next several years. Then think about what kind of site and what kind of house will best meet these needs and wants.

Consider: Are you looking for a neighborhood school for your kids? A park they can walk or bike to by themselves? Do you find gardening and yard work a pleasure or an aggravation? Are you a homebody, or do you love to go out to restaurants and theaters frequently? Do you cook and entertain a lot at home? Is it important to you to have close neighbors? Do you hate to commute? Do you need a home office? How often do you grocery shop? Do your household members need a lot of private space?

If you were planning to build your dream house now, what would the top goals be? What purposes, needs, and desires do you want to satisfy in your life that the right home can contribute to? These could include low building and operating costs, minimal maintenance, short commuting times to work and school, and a desire for greater independence by producing solar electricity, or harvesting rainwater.

You may be surprised to find that you have conflicting wants and needs. That's inevitable, but all the more reason to spend a lot of time on this step. When you have a good start answering basic questions about your family's lifestyle and values, you'll be able to make good choices about site and space needs.

Resources

[Before You Build - A Preconstruction Guide](#)

Robert Roskind, Owner Builder Center

Ten Speed Press

www.tenspeed.com

[The Not So Big House - A Blueprint for the Way We Really Live](#)

Sarah Susanka

www.notsobighouse.com/books.asp

[A Primer on Sustainable Building](#)

Dianna Lopez and William Browning

www.rmi.org/store/pid960.php

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Step 2: Form Your Team

It takes a lot of people to make a house a reality: designers, engineers, a general contractor (builder), construction workers, appraiser, lender, insurer, realtor, building officials, inspectors, and more. Maybe you won't need all of them, and you probably won't have to choose all of them yourself (for example, the lender may choose the appraiser; the builder probably will select all the construction workers). But you need to make sure that all these people are on the same team – your team – all communicating and cooperating to produce the best possible result.

Unfortunately, it's quite common for the various parties to have little or no contact with each other. They may even view each other as adversaries. What starts as a lack of communication can snowball into conflicts that result in a lower-quality and higher-priced home.

A. Benefits of a good team

A good team shares and integrates its expertise. A building is not an aggregation of unconnected parts, but rather a unit, each part affecting another. Team members understand this and pool their knowledge so better solutions to problems can be found and money saved.

If the designer is planning a 12'-3" wide room that is to be carpeted, the builder might suggest that it be made 12'-0" to accommodate a standard-sized roll of carpet, reducing waste and expense. If the heating and cooling contractor informs the designer in early planning about the space needed for equipment and ducts, an effective system can be installed, not a poor compromise. He could also advise about the impact of windows on the heating and cooling system. By making better window choices, a smaller air conditioner might be possible. Money saved could pay for the better windows. The owner could then enjoy greater aesthetics, comfort and a lower utility bill.

B. Selection of a good team

You want team members committed to working cooperatively and willing to spend the time this requires; compatible and trusting of each other; open to new ideas; knowledgeable about green building; and experienced in the kind of building you want (or capable of learning quickly). Be prepared to pay a little more for such professionals. You'll save time and hassle in the short run, and money in the long run, because you'll get a better building.

You may worry that you won't know how to choose the right people. But once you've begun to grasp all 7 steps, you will have a sharper focus and have many good questions to ask prospective team members. Ask how they have gained their knowledge of green building, how they keep up with new developments, and most importantly, what aspects of green building they have incorporated in their previous work.

If you have a local green building program or organization, ask for recommendations. In all cases, check references thoroughly. Look at a number of projects in person, and ask former clients if they had a satisfying experience.

Resources

[Greenbuilder Website](#)

www.greenbuilder.com

Information about green building professionals in U. S.

[U.S. Green Building Council – Houston Chapter](#)

www.usgbc-houston.org

Houston network of green building professionals and enthusiasts

Step 3: Design for Your Conditions

Before you design your house – before you even choose a site – you need to know the conditions of your region. These include such things as the climate, topography, and soil type. They determine what kind of a building will be durable, comfortable, safe, and efficient in that area.

No region has ideal conditions. The better you understand your conditions, the more you can maximize the positive ones and minimize the negative ones by your choices of site, design, materials, and systems. It's easier and cheaper to work with nature than against her.

A. Understanding your region

1. Temperature

a. Severity of winter and summer temperatures – How much of the time and when is it too cold to be comfortable? How much of the time and when is it too hot? Knowing this precisely will help you decide matters such as the best house shape and placement on the site, how much window area to have and where to place windows, how much insulation you'll need, whether you'll need a heating or cooling system, and if so, how efficient it should be.

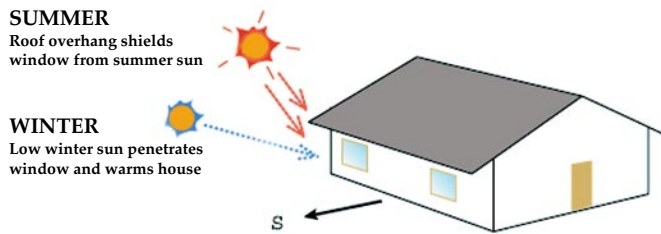
b. Temperature differences between day and night – Understanding temperature shifts from night to day helps you determine the best building materials for your region. For example, in the desert southwest, where there are warm days and cool nights, masonry materials such as adobe walls and tile roofs and floors, work well. Masonry stores a lot of heat but it changes temperature very slowly. In the cool night it gives off the heat it stored up in the hot day, just when the occupants need it. This process works in reverse during the day to help keep the home cool. In a region with both a cold night and cold day, masonry would get cold and stay cold.

c. Ground temperature – Understanding ground temperature helps you decide what foundation type and flooring materials will work best in your area. In a hot climate with a constant comfortable ground temperature, an uninsulated concrete slab provides both a serviceable foundation and an energy-efficient, comfortable finish floor. As

long as occupants don't cover the floor with an insulating material like carpet, they'll benefit from the cool ground temperature, and won't need as much air conditioning. In a cold climate, such a floor would get too cold for comfort.

2. Sunlight

Notice that the arc of the sun is higher in the summer than in the winter. Fortunately this arc is entirely predictable, unlike the weather. By knowing exactly where this arc is in your region at the hottest and coldest times of the year, you can place and size windows and overhangs to let in just the amount of heat you need.



3. Rainfall

Knowing average annual rainfall, volume in a short period, and time of year that rain typically falls helps you make choices about landscaping, roof pitch, and building materials that will reduce landscape failures, leaking, erosion, rot and mold. For example, in regions with torrential rains, it's important to get water off the roof fast so it doesn't drive back up under the roofing and leak into the house. A steeply pitched roof does this much better than a flatter one.

4. Relative humidity

Low humidity encourages the growth of viruses and high humidity encourages mold growth, which causes problems with rot and allergies. Both extremes are uncomfortable and unhealthy. Understanding relative humidity in your area enables you to choose the proper construction methods, materials, and ventilation systems to avoid these problems. In an area with long cold winters, a vapor barrier must be installed on the inside of the exterior walls. This keeps the warm, moist interior air from entering the wall, where it could cool down, condense, damage the insulation, and rot out the wall. In warm areas, sometimes it's more humid outside, sometimes inside. There's no ideal way to build for this, so it's best to install no vapor barrier and let the vapor move freely through the wall. The wall is not likely to be under any one condition long enough for damage to occur.

5. Prevailing winds

Understanding the wind patterns of your region helps you design a home that takes advantage of refreshing breezes and avoids harsh winds. This will affect your choices about window size and placement, and roof shape.

6. Special conditions

Good design also requires knowledge of conditions such as earthquakes, hurricanes, termites, soil stability, and the effects of nearby bodies of water or mountains.

B. Choosing a site and design

Once you understand the conditions of your region, you'll be able to pick a site that minimizes negative conditions and maximizes positive ones. Your site might be quite different from its neighbors. The city of Austin, for example, is split into two markedly different geographic regions. Soil, plants, and weather are quite different in these two areas. Even lots in the same block may be very different: one may have big shade trees, a prevailing breeze, and excellent soil conditions for the foundation. The next lot may have opposite conditions.

Once you know your site thoroughly, you'll be able to make a design that exactly suits it. Spend your time, effort and money on what matters most in your region and on your site.

It is helpful to look at the historical building styles in your area to see how people got comfort passively from the building design and site in an era before modern heating, cooling and humidity control systems. You don't have to build a home in a historical style to take advantage of the design features used, however. A high ceiling works the same way whether a home is contemporary or Victorian. Heat will rise above the occupants. In a hot climate, that's a plus, but in a cold one, it's not.

Designing for a Southwest Climate

Site:

1. North/south exposure (hot west-facing slopes avoided)
2. Deciduous trees on east and west for sun protection

Design:

3. Long, narrow shape; long walls and most glass facing north/south so smallest area faces east and west sun
4. Large overhangs and covered porches on east and west for sun protection (skylights and sunrooms avoided)
5. Windows for cross ventilation and heat exhaust
6. High ceilings, so hotter air rises above occupants
7. Light exterior colors to reflect sun's heat

Resources

National Climate Data Center

<http://lwf.ncdc.noaa.gov/oa/ncdc.html>

Historical average climate data for 270 U.S. cities

Florida Solar Energy Center

www.fsec.ucf.edu/

Information for designing and building in hot, humid climates

Step 4: Choose Green Materials

Once you've selected a good site for the conditions of your locale and have a pretty clear idea what kind of design will work well on it, you can think about materials. Materials should not be divorced from site and design, however. If you have an extremely steep site, for example, a light structure out of wood or metal studs would probably work better than a heavy one made from an earth material. There are 7 criteria for choosing materials.

1. Is the material effective in your conditions? Most materials have a range of conditions in which they work best. A material that works well on the cloudy northwest coast might deteriorate in the relentless desert sun.

2. Is the material healthy and safe? Materials need to be healthy and safe for the workers who extract, harvest, manufacture and install them, and for the inhabitants who are exposed to their fumes and particles in tight modern buildings. Above all, material production, use, and disposal must be safe for the planet. We don't want our homes to add to such problems as pollution, global warming, loss of habitat, and depletion of irreplaceable resources.



Metal roofs can last decades longer than asphalt shingles

3. Is the material durable and easily maintained? Using long-lasting materials saves resources needed to replace them, reduces disposal costs, and usually requires little or no maintenance. Exterior walls made of brick or stone won't rot, are termite proof, and never need painting.

4. Is the material used efficiently? There's a lot to consider.

a. Is the material from your region and is it processed there? Transportation results in pollution, so the less transport needed, the better. Buying from your region has the added benefit of helping your local economy.

b. Can the material be used in a natural state, or with very little processing? Processing resources such as carpeting or vinyl siding tends to use a lot of resources, especially energy and water. But stone and wood can be used with little or no processing.

c. Can the material serve more than one purpose, so other materials won't be needed? A rammed-earth wall does not need to be insulated or covered with a finish material, inside or out, while a wood-frame wall needs exterior siding, insulation in the cavities, an interior wall covering such as sheet rock, and paint.

d. Does the design and/or construction method use material efficiently? Factory-built construction, standardized materials, and using the minimum amount of material necessary all reduce waste.

e. Does the material make efficient use of the resources it's made of? Here are some examples:

- Engineered materials, such as finger-jointed studs made with short pieces of lumber glued together;
- Products with recycled content, such as steel framing made of scrap steel, or carpet made of plastic bottles;
- Products that are easily recyclable, such as glass blocks and concrete blocks;
- Reused materials from dismantled buildings.

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RDA is a non-profit organization dedicated to the advancement of architecture, urban design, and the built environment. Through its lecture programs, civic forums, tours, and *Cite*, RDA creates a public forum to stimulate discussion, involvement, and cooperation among the many groups of citizens who are able to improve the quality of life within Houston and its environs. Membership is open to the general public.



Rice**DesignAlliance**

www.rda.rice.edu

Continued from p. 35

5. Is the material available in your area, and can contractors work with it? If so, you will save time and money and have fewer problems.

6. Is the material cost effective? If cost is your top consideration, be advised to look at all costs, now and in the future, not just the purchase price. What maintenance will be needed? How long will a product last? Which choice will give you the most comfort? Which choice is more likely to keep you away from the doctor?

7. Is the material aesthetically satisfying to you? No one expects you to choose a material that you don't find appealing – that's an important criterion, too.

There is seldom a perfect material choice. But some criteria matter more than others. What might seem like a bargain in the store might not really be one in the long run if the material does not hold up well or if it provokes your allergies. Still, given all the choices, there's bound to be a good one for you.

Resources

Efficient Windows Collaborative

<http://www.efficientwindows.org>

How to select the best windows for your location

Green Building Resource Guide

John Hermansson

www.greenguide.com

Environmental Building News Product Catalog

122 Birge Street, Suite 30
Brattleboro, Vermont 05301
(802) 257-7300

www.buildinggreen.com

Oikos Product Directory

Iris Communications, Inc.
P. O. Box 6498
Bend, OR 97708-6498
(541) 317-1626

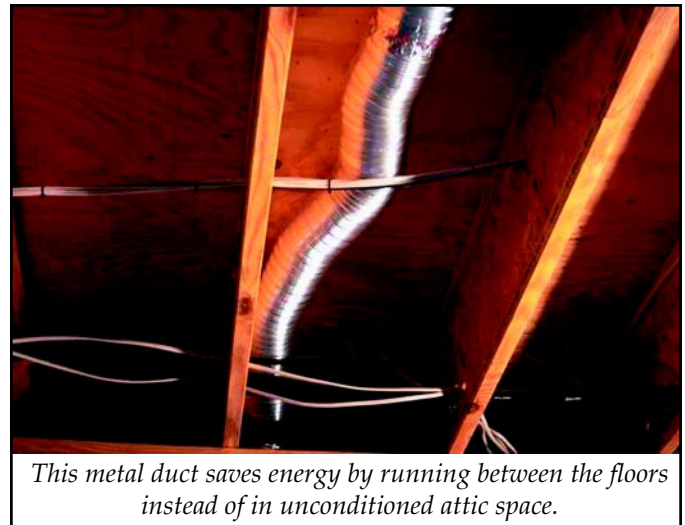
www.oikos.com/green_products/index.php

Step 5: Choose the Right Energy Systems

Modern heating, cooling, and ventilation systems, lighting, and appliances play a major role in providing us with comfort and convenience, good health and safety. If you understand a few basics, you'll be able to get these benefits for a reasonable price.

A. Heating, cooling, and ventilation systems

By far the most cost-effective way to feel comfortable in a building is to control your environmental conditions by passive means: finding a site that protects you from the worst elements of your region, and designing your building and choosing materials that do the same (Step 3 and Step 4). But passive methods won't make you comfortable all the time in most parts of the country. For that, you'll



This metal duct saves energy by running between the floors instead of in unconditioned attic space.

need an active heating, cooling, and ventilation system.

To get comfort, safety, and affordability from your system, consider efficiency, humidity control, air movement, air quality, and system type.

1. Efficiency: Whether your system will be efficient depends on the following:

a. Efficient equipment – Your mechanical system costs you money every minute it runs. In a hot climate, choose equipment with the highest cooling efficiency rating you can afford. If you need heating too, but aren't likely to use it much, don't spend a lot on heating efficiency. In a cold climate do the reverse.

b. Correctly sized equipment – Equipment size must be based on the actual amount of cooling and heating a building needs. Need is based on the climate, size, design, and construction of a building – factors such as the amount of window area and the direction it faces, window shading, the amount of insulation, etc.

If the equipment is too small, it can not heat or cool adequately. But in most homes, the equipment is too big to work right. Because an oversized unit reaches the thermostat temperature quickly, it doesn't run long enough at one time to reach the efficiency it was designed for.

In a hot humid climate, you need the cooling system to dry the air as well as cool it. The system can only respond to the thermostat, however, and the thermostat only reads temperature (not humidity), so it shuts off before it can dehumidify properly. As a result, you'll feel clammy, and maybe sick as well from the mold thriving in the moist air. A properly-sized unit is cheaper to buy, cheaper to operate, and will run long enough to dehumidify.

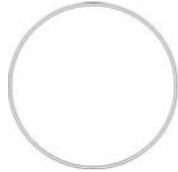
c. Effective placement – The best location for equipment and ductwork is inside the insulated space, so conditioned air is less affected by outside conditions. A good location is an insulated basement. In the south, houses rarely have



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basements, so systems are usually in attics. Since an attic may get up to 160° on a summer day, that's the worst possible place to run ducts filled with cold air.



Bad duct installation prevents good air flow

Note: The attic wouldn't be such a bad location if the insulation were installed just under the roof, instead of its usual place on the floor of the attic. Then the ductwork would be inside the insulated space.

d. Effective design and installation - The extra money you pay for high-efficiency equipment will be wasted if the system is poorly installed. If the installer puts 90-degree turns in the ducts that weren't in the original design, the extra friction caused by air swirling around the sharp bend will prevent the needed amount of air from getting to the rooms. If the ducts leak (and they always do), conditioned air seeps out, or unconditioned air gets sucked in.

Most leaks cannot be seen. They can only be found by testing. Testing is not standard practice, so you must ask for it. Leaks must be sealed with a material such as latex mastic that won't come off over time.

2. Humidity control: In extra-humid rooms such as baths, laundry and kitchen, be sure to install vent fans that exhaust air *outside*. Connect them to a timer or (better) a humidity sensor, so they will turn off automatically. Also, the quieter the fan, the more likely you are to use it.

3. Air movement: It's important for a system to move enough air to and from every room (both supply and return) to function properly and provide comfort. The location of supply and return registers is also critical to good airflow. Let the contractor know this is important.

4. Air quality and safety: Forced-air systems cause huge changes in air pressure. Dangerous fumes from a gas furnace or water heater (such as carbon monoxide) may get sucked into the living space instead of exhausting out of the house through the vent pipes. This is called backdrafting. For safety's sake, choose a sealed-combustion unit that gets combustion air from outside the house instead of robbing it from the air you breathe.

A good filter improves air quality and protects equipment (many do neither). Filter efficiency ratings are often wildly misleading. A claim of 95% efficiency may only mean it's good at filtering marbles. If possible, find out the "dust-spot efficiency" – the higher the number, the better. A pleated-media filter does a good job for the least money.

5. Type of system: The best type of system for your home will vary from one part of the country to another, for all the usual reasons – conditions, availability, expertise in your community, budget, and so forth.

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B. Lighting

If you compare a well-lit home with a poor one, you will know that good lighting is not a luxury. It's necessary for people to be productive, healthy, secure, and safe. It's also important for its psychological effects – the way it can make space cheerful, welcoming, cozy, interesting, romantic, or dramatic. Let's look at how we can get better light in buildings – whether from daylight or electric lighting.

1. Daylight: To get the maximum benefit from daylight, be sure your designer gets light as deep into the living space as possible. Windows high on a wall are especially effective for doing this with a minimum of annoying glare. You want light to hit as many surfaces as possible and reflect back on other surfaces. Light-colored paint increases reflection. Be cautious about the use of skylights because they may allow too much heat in, as well as glare.

2. Electric Lighting: There is a wide selection of electric fixtures and bulbs. Your choices will depend on its intended purpose, the amount needed, the efficiency, and the way colors appear under them.

a. Purpose of the light – Your lighting choices depend on what you are trying to accomplish. Do you need general lighting to get around safely; indirect lighting to keep spaces from looking gloomy; intense, highly focused and totally glare-free light for tasks such as reading or sewing; accent lighting to highlight a painting or architectural feature; or decorative lighting, such as a chandelier?

b. Type of light – Choose the best kind of light for your purpose. For residential use, you will probably use some standard incandescent lighting for creating a warm, cozy atmosphere; halogen incandescent when you need a very intense or focused light for reading or highlighting an object; or fluorescent for most other uses, since it's very efficient, long lasting, and doesn't produce a lot of heat.

You might be surprised to learn that fluorescent lighting is now available with electronic ballasts that don't flicker or hum, and light that is warm and flattering in color. You may have to go to a commercial lighting supplier to find the fixtures and bulbs you want.

Over its lifetime, an 18-watt fluorescent light will save 570 kilowatt hours of electricity (preventing over 1,300 lbs. of carbon dioxide emissions) compared to a 75-watt incandescent bulb (which gives about the same amount of light).

c. Amount of light – Install the amount of light needed for your purpose. You might think you need a lot of light to see outside at night, but actually you need very little because at night the contrast is so great. A major reason not to use more light than you need is that it produces a lot of heat. An incandescent bulb turns only 7% of the electricity it uses to light – the other 93% turns into heat. This is not an efficient way to heat your house.

d. Fixture type and placement – Choose fixtures that throw light where you need it, and place light fixtures where they will do their job best. Your home designer may be able to advise you about this, or you may want to add a professional lighting designer to your team. You can also seek advice from a commercial lighting supplier.

C. Appliances

Americans love the convenience of appliances. Some new appliances can save more than 50% of their energy use compared to appliances built 10 years ago.

1. Look for energy-efficiency labels, such as the EnergyGuide or Energy Star: It's easy to find and understand the bright yellow EnergyGuide label on appliances such as refrigerators, dishwashers, and water heaters.

2. Estimate the life-cycle cost: Look at the true cost over time, not just the purchase price. Electric water heaters, for example, may be slightly less expensive, but are the most costly in the long run because competing gas fuel costs less.

Resources

Consumer Reports

www.consumerreports.org

Sizing air conditioning systems

Coalition for Energy Efficiency

www.cee1.org

Product directories describing top-rated efficient appliances

Consumer Guide to Home Energy Savings, 8th Edition

American Council for an Energy-Efficient Economy

www.aceee.org/consumerguide/index.htm

Energy Star Program

www.energystar.gov

Product directories for efficient appliances, lamps, building products

Gas Appliance Manufacturers Association

www.gamanet.org/gama/inforesources.nsf

Product directories describing energy efficiency of space and water heating equipment

A good primer on environmental lawncare, including composting, earthworms, grasscycling, water conservation, and Integrated Pest Management.

Step 7: Test & Maintain Your Green Home

Once you've built your green home, you'll want to make sure it's safe and able to perform as efficiently as you and your team intended. You'll also want to maintain it properly to prevent deterioration in the future. Address these matters in the planning stage, so you'll make building choices that make testing and good maintenance possible.

A. Preparing your home for occupancy

1. Get rid of harmful fumes: It's a good idea to air out a new building as much as possible. New building materials contain a lot of chemicals, such as formaldehyde, that easily form unhealthy gases. These gases gradually dissipate, so the more time that elapses before people move in, the better. Your best bet is to avoid choosing materials containing unhealthy chemicals in the first place. Also avoid choosing materials difficult to maintain without introducing nasty chemicals into your home in the future.

2. Test for safety and efficiency: Your contract with your builder should include a list of tests to be performed on your house, and should spell out the extent to which problems will be corrected, and who is qualified to do the tests and repairs. These three tests are the most important:

a. Duct leakage test – If you have a forced-air heating or cooling system, get the ducts tested for leaks. A well-sealed system has no more than 5-10% percent leakage.

b. Safety backdraft test – If you have a gas water heater and gas furnace that do not have sealed combustion and are located where fumes from the flame could get into your living space, their vents should be tested. With all equipment turned on (the air handling system and bathroom, laundry room, dryer, and stove-vent fans), so the air pressure in the house is as low as it's ever likely to be, test to make sure the combustion gases exhaust to the outside, instead of backdrafting to harm occupants.

c. Blower door test – This test tells you how much air is leaking in and out of the "thermal envelope" or insulated shell of the house. The more extreme your climate, the more important it is to control leakage, since air leaking out has been heated or cooled.

As a general rule, leakage of more than 0.50 Air Changes Per Hour is not energy efficient. (This number means that the air in your house will be replaced by outside air every 2 hours.) For good health, you need at least 0.35 Air Changes Per Hour. Since you cannot control the temperature or humidity of incoming air, you need mechanical ventilation. In a cold climate, the ventilation system should recover heat from exiting air, and in a humid climate it should dehumidify incoming air.

B. Maintaining your home

With good maintenance, your home will last indefinitely. Here are some of the most important aspects of maintaining your home.

1. Materials: For durability and energy efficiency, be sure the outer "skin" of your house keeps doing its job of keeping out weather and pests. That means timely caulking and painting of siding and trim, and replacing weatherstripping as needed.

2. Heating, cooling and ventilation systems: For health, safety, efficiency, and comfort, get your heating and cooling system checked out at least once a year. If your system has filters, change or clean them as often as needed.

3. Cleaning: Regular cleaning helps materials last longer. Choose cleaning products carefully to avoid ones that could damage your house or your health.

4. Pest control: Products that harm pests may harm you too, so choose pest control methods for both inside and outside carefully. If you keep moisture away from your house, keep your landscaping healthy, and do regular cleaning and maintenance, your house won't be so attractive to pests. It also helps to choose building materials that don't provide food for pests.

5. Site and landscaping: Over time, soil may build up, so drainage patterns on your site may change. Be sure water continues to drain away from your foundation to areas where you need it, such as planting beds. Keep vegetation away from the foundation, walls and roof where it can cause damage. Keep trees trimmed to maintain the solar access your house needs for heat and light.

Resources

[Affordable Comfort, Inc.](http://www.affordablecomfort.org)

www.affordablecomfort.org

Information about testing your heating and cooling system

[Biointegral Resource Center](http://www.birc.org)

www.birc.org

Information on Integrated Pest Management



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Make a Difference in the Built Environment

How to go about building green:

1. Consider your life style
 - Think about your priorities, how you and your household lives and any changes that may occur over the near future.
 - Identify your goals – low building/operating costs, minimal maintenance, short commuting times, rainwater harvesting, etc.
2. Pull your team together
 - Are you going to work with a production builder or a custom builder? How knowledgeable are they about green building? Are they willing to learn and try new things?
 - Can you screen the team ahead of time: designer, engineer, builder (general contractor), construction workers, appraiser, lender, insurer, realtor, inspectors, etc.?
3. Consider the site
 - Concentrate impact on land already degraded
 - Preserve open space/wildlife habitat
4. Consider energy usage
 - Energy is one aspect that we understand, can model and measure. Research how you can reduce your energy usage.
 - Look at how to reduce the impact of energy usage (use renewables instead of fossil fuel)
5. Consider indoor environment and effect on health
 - We spend a vast amount of time in our buildings. Research how to make your home a healthy place to live.
 - Consider your furnishings, pest management system, cleaning supplies, as well as the structure of the house.
6. Consider material selection
 - Avoid products with high off-gassing of VOC's (volatile organic compounds).
7. Consider water usage
 - Use rainwater collection for irrigation.

Resources

- The New Ecological Home: A Complete Guide to Green Building Options by Dan Chiras
- Green by Design by Angela Dean
- Good Green Homes: Creating Better Homes for a Healthier Planet by Jennifer Roberts
- Designs for a Healthy Home: An Eco-Friendly Approach by Dan Phillips
- Local Green Materials: www.localgreenmaterials.org



HARC **Houston Advanced Research Center** www.harc.edu

Dedicated to moving knowledge to action to improve human well-being and to protect the environment.

Our High Performance, Green Building Team can assist you and your business in setting and obtaining your environmentally responsible goals:

Supporting development of high performance, green buildings

- Energy efficient
- Cost effective
- Healthy for occupants and the environment

Assisting with building renovations

- Optimizing the energy efficiency
- Improving the overall environment for occupants

Consulting services include:

- Project visioning and definition
- Leadership, facilitation and documentation of design charrette that addresses pre-design issues
- Creation of marketing materials for the development or renovation
- Support to building design decision-making
- Management assistance throughout process
- Planning for operations and maintenance activities

Contact: Terri Kurtin/tkurtin@harc.edu/281-363-7926

What's Green In Houston? Comparing Rating Programs

There are 3 green rating programs for new single family homes in the Houston area.

The most prolific is *Energy Star*, a national program sponsored by the Department of Energy and the Environmental Protection Agency that awards its seal to homes that exceed their International Energy Conservation Code requirements by 15%. It is implemented at the local level. The Star program employs a third-party inspector to verify insulation levels, and to conduct mechanical testing on how well air ducts are sealed and how much air leaks into the house through infiltration. The Houston region is one of the 5 largest in numbers of annual participants in the Energy Star program nationwide.

The program has shortcomings. It has only one level of "pass/fail" requirements, unlike some other rating systems that have several grades (though it has a score or index that allows you to compare it to other Star homes). And it only deals with energy savings, and ignores other resource issues such as water consumption, recycling of building waste, indoor air quality, and green building materials. For more information on the program, go to: www.houstonenergystarhomes.com/choose_builder.htm

Homebuilders that participate in Energy Star include:

Ashton Woods Homes • www.ashtonwoods.com
Beazer Homes • www.beazer.com
Carlisle Home • www.carlislehomes.com
Castlerock Communities • www.castlerockcommunities.com
Centex Homes • www.centex.com
David Powers Homes • www.davidpowershomes.com
David Weekley Homes • www.davidweekleyhomes.com
Hallmark Design Homes • www.hallmarkdesignhomes.com
HHN Homes • www.hhnhomes.com
Imperial Homes • www.imperialhomestexas.com
KB Homes • www.kbhome.com
Kimball Hill Homes • www.kimballhillhomes.com
Lindenwood Homes • www.lindenwoodhomes.com
Lennar Homes • www.lennar.com
McGuyer Homebuilders • www.mcguyrhomebuilders.com
Meritage Homes • www.meritagehomestexas.com
Newmark Homes • www.newmarkhomes.com
Partners in Building, L.P. • www1.partnersinbuilding.com
Perry Homes • www.perryhomes.com
Pulte Homes • www.pulte.com
Richmond American Homes • www.richmondamerican.com
Royce Builders • www.roycebuilders.com
Ryland Homes • www.ryland.com
Trendmaker Homes • www.trendmakerhomes.com
Village Builders • www.lennar.com
Wilshire Homes • www.wilshire-homes.com

The Greater Houston Builders Association began its *Green Building Initiative* in late 2005. Homes that participate must be Energy Star compliant, but this program is much more comprehensive. It includes water conserva-



Energy Star requires third-party testing of duct sealing and infiltration in new buildings

tion, recycling of building waste, indoor air quality, green building materials, site preparation, and maintenance.

But again, it is a pass / fail system with only one grade. And the green measures, with the exception of the requirement for Energy Star certification, are self-certified by the builders and not a third party. For more information, go to www.ghba.org, or call (281) 970-8970.

Builders involved include:

Carlisle Home • www.carlislehomes.com
Dakota Blue Homes • www.dakotabluehomes.com
David Powers Homes • www.davidpowershomes.com
David Weekley Homes • www.davidweekleyhomes.com
Greenhaus Builders • www.BrothersStrong.com
Habitat for Humanity • www.houstonhabitat.org
Olympia Builders • www.olympiabuilders.com
Pulte Homes • www.pulte.com
Ryland Homes • www.ryland.com
Trendmaker Homes • www.trendmakerhomes.com
W.E. Gilbert Company • www.wegilbert.com
Wilshire Homes • www.wilshire-homes.com

A third rating system is a pilot program by the U.S. Green Building Council. The organization has been conducting its *Leadership in Energy and Environmental Design (LEED)* program in commercial buildings since 1999. It began a pilot program for single family homes in 2006.

It differs from the other home rating programs in that participation has 4 grades, depending on the number of measures applied in a building. It is third-party certified. It is expected that the higher LEED grades will greatly exceed the standard for the Green Building Initiative.

Houston architects and designers involved in the program at press time include:

LaVerne Williams, AIA • www.environmentassoc.com
Kathleen Carrier • www.evergreendesignstudio.com

Builders for these houses include:

Dovetail Builders • www.dovetailbuild.com
Renaissance Builders • www.rbi-houston.com

The company rating pilot homes for LEED in Texas is: Contacts, LLC, 4823 McCullough Avenue, San Antonio, Texas 78212, (210) 824-8758.

GREEN MATERIALS



Every year, America lays 650 square miles of carpet, nails 475 square miles of flat wood and 2,200 linear miles of board lumber, produces 171 miles of glass windows, and coats its buildings with 9,300 square

miles of paint. Much of this is installed in existing structures. Green construction materials exist to reduce natural resource depletion. Some are of such high quality that they can last the life of a house. Products and information listed below will help you make environmental choices easier.

CHOOSING LOW-TOXIC PAINTS

Americans use over half a billion gallons of paint each year, enough to cover the state of New Hampshire. These chemicals have environmental effects both to people exposed to them in buildings and to the general public.

Though there is no one type of environmental paint, there are several alternative approaches that are being pursued simultaneously by various companies, all of which are producing something better than conventional products. These include: 1) paints and finishes with low Volatile Organic Compounds (VOCs); 2) paints using natural materials; 3) low-tox paints for the chemically-sensitive; and 4) least-toxic paint removers.

Paints With Low Volatile Organic Compounds

Volatile organic compounds (VOCs) are the fumes that you smell while you paint, and sometimes for several days after. A VOC is an organic chemical that becomes a breathable gas at room temperature. Some examples are benzene, toluene, and xylene. These fumes can cause various types of chemically-induced reactions ranging from mild symptoms that resemble allergies to severe illness linked with Multiple Chemical Sensitivity. Although most VOCs from paints greatly diminish after a few weeks, small amounts of VOCs continue to be emitted for months. Low-VOC alternatives are now widely available in a variety of colors and types (Flat, Semi-Gloss, etc.).

Most major paint companies now carry a line of low or zero VOC interior paints that are stocked or ordered from dealers. However, they may be confined to lighter colors.

Benjamin Moore – ECOSPEC
ICI Paints – LIFEMASTER 2000
Kelly Moore – ENVIRO-COTE
KWAL Paint – ENVIRO-KOTE
Pittsburgh Paint – PURE PERFORMANCE
Sherwin Williams – HARMONY

Exterior Paint With Low VOCs

Fine Paints of Europe Eco line (800) 332-1556
www.finepaintsofeurope.com
Phone or Web sales

Fuhr International (817) 274-6200
www.fuhrinternational.com
Phone Sales

Rodda Paint (800) 452-2315
www.roddapaint.com
Certified by Greenseal as environmentally compliant
Phone Sales

Finishes, Stains, and Varnishes With Low VOCs

AFM Enterprises (800) 239-0321
www.afmsafecoat.com
Local: Allergy and Health Store

BonaKemi USA (800) 574-4674
www.bonakemi.com
Eon 70 professional water-based, low-VOC wood finish
Ordered from many flooring stores

Eco Design Co. (800) 621-2591
www.bioshieldpaint.com
Phone or Web sales

Fuhr International (817) 274-6200
www.fuhrinternational.com
Phone Sales

Perma-Chink Systems – Eastern Div. (800) 548-3554
www.permachink.com
Lifeline™ waterbased acrylic stains and finishes
Phone or Web sales

Hood Finishing Products (800) 229-0934
www.hoodfinishing.com
Hydrocote wood finish and stain
Phone or Web sales

Target Coatings (800) 752-9922
www.targetcoatings.com
Low-toxic wood finishes and laquer
Phone or Web sales

Tried and True Wood Finishes (607) 387-9280
www.triedandtruewoodfinish.com
Local: Woodcraft Supply
Phone sales

Van Technologies (218) 525-9424
www.vtcoatings.com
Low-toxic sealers and stains
Phone sales

Paints Using Natural Materials

There are commercial coatings that are made with all-natural or partially natural ingredients, including vegetable oils, plant resins, minerals, plant and earth pigments, and in some cases, milk. These coatings are very durable and wash easily. But the cost is usually higher than conventional products due to the price of materials, the small size of the manufacturers, and the fact that they are often imported. The variety of colors is not as great as conventional paints, and they are available only by mail order or in specialty stores.

Eco Design Co. Bioshield line (800) 621-2591

www.bioshieldpaint.com

Phone or Web sales

Anna Sova Milk Paint (877) 326-7682

www.annasova.com

Web sales

Aglaia Paints (800) 322-6843

www.aglaiapaint.com

Phone or Web sales from Ecohaus retail store

OSMO line of finishes and stains (800) 281-9785

www.environmentalhomecenter.com

Phone or Web sales

The Old Fashioned Milk Paint Co. (866) 350-6455

www.milkpaint.com

Local: Woodcraft Supply, Heights Antiques on Yale, Molly Rose Design, Bering's

The Real Milk Paint Co. (800) 339-9748

www.realmilkpaint.com

Local: Heights Antiques on Yale

Sinan Company Auro brand (530) 753-3104

www.sinanco.com

Phone or Web sales

Southern Diversified Products (601) 271-2588

www.safepaint.net

Web sales

Sutherland Wells, Ltd. (800) 322-1245

www.tungoilfinish.com

Phone sales

Velvit Products (920) 722-8355

www.velvitproducts.com

Texas: Ecowise (Austin) – (512) 326-4474

Low-Toxicity Paint

Some coating products use conventional synthetic materials, but reduce or eliminate toxic additives. These paints reduce or eliminate exposure to biocides and fungicides that are normally put in paints to preserve them from bacteria, mold, mildew, and insects, and to protect the painted surface. Some of these products eliminate other additives as well, such as formaldehyde and antifreeze.

The shelf life of these paints can be greatly reduced compared to conventional paints, particularly after the can is opened. Paints with no biocides cannot be used in areas of high humidity such as bathrooms or exteriors in wet climates because they are susceptible to attack by mildew.

Paints - Low Toxicity

AFM Enterprises (800) 239-0321

www.afmsafecoat.com

Least toxic paints, finishes, and products; no biocides

Local: Allergy and Health Store

Best Paints (206) 783-9938

www.bestpaintco.com

Paint with no biocides

Phone sales

Envirosafe Products (888) 281-6467

www.envirosafepaint.com

No biocide, no fungicide, no ethylene glycol

Texas: Ecowise (Austin) – (512) 326-4474

Murco Wall Products (713) 699-3992

www.murcowall.com

M-100 hypoallergenic paint

Local: Houston factory

Paint Removers

Paint strippers can be very dangerous. The harshest among this group of products uses methylene chloride as a solvent. This is linked to heart attacks, kidney disease, and cancer. Other paint removers use petrochemical solvents that are toxic and flammable.

A group of water-based paint removers is being manufactured that does not use flammable or volatile ingredients. They are effective and remove several coats of paint at a time, but they take about 10 hours to be effective. They are an “overnight” product.

Note that while these products are environmentally preferred to conventional ones, paint removing can be hazardous for another reason — the paint. Lead paint in households was not banned outright until 1978, and mercury, used as a biocide, was not banned in household paints until 1991. (It is still used in some commercial exterior paints.) Care should be taken when removing old paint, as it sometimes must be disposed of as hazardous waste.

3M Safest Stripper (888) 364-3577

www.3m.com/product/

Local: Ace Hardware

Back To Nature Products line (800) 211-5175

www.backtonatureprod.com

Local: Ace Hardware at Cinco Ranch, Alspaugh Ace Hardware, Bering Home Center, Hausler's Paint, Kelly Moore, Krause Paint, Lake Hardware, McCoy's, Sherwin Williams

Diedrich 606 Multilayer Paint Remover (800) 323-3565

www.diedrichtechnologies.com

Local: Sherwin Williams (special order)

Dumond Chemicals Peel-Away line (212) 869-6350

www.peelaway.com

Local: Sherwin Williams

Franmar Chemicals SOY•GEL™ (800) 538-5069

www.franmar.com

Local: Trinity Hardwood, Touchstone Decorative Concrete

CONCRETE ALTERNATIVES

Alternative Concrete for Flatwork

The U.S. has enough highways, streets, driveways, and parking lots to cover the state of Indiana. This concentrates pollution when rains wash silt, car fluids, other chemicals, and heavy metals that collect on impervious cover into streams and lakes. It also increases the likelihood of flood-



Water runs quickly through porous concrete

ing, as land covered by concrete cannot absorb rain.

A unique way to render concrete pervious uses a liquid catalyst added to wet concrete that creates honeycombed air pockets. At least 2 Texas companies supply this. The technology has the added advantages of stopping peak flooding and removing pollutants, eliminating the need for detention ponds if proper base materials are installed.

Ecocreto of Texas (512) 291-8394
1807 W. Slaughter Lane, #200-496 • Austin, TX 78748
www.ecocreto.com

Stoney Creek Materials (866) 880-1008
P. O. Box 342306 • Austin, TX 78734
www.stoneycreekmaterials.com

Aerated Concrete

Autoclaved aerated concrete (AAC) is made by mixing aluminum oxide powder with concrete, which causes the material to “foam,” creating a mass filled with tiny air bubbles. The material is then steam-cured in an autoclave. The resulting tempered building product is 80% air.



Aerated Concrete is sawed like lumber

AAC is lightweight (aiding in the speed of construction), pest- and termite-proof, mold-resistant, non-combustible, and has the incredible acoustic ability to dull noise. The material has a high insulation value and saves energy in many regions of the country. AAC is so strong that it is earthquake-resistant. But it is amazingly versatile and can be sawed like lumber. It is manufactured in blocks similar to large bricks, and panels for walls, roofs, floors, and acoustic fences that are reinforced with steel (typically 2-6 inches wide). The blocks can be mortar set, while the panels can be fastened with screws or slid into steel frames.

AAC has been used commercially since the 1920s. There are 4 factories in the U.S., and another company supplying the U.S. from Mexico. These companies are listed below.

A newer process is now creating Aerated Concrete without autoclave curing. It promises to be more energy efficient while holding similar strength. A Texas factory that manufactures this product began operation in 2005.

Aerated Concrete Corp. of America (407) 884-0051
3351 West Orange Blossum Trail • Apopka, FL 32712
www.accoaac.com

AERCON (800) 489-6474
2911 Turtle Creek, Suite 300 • Dallas, TX 75219
www.aerconfl.com

FlexCrete Building Systems (512) 692-6838
3801 N. Capital of Texas Hwy., E240-134 • Austin, TX 78746
www.flex-crete.com

SafeCrete (706) 965-4587
7638 Nashville Street • Ringgold, GA 30736
www.safecrete.com

TruStone America (877) 351-4448
280 Broadway, Suite 202 • Providence, RI 02903
www.trustoneamerica.com

Xella AAC (210) 402-3223
1535 Brady Blvd., Suite 2 • San Antonio, TX 78237
www.texascontec.com

FLOOR MATERIALS

SMOOTH FLOORING

Green Building encourages smooth floors because they are generally easier to clean and more durable. Vinyl plastic (PCV), however, is discouraged because it is extremely toxic to manufacture; it comes from the same chemical family as DDT and PCB. Over time, some of the chemical plasticizers and hardeners in vinyl products deteriorate into toxic dust in the indoor environment. This is of particular concern for children, who spend a lot of time close to the floor. Below is a discussion of things to look for in other smooth flooring types: wood, tile, linoleum, and cork.

Wood

As common as wood flooring is, there are several things

Janka Wood Hardness Scale	
Ipe (Ironwood)	3680
Teak, Brazilian	3540
Purpleheart	2890
Cherry, Brazilian	2820
Burbinga	2690
Gum, Spotted	2473
Mesquite	2345
Mahogany, Santos	2200
Gum, Sydney Blue	2023
Merbau	1925
Jarrah	1910
Hickory/Pecan	1820
Padoak	1725
Wenge	1630
Sapele	1500
Maple, Brazilian	1500
Maple, Hard	1450
Cypress, Australian	1375
Oak, Tasmanian	1350
Ash, White	1320
Beech	1300
Oak, Red	1290
Iroko	1260
Birch	1260
Pine, Heart	1225
Oak, White	1210
Teak, Thai	1078
Walnut, Black	1010
Cherry, Black	950
Longleaf Pine	870
Shortleaf Pine	690
Douglas Fir	660

that make wood “green.”

Durability – Commercial floor products can be made from several dozen species of trees. One of the ways to scientifically measure the durability of various floor products is the Janka Hardness Scale. In relative terms, it shows how easy it is to dent a material. Pine is one of the softest woods on the market, while Ipe (pronounced “e’-pay”) or ironwood is over 400% more resilient.

Just because a wood is more durable doesn’t necessarily mean it will cost more. Some wood is simply rarer, harder to manufacture, or more desired because of its appearance. Cherry wood, for instance, is less durable than oak, but more expensive. But more often than not, there is a premium related to hardness.

Sustainably Harvested – Forests have often been over-harvested or completely removed in the haste for quick profits. This has often lead to erosion and flooding, and affects plant diversity, wildlife habitat, and recreational areas. The Forest Stewardship Council has given its certification seal to about 50 U.S. flooring manufacturers or importers for their use of wood from certified forestry operations. The entire list can be obtained at the organization’s Web site: www.fsc.org/

Local Material – Even if wood is durable, recycled, and/or sustainably harvested, there are energy penalties associated with transporting it over long distances. Locally produced material also contributes to the local economy. Brazilian woods are a classic example of the trade off. They are often extremely durable and prized for their appearance, yet they come from another continent. But mesquite flooring, produced in Texas, has a high durability, good appearance, and is not likely to become overharvested anytime in the near future.

Salvaged Material – Often vintage wood is salvaged from old buildings and train trestles for reuse. This often has character lacking in trees from modern plantation forests. Four salvaged wood suppliers can be found in the area.

Historic Houston (713) 522-0542
 1307 W. Clay
 Houston, TX 77019
www.historichouston.org
Salvaged timber from old Houston buildings; mostly oak and pine.

Klassic Hardwoods (713) 942-9799
 3900 Almeda Street, Suite B
 Houston, TX 77004
www.klassichardwoodfloors.com
Maple, red oak, white oak, long-leaf antique heart-pine.

Mason’s Mill & Lumber Co. (713) 462-6975
 9885 Tanner Road
 Houston, Texas 77041
www.masonsmillandlumber.com
Floors and beams made from antique pine.

The Woodshop Of Texas (888) 950-9663
 6001 Emmett F. Lowry Expressway
 Texas City, TX 77591
www.antiqewood.net
Salvages timber from 19th century buildings and recycles it for flooring and beams. Inventory includes chestnut, maple, oak, heart pine, hickory, fir, submerged cypress & white pine.

Bamboo – the “Unwood”

Bamboo is technically a grass, but its rough stalks can be harvested and glued together to create flooring and veneer products indistinguishable from wood (without a DNA test). It offers the same benefits as wood, but has a short growth cycle of approximately 5 years depending on the variety. (Some oak trees need over a century before they can be harvested.) As a result, bamboo is considered a highly sustainable product that saves our old-growth forests. Its color typically resembles light colored pine or oak, though it can be “carbonized” for a caramel color. Its Janka hardness depends on the product, but many products are as strong or stronger than red oak. Carbonized bamboo is about 1,000 on the scale, but non-carbonized products can range between 1,400 and 1,700, and a few specialty products boast a hardness rating of over 2,000.

Bamboo’s main environmental deficit is that all U.S.-sold products are imported. Most of it comes from Asia, though at least one manufacturer is in Europe. Nothing

technically prevents bamboo from being processed domestically. But according to one distributor, mass production techniques would need to be perfected to compete with the labor-intensive process overseas for bamboo products to be cost effective to produce in the U.S.

Tile

Hard surfaces like ceramic tile offer outstanding durability and easy maintenance. When buying tile, there are several things to consider in a green product.

1. Quality – Like wood, tile is rated for hardness. The scale is 1 to 5, with 5 being the most resilient. Some tile, called color body porcelain, is made so that the color extends through the entire tile. If the surface is scratched, it is less apparent, and in less need of replacement.

2. Local Material – Tile is enormously heavy by volume and takes a lot of fossil fuel to ship. Buying products made by local manufacturers will save most of this energy.

3. Recycled Material – Several factories make products from recycled or reclaimed glass and aggregate. A list of some of these products is below. (Note: PC = Post Consumer Recycled Content; PI = Post Industrial Recycled Content)

Bedrock Industries (877) 283-7625
Blazestone (0-100% PC glass depending on color)
www.bedrockindustries.com
Phone sales

Coverings Etc. (800) 720-7814
EcoTerr™ (Some colors contain 80% PI marble or granite waste; others 70% PC/10% PI glass)
www.coveringsetc.com
Phone sales

Crossville Porcelain Stone (800) 221-9093
Ecocycle Tile (PI factory waste)
www.crossvilleinc.com
Local: Master Tile

Granite & Marble Resources (847) 626-0660
Crazy Paver Stone Mosaic (PI quarry waste)
www.mGlassTile.com
Phone sales

Terra Green Ceramics (765) 935-4760
Terra Stone, Terra Traffic, Terra Classic (55% PI glass)
www.terragreenceramics.com
Local: Daltile

Linoleum and Cork

Natural linoleum, available in tile and sheet form, is a long lasting, low-maintenance material primarily made of renewable, low-impact materials. These include linseed oil, pine or other resin, ground cork, wood flour, mineral filler, and pigments. Backing is natural jute or polyethylene, depending on manufacturer and style. Linoleum has both anti-bacterial and anti-static properties that make it

an attractive option for health care facilities and offices with electronic equipment. It costs more than most vinyl products, but can have a life over 40 years. Individuals who are extremely chemically sensitive may not want to utilize linoleum due to the offgassing of the linseed oil.

Cork is a natural product sustainably harvested from the bark of the cork oak tree. The outer casing of the tree can be harvested every 9 years without harm to the trees, which are known to live well over a century. The unique cellular structure of cork gives this flooring excellent impermeability, resilience, insulation, sound absorbency, and fire retardation. Like wood, it must be sealed for maximum durability. The product can last over 40 years, and can be sanded and refinished like wood if damaged.

Linoleum and cork can be purchased through many local floor retailers, but they are both imported from Europe. While cork trees can be grown in the U.S., there is no domestic industry. The product is manufactured in Portugal and Spain. Linoleum was once produced in the U.S., but was phased out by 1975 because of the popularity of other floor products such as vinyl.

Stained Concrete – The Unfloor

An alternative to tile surfaces is coloring concrete slab foundations with special etching paints that permanently stain the surface at a cost less than many flooring alternatives. This can also be accomplished less expensively with wood stains rubbed into the slab. The popularity of stained floors is a testament to the growth of the green building industry. Ten years ago there were relatively few people that stained floors. Today, there are many listings in the Yellow Pages under "Concrete Decorative & Stamped."

CARPET

About 650 square miles of carpet are manufactured in the U.S. each year, almost 200 times the material produced in 1950. Then it was a luxury. Today it is a standard. It is sought for its comfort, appearance, sound absorbing qualities, and (often) low price. But its environmental and health impacts are frequently overlooked.

Carpet is usually made out of non-renewable petrochemicals, and can offgas dangerous fumes when first installed. This can harm indoor air quality and make people ill. It is difficult to recycle. Its numerous fibers are almost impossible to keep clean, and it becomes a sink for chemicals tracked into a building, as well as a home for mold, dust mites, and in the case of pets, fleas. And many brands are not only inexpensive, but cheap, requiring numerous installations of replacement material over time.

Green building often discourages carpet in favor of smooth floor materials that can be easily cleaned and have a long lifespan. But there are things that can be done to make carpet a greener product.

1. Air Quality – The carpet industry’s national association, the Carpet and Rug Institute, has created an emissions labeling standard that has greatly reduced indoor air quality impacts in complying products. Many, though not all, large manufacturers are starting to comply with the “Green Label Plus” program. Carpet glues can also be a problem. Asking for products with VOCs (Volatile Organic Compounds) of 10 grams per liter or less is strongly advised for those concerned with indoor air quality.

2. Recycled and Renewable Materials – The use of non-renewable petrochemicals in carpet can be minimized with recycled content. It can be largely eliminated with renewable materials. Many companies in the carpet industry have taken large steps in these directions.

The use of recycled material is taking place in both backing and face materials. For many commercial carpet (broadloom) sheets with polyurethane backing, recycled content is combined with 7-10% soy oil for a 50-60% recycled/renewable content. For carpet tiles with vinyl backing, several companies are also using high percentages of recycled content. Polyester carpet faces are being made with 100% recycled material from PET-plastic soda bottles. Nylon carpets are also being made with recycled content, though the percentage is generally much lower and most of the recycled material comes from “post-industrial” factory waste, not “post-consumer” material.

Interface Flooring Systems is using a fiber blend that includes 33% material extruded from chemicals derived from corn sugar. Mohawk Industries will be using this same strategy in the near future.

Of course, carpets and rugs were made with bio-based material before there was plastic. A few major synthetic carpet manufacturers are marketing products using natural fibers.

3. Longevity – Low-priced carpet is not meant to last. Buying higher quality and /or commercial grade products will generally allow a greater lifespan. Polyester carpet can be made with 100% recycled face material, but it is not as durable as nylon.

4. Installation – Using “carpet strips” on the floor to hook the material rather than nail or glue it allows for easy removal in case of water spills or major cleaning.

5. Recycling of Old Material – About 300 square miles of carpet a year are disposed of in landfills or incinerators. Does the company you purchase from have a policy of product stewardship to recycle used material?

The list of manufacturers and products below takes these factors into account. All manufacturers listed were either compliant with the Green Label Plus standard or are in the process of becoming compliant as of April 2005.

Certain companies have had the environmental claims of their products verified through third-party documentation by Scientific Certification Systems (SCS), a non-profit that scrutinizes green products. These are often classed as “Environmentally Preferable Products” (EPP), and meet a variety of requirements that make them superior to conventional products, including the use of recycled and renewable material, reduced pollution in the manufacturing process, and a major company-wide commitment to recycling old carpet. Products with SCS EPP Certification are noted. *Other recycled products are listed as well, though there is no SCS documentation of their claims.*

Most of these manufacturers are selling products where recycled and renewable content is either standard or an option. (Carpets with optional materials are often special ordered to attain LEED green building standards in commercial buildings.) Currently, many of these companies provide an optional polyurethane cushion backing made by Universal Textile under the trade name Biocel™. The backing is licensed to individual companies who often rename it for their own marketing purposes, but it is still the same product that contains between 50-60% recycled and rapidly renewable (soybean oil) content. Biocel™ material content is certified by SCS.

In addition to the ones mentioned below, a number of other manufacturers make carpet out of wool, sisal, jute, seagrass, abeca, and coir. Many local retailers carry them or can order them.

Abbreviations:

R – Residential

C – Commercial

PI – Post-Industrial Recycled Content (from factories and other pure waste streams)

PC – Post-Consumer Recycled Content (from used products)

Atlas Carpet Mills (C/R) (800) 367-8188
www.atlascarpetmills.com

Recycled Content: Carpets with SCS Certified “Lumena” fibers have 4% PI Biocel™ polyurethane backing special order.

Beaulieu of America (800) 227-7211
www.beaulieugroup.com

Brands: *Coronet (R), Hollytex (R), Beaulieu (R), BOLYU Contract (C), Cambridge Commercial Carpets (C)*

Recycled Content: *Coronet* Second Nature and Styled for Living have 100% recycled plastic yarn. Biocel™ (Performer Plus™) polyurethane backing special order for commercial.

Bentley/Prince Street (C/R) (626) 934-2153
www.bentleyprincestreet.com

EPP Certified: All Products

Recycled Content: All products have 10-50% recycled PI yarn; Scan (broadloom) and UPC (tile) have 100% face yarn from factory scrap. Optional backing has 14% PC polyurethane.

Blue Ridge Commercial Carpet (C/R) (800) 241-5945
www.blueridgecarpet.com

Brands: *Blue Ridge, Blue Ridge Home*

Recycled Content: Modular tile vinyl backing is 40% PI; Zeftron Savant® broadloom has up to 25% recycled fiber. Zeftron Solur® has recycled content up to 10%. Zeftron Solur® with enviro6ix

uses a minimum of 25% recycled content. Biocel™ (PowerLock Plus™) polyurethane backing special order.

C & A Floorcoverings (C) (800) 241-4902
www.powerbond.com

EPP Certified: ER3 Modular Tile, ER3 Cushion
Recycled Content: ER3 Modular Tile, ER3 Cushion, and Ethos: 30% - 52% recycled content in carpet backing. Products with 45-51% overall recycled content including yarn: Habitat ER3 tile; Ecotone tile; Topography ER3 tile; Topography ER3 cushion rolls; Topography - Ethos cushion 100.

Constantine (C/R) (800) 308-4344
www.constantine-carpet.com

Recycled Content: 50% PI Solutia nylon yarn can be specified. 33% PI for vinyl backing for tile or 6 ft. rollgoods. Biocel™ (Environmentally Enhanced EPA3™) backing special order. Wool: Two-tone wool; scotchguard treated; with or without insect treatment.

Crossley Carpet Mills (C/R) (800) 667-8181
www.crossley.ca

Recycled Content: 4% PI content in yarns of All That Jaz, Broadband, Cellular, Frequency, Internet 2.0, Rave Review, Savana, Wireless. Biocel™ polyurethane backing special order.

Fortune Contract (C) 800-359-4508
www.fortunecarpet.com

Recycled Content: For nylon facing, it is 30%; for backing it about 25% Renewable content (soy)
Wool carpet also available

Interface (800) 336-0225
www.interfaceinc.com

Interface Flooring Systems (Tiles) (C)
EPP Certified: All Commercial products that use GlasBac® RE backing and EPP-certified DuPont Antron face fiber. Backing averages 46% recycled content. Total recycled content (backing and face fiber) is 55%. (More than 40% of Interface's product offering is available as EPP. A number of Interface styles are offered as standard with EPP certification, while other styles with Certification are optional.)

FLOR (Tiles) (R): 38-50% PC (not EPP Certified).
Rapidly Renewable Fiber: Vertical Circle (C) and Terra (C/R) both contain 33% PLA (corn fiber) in face
Wool: Heartfelt (R) contain 50/50 wool/hemp blend

J&J Commercial (C) (800) 241-4586
www.jj-invision.com

Brands: *J & J Commercial, Invision Carpet Systems*
Recycled Content: All products have between 13-49% overall recycled or rapidly renewable content. In Titanbac™ and Endure™ Plus broadloom products, 6-8% is from PC or soy oil content. Biocel™ polyurethane backing is also an option.

Julie Industries (C) 978-988-8802
www.staticsmart.com

Kraus Carpet Mills (C/R) 800-265-2784
www.krauscarpet.com

Recycled Content: 30% recycled Natiq face fiber in Dalian; Framework; Gatewood; Geologic; Neolithic; Senator; Stanford II

Lees Carpets by Mohawk (C) (800) 523-7888
www.leescarpets.com

EPP Certified: All Commercial broadloom carpet backings have Unibond™ (26% recycled content with 3% PC and 23% bio-based content) or Unibond™ RE™ (47% recycled content with 31% PC

and 16% bio-based content). Biocel™ polyurethane backing special order; installed on the back of Unibond™. Between 5-10% PI yarn in all products.

Mannington Carpets (C) (800) 241-2262
www.mannington.com

Recycled Content: All carpets with vinyl tile backing have recycled content (8-13%). Optional DeltaLok™ backing has 14% PC material. Biocel™ polyurethane backing special order.

Masland Carpets (C) (800) 633-0468
www.maslandcarpets.com

Biocel™ (Unilok™, Permalok™, and Hardware Plus™) polyurethane backing special order.

Milliken and Company (877) 327-3639
www.milikencarpet.com

Brands: *Miliken Carpet & Rugs (R), Miliken Hospitality Carpet, Miliken Commercial*

EPP Certified: *Movements, Color Accent, and Earth Square* (refurbished)

Recycled Content: Tile average 36% PI for the backing weight. Image Tile – 100% recycled PC can be special order for large volume (large premium over standard product).

Mohawk Industries (C/R) (888) 387-9881
www.mohawkind.com

Brands: *Mohawk, Aladdin, Bigelow Commercial, Customweave, Diamond, Durkan Patterned Carpets, Horizon, Image Ind., World Carpets, Wundaweave.*

Recycled Content: Mohawk Commercial Carpet (15-50% recycled yarn), Bigelow Commercial (15% recycled yarn). Aladdin – 100% PC polyester yarn in face. Biocel™ polyurethane backing special order.

Wool: Karastan 100% wool area carpets & rugs; no recycled content in backing.

Monterey Carpets (C) (800) 678-4640
www.montereycarpets.com

Biocel™ (The Enhancer) polyurethane backing special order.

Pacific Crest Mills (C) (800) 522-8838
www.pacificcrest.com

Brands: *Pacific Crest, To Market*
Biocel™ (E-Lok BioBak™) polyurethane backing special order.

Royalty Carpet Mills (R) (800) 854-8331
www.royaltycarpet.com

Brands: *Royalty, Camelot, Berben*

Shaw Industries (800) 441-7429
www.shawfloors.com

Brands: *Cumberland Carpets, Design Origins, DesignWeave, Patcraft Commercial Carpets, Philadelphia Contract (R/C), Queen Commercial, Shaw Contract, Shaw Hospitality, Shaw Tek, Tuftex (R).*

Recycled Content: ECO Solution Q (broadloom) has 25% recycled face fiber and can be ordered from several divisions, including Shaw Contract, Philadelphia, Queen Comfort. Shaw Commercial has Ecoworx™ backing (40% recycled content) on all Shaw Contract tile and 6 ft. products with cushion olefin backing (not vinyl). Carpets with BASF recycled yarn and Ecoworx™ backing have 37% total recycled content (34 PI, 3% PC).

Roof Materials

Reroofing is a time to upgrade material for environmental characteristics like longevity, recyclability, and heat reflectivity, as well as safety concerns like fire.

Asphalt shingles use recycled, mixed paper in their base and some use reclaimed minerals in the surface aggregate. In relative terms, this type of material does not have a long life, usually has only a minimum fire rating, and generally reflects heat poorly. Though the shingles can theoretically be recycled, this is seldom done.

Slate, clay tile, and cementitious roof materials offer excellent durability but are heavy. Fiber-cement composite roof materials are somewhat lighter and use fiber materials resourcefully. Some use recycled paper and wood fiber. Some have 50-year warranties.

Metal roof materials (steel, copper and aluminum) contain high percentages of recycled content (up to 100% in many aluminum products). Metal can be easily coated with a white reflective paint and is lightweight and durable. These can also last many decades before replacement. They provide a good surface for rainwater collection systems. An additional advantage is that these materials are easily recycled when the roof is replaced.

Recycled plastic roof materials have been introduced as a lightweight, environmental, and durable option. Recycled rubber roofing is also beginning to be manufactured. This product does not have a long track record, but it should prove quite durable, and puts recycled tires and plastic to good use. For those interested in capturing rainwater from roofs for drinking purposes, it is not known at this time if there is a taste or purity impact from using rubber roof material.

Clay and Concrete Tile

Clay tile is one of the highest quality roofing materials and good choice for rainwater collection. The quality of the clay tile depends on the quality of the clay. Lower-end tiles are susceptible to freeze-thaw damage, meaning that the clay's expansion and contraction from large temperature changes can cause deterioration. Inquire about production location, favoring the shortest distances, which will help the local economy and lower transportation costs.

Concrete tiles offer excellent durability but are heavy, requiring a stronger support structure. They are a cost-effective alternative to clay but retain heat longer. Environmentally, they are more energy-intensive to produce.

Fiber-cement composite slates and shakes are long-lasting and somewhat lighter than concrete tiles. However, they are not commonly found in light colors, so they absorb more heat. Certain brands may not serve well in climates with severe temperature variations, but this has not been an issue for Texas.

Metal Roofs

Metal roofs are becoming quite common, and giving a long list of products might confuse as many people as it assists. The next page has a list of some of the major local roof suppliers that carry metal roofing materials - most can order several lines. Some products are made to resemble conventional shingles and shakes. The best thing for a homeowner is to look at these companies' information and product samples to specify the right material for your contractor. Many roofing contractors found in the Yellow Pages also have information and product samples.

Investigate the following qualities when selecting metal roofing materials.

Protective Coatings – Zinc (galvanized) coatings oxidize to protect the steel. Protection is lost when the oxidation process uses up the zinc, and the steel underneath can rust. On low-sloped roofs in wet climates, coating loss and rust can show up in as little as 5 years. Aluminum coatings are superior to zinc, carrying warranties up to 20 years. They are inert, and do not degrade over time. Aluminum-zinc alloys, or Galvalume, will outperform aluminized coatings and exceed 20-year warranties.

Paint – Only use factory-applied paint. Polyester resin finishes offer least durability. Fading will occur in 5 to 7 years. Silicone-modified polyester finishes are superior (the more silicone, the better the performance). Twenty-year warranties are available. Fluoropolymer resins provide a state of the art finish. Paint companies produce these coatings under the brand names of Kynar, Hylar, Duranar, Nubelar, Fluoropon, Trinar, and Visulure. Bare aluminized or Galvalume panels can last 40 years without maintenance and is a better choice than polyester resin finishes.

Panel Thermal Movement – Metal panels respond to temperature change by expanding and contracting. This can cause the fastener hole size to increase, resulting in leaks. Newer fasteners have rubber washers which can withstand heat and UV rays and cover holes. Solid aluminum has a higher coefficient of expansion than steel and will strain fasteners with increased movement from temperature change.

Dark colors will experience the largest thermal movement (and cost more in air conditioning bills). Panels installed over purlins will not harm the roof system with thermal movement.

If installing over a solid deck, use Z-shaped metal sleepers over the decking. The sleepers will move with the panels and eliminate fatigue where the screws penetrate the panels. If these are not used, the screw hole will become elongated causing leaks, or the screws will lose their grip.



Photos Courtesy of: Ludowici Roof Tile, Marc Richmond (metal panels), and GEM, Inc. (Euroslate).

DURABLE ROOF PRODUCTS IN HOUSTON

This list of stores and businesses includes many of the suppliers of durable roofs for residential applications in the Houston area. These product sources have showrooms, offices, or sales reps where you can obtain samples and/or product literature. Once you decide on a product, you can give the specs to your contractor or builder.

	Manufacturer	Supplier	Contractor	Metal	Tile	Cement Tile	Synthetic Shingle	Slate
ABC Supply	7710 North Sheperd Drive	Houston, TX 77088	(281) 405-9559	www.abcsupply.com	✓	✓	✓	✓
ABC Supply	11155 FM 529	Houston, TX 77041	(713) 466-1505	www.abcsupply.com	✓	✓	✓	✓
ABC Supply	13945B Murphy Road	Stafford, TX 77477	(281) 261-7242	www.abcsupply.com	✓	✓	✓	✓
ABC Supply	938 South Frazier	Conroe, TX 77301	(936) 788-1668	www.abcsupply.com	✓	✓	✓	✓
ABC Supply	333 Tristar Drive	Webster, TX 77598	(281) 990-6900	www.abcsupply.com	✓	✓	✓	✓
AEP Span	Call to reach local rep.		(800) 527-2503	www.aep-span.com	✓	✓	✓	✓
Architectural Building Components	11625 North Houston Rosslyn Rd.	Houston, TX 77086	(281) 931-3986	www.archmetalroof.com	✓	✓	✓	✓
Berridge Manufacturing	1720 Maury	Houston, TX 77026	(800) 231-8127	www.berridge.com	✓	✓	✓	✓
Bradco Supply	6758 Northwinds Dr.	Houston, TX 77041	(713) 849-5551	www.bradcosupply.com	✓	✓	✓	✓
D'Hanis Clay	311 E. Nakoma	San Antonio, TX 78216	(800) 299-9399	www.dhanisbricktile.com	✓	✓	✓	✓
Factory Direct	Home appointments		(866) 867-3482	www.1877ourroof.com	✓	✓	✓	✓
JEH-Eagle Supply	10835 Bammel North Houston Rd.	Houston, TX 77086	(281) 537-9893	NA	✓	✓	✓	✓
Metal Deposits	12555 I-10 East	Baytown, TX 77521	(800) 606-8271	www.metaldépot.com	✓	✓	✓	✓
Millennium Building Components	18815 Aldine Westfield	Houston, TX 77073	(877) 935-2500	www.rigidbuilding.com	✓	✓	✓	✓
Monier Life Tile	30595 FM 529	Brookshire, TX 77423	(281) 371-2634	www.monierlifetile.com	✓	✓	✓	✓
PermaBond Roofing & Sheet Metal	9119 Meadow Vista Blvd.	Houston, TX 77064	(281) 469-7663	www.permabondroofing.com	✓	✓	✓	✓
Roofing Supply Group	2600 Westmount Houston Rd.	Houston, TX 77038	(281) 447-7759	www.roofingsupplygroup.com	✓	✓	✓	✓
Spec Buildings	7667 Mosley	Houston, TX 77017	(713) 941-4552	www.specbmc.com	✓	✓	✓	✓
ThornTree Slate & Marble	10105 West Gulf Bank	Houston, TX 77040	(713) 466-0405	www.thorntreeslate.com	✓	✓	✓	✓
West End Lumber	13246 Murphy Road	Stafford, TX 77477	(877) 239-4285	www.Westendlbr.com	✓	✓	✓	✓
West End Lumber	1155 West Loop North	Houston, TX 77055	(800) 713-4629	www.Westendlbr.com	✓	✓	✓	✓
West End Lumber	9335 Highway 6 North	Houston, TX 77095	(800) 833-5950	www.Westendlbr.com	✓	✓	✓	✓
West End Lumber	14950 Gulf Freeway	Houston, TX 77034	(800) 388-6093	www.Westendlbr.com	✓	✓	✓	✓
West End Lumber	210 N. Loop 336 E	Conroe, TX 77301	(877) 688-5260	www.Westendlbr.com	✓	✓	✓	✓

When Cooling Costs Go Through The Roof

Roof Color and Air Conditioning



White Roof of Commercial Building

While it's common knowledge that dark colors attract heat, this simple rule is lost on many builders and roofers. This heat penetrates the attic and air ducts to drive air conditioning costs up and comfort levels down.

Even if light colors are used for roofing, not all light colors are alike. Many roof materials reflect light but not (infrared) heat. Smooth surfaces reflect heat better than rough surfaces. And coatings applied over roof surfaces can greatly increase heat reflectance. Coatings also absorb ultraviolet light, which protects the roof materials. This can extend the life of roofs, particularly asphalt.

A standard to assess roofs for their heat attraction has been devised called the Solar Reflectance Index (SRI), which combines both light reflectivity and heat retention. (An Index of 100 is optimal.) Below is a list of various roof materials, their Index, and the number of degrees that their temperature was increased above ambient temperatures. (If the rise was 90°, and it was already 100° outside, the roof temperature would be 190°.) These figures will vary depending on location, time of year, roof slope, and product used. But they give a good comparison.

Metal roofs, tile roofs, and roof coatings are more expensive, but roofs with these materials have a greatly increased life compared to most lower-cost materials.

Product	Temperature Rise	SRI
Ceramic Materials		
Red Clay Tile	62 F	41
Red Concrete Tile	77 F	23
White Concrete Tile	22 F	91
Concrete Tile, Light Beige Coating	32 F	78
Concrete Tile, Light Brown Coating	53 F	49
Concrete Tile, Pale Bluish Purple	54 F	48
Concrete Tile, Pink & Gray Coatings	42 F	64
Fiber Cement, Earth Brown	69 F	28

Metal Roofing		
Bare Galvanized Steel	55 F	46
Aluminum	48 F	56
MBCI Siliconized Polyester White	37 F	71
Atlanta Metal - Kynar Snow White	28 F	82
Asphalt Shingles		
ISP K-711 White	59 F	41
Generic White	70 F	27
Generic Grey	73 F	23
Gray	87 F	4
Light Brown	76 F	19
Dark Brown	87 F	4
Green	76 F	19
Coral	79 F	15
Generic Black	90 F	0
Roof Coatings (White)	9-30F	88-107
Membranes		
Gray EPDM	72 F	24
White EPDM	26 F	85
Black EPDM	89 F	1
Hypalon	19 F	95
T-EPDM	14 F	101
Dark gravel on BUR roof*	83 F	9
Light gravel on BUR roof*	61 F	30
White-coated gravel on BUR roof*	30 F	80

(*BUR stands for "Built Up Roof")

Some new roofing products are incorporating a reflective pigment that allows dark-colored roofs to attain higher reflectance than conventional pigment. Darker colors such as black, brown, blue, and green typically have a reflectance on 4-18%. But new pigments can raise reflectance above 40%. This is particularly important in low-sloped roofs for residences, where darker colors are often preferred for aesthetic reasons.

But these new products still do not rival the reflectance of lighter colors. Moreover, reflectance will only go so far in lowering the SRI in heat retaining products such as asphalt shingles. As of this date, only one company is even making dark-colored asphalt shingles with higher reflectance: Elk Roofing, with its "Cool Color Series."

For more information about the energy saving ability of roof products, there are several sources.

Cool Roof Rating Council – www.coolroofs.org
 This organization rates and promotes energy-saving roof materials. Roof products are third-party rated.

Energy Star – www.energystar.gov
 U.S. government program rating building products, buildings, and appliances. Roof products are recommended. Roof ratings are sometimes self-reported by manufacturer.

Lawrence Berkeley Laboratories Heat Island Program – <http://eetd.lbl.gov/HeatIsland/>
 This program researches ways cities can lower their temperature with light-colored roofs, streets, and tree planting. It has rated several hundred types of roof surfaces.

Advanced Board Systems

In an effort to save trees, and reduce energy use and noise inside buildings, various manufacturers have developed interior and exterior panels made of recycled wood and paper, certified wood, and agricultural wastes like straw. Some, though not all, carry a first-cost premium, because they are higher quality or made in small manufacturing facilities. But the products are more environmental and can save costs in the long run.

Dura Building Systems (866) 364-1198
 2747 State Highway 160
 Whitewright, TX 75491
www.dura.com

Compressed straw panels for interior walls, ceilings, and partitions

Agriboard Industries (940) 495-3590
 1000 Industrial Park
 Electra, TX 76360
www.agriboard.com

Agriboard™ Structurally Insulated Panels with compressed wheat straw sandwiched between oriented strand board; uses include external walls and interior partitions

Environ Biocomposites Mfg., LLC (800) 324-8187
 221 Mohr Drive
 Mankato, MN 56001
www.environbiocomposites.com

Biocomposite panels made from sunflower hulls, wheat straw, and soy flour; uses include cabinetry, decorative wall panels, architectural millwork, table tops and other work surfaces. (Not recommended for kitchen and/or bath applications.)

Homasote Company (609) 883-3300
 P. O. Box 7240
 W. Trenton, NJ 08628-0240

Wholesale distributors:

Primesource Building Products (281) 485-5772

Retail: Stahlmam Lumber

440 Homasote® for sheathing, carpet underlayment, decking made from 100% recycled newsprint



Table and counter tops made with Phenix Environ®

Kirei USA (619) 236-9924
 1805 Newton Avenue
 San Diego, CA 92113
www.kireiusa.com

Decorative paneling made of sorghum stalks for wall, millwork, ceiling, floors

Meadowood Industries, Inc. (650) 637-0539
 P. O. Box 257
 Belmont, CA 94002
www.meadowoodindustries.com

Meadowood 1/4 inch sheet from ryegrass straw for wall and ceiling board. Wallboard pattern replaces paneling or sheetrock.



Wheat board assembly line at Affordable Building Systems in North Texas