7 Steps to Green Building

Step 1. Assess Your Needs.

Step 2. Form a Team.

Step 3. Design for Your Conditions.


Step 5. Choose the Right Mechanical Systems.


Step 7. Test and Maintain.
7 Steps to Green Building

Preface

So you're thinking about building a new home--or maybe remodeling the one you have now? How about making it "green"?

A green home is one that's healthy, comfortable, efficient, durable and low maintenance--all the things that most people expect from quality building. A green home provides you with all these benefits in a way that's also easier on the environment.

When you think of the environment, you probably think about the natural environment--mountains, rivers, and forests. But our buildings are part of the environment too. The fact is, a huge portion of our natural resources are used for building, and a large part of our pollution and health-related problems result from building. Fortunately, it's possible to reduce the negative effects of building by doing it a different way.

But what is this "different way" like? Would it be attractive? Convenient and pleasant to live in? Would it be hard to do? Could you afford it?

Actually, you can't tell if a home is green just by looking at it, because green is more than skin deep. That's lucky, because it means your green home can be just about any style you like. Even when you know what's under the skin, you still can't be sure. That's because what's green in one part of the country may not be green somewhere else.

You can't tell a green home by the price either. You could spend huge sums being an "eco-consumer", purchasing every high-efficiency gadget on the market, or you could make your house green using simple, economical materials and good design alone.

We can't stop building homes--we all need them. But with careful planning, we can make buildings that enhance our lives and lessen the impact on our planet.

The following Seven Steps to Green Building will provide you with a guide to make your home Green By Design.
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7 Steps to Green Building

Introduction

This section introduces you to seven steps to consider in a green building project. We’ll be talking about houses here, but most of the ideas presented are applicable to any kind of building—new construction or remodeling, residential or commercial. These steps are not meant to be comprehensive, but to give you some guidance as you make your building plans.

Whether you are ready to start building or remodeling in the next few months or the next few years, you should start planning now. Planning is the most important and time-consuming part of a quality building. A good plan is the key to any successful building, whereas a poor plan will never yield a good result, no matter how fine or expensive your materials.

Once you understand the basic issues raised in these seven steps, you’ll see that green building is not a specific style limited to a narrow range of materials. It’s a process—the process of fully considering the end use of your home and the related consequences of your design decisions. The goal is to end up with a building that meets your deepest wants and needs without compromising the environmental needs of future generations.

We recommend that you read this document at least twice. Aim first for a general understanding of all seven steps and a big picture of what green building is really about. Then, before you start making decisions about individual steps, go back over each step more thoroughly, and consider how one step informs decisions that will be raised at another step. This process will help make your choices clearer.

You should expect to spend more time planning than actually building.
Step 1. Assess Your Needs.

First of all, think about how you and the other members of your household need and want to live, and how that might change over the next several years. When you’ve analyzed this as well as you can, then think about what kind of site and what kind of house will best meet these needs and wants.

Here are examples of the sorts of questions you need to 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—once a week, daily? Do your household members need a lot of private space, or not?

Urban, suburban or rural? New or old? Large or small? Conventional or unusual? What kind of house is right for your family?
Here are some comments from people who are making building decisions:

**Theresa:** “My husband just retired and wants to build out by the lake where he can fish and garden. I won’t be retiring for a couple years though, and I hate the thought of that long commute. Also, my mother lives with us and doesn’t drive any more. Where we live now, she can walk to the community center and the shops she enjoys, and I know she really values her independence. If we wait a while to build, I think we can figure out a way to satisfy everyone’s needs.”

**Morrie:** “Our house is in need of some major repairs and feels pretty cramped. It seemed like some remodeling and extending the living room 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.”

**Luke:** “I want a new house so I can have exactly the house I want. My current house is never comfortable, even though the utility bills are sky-high. Some rooms are always drafty in winter, and others are always like an oven in summer. It seems kind of moldy, too, and I have the feeling it’s contributing to my allergy problems. I know a house can be better than this.”

As you try to set your building goals, 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 questions like the ones above, you’ll be able to make good choices about site and space needs. Making decisions about matters like style or material (will the house be wood frame, concrete, insulated panels, etc.) can come later.

If you were planning to build your dream house now, what would the top goals be for your household? What purposes, needs, and desires do you want it to satisfy in your life that your home can contribute to? Examples might be: a desire to keep building and operating costs very low; a desire for minimal maintenance; a desire to avoid lots of driving; a desire for a healthy home, or even a desire for greater independence (to produce your own electricity, have your own water supply, etc.).

### Resources

**A Primer on Sustainable Building**
Dianna Lopez & William D. Browning
www.rmi.org/catalog/gds/htm
Brief, comprehensive and readable introduction to green building

**The Not So Big House**
Sarah Susanka, Kira Obolensky
The Taunton Press

**Before You Build**
A Preconstruction Guide
Robert Roskind, Owner Builder Center
Ten Speed Press
www.tenspeed.com
Lists of many questions to consider before you buy, or design and build a home

**Natural Home Magazine**
www.naturalhomemag.com
Step 2. Form a 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. You’ll need to choose people who are willing to work as a team and you’ll need to make sure the design and building process is set up to facilitate this.

You might assume that teamwork is the norm. It isn’t! It’s actually more 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 to a lack of coordination and to conflicts that result in a lower-quality and higher-priced home.

Step 2.

Form a Team.

It takes a lot of people all working together to make a house a reality. Here are just a few of the team members you might need—a lender, designer, builder, and craftspeople.
A. Benefits of a good team

A good team will help you refine and prioritize your goals, and then help you make the specific choices that meet your goals. For example, it may not have occurred to you that a building affects your health, but a good green team will be sure you understand this. Then they will advise you about what to include and exclude in your home to promote a healthy indoor environment (where you will usually spend the most hours of your day).

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.

Here are a few examples of how integrated planning might work: 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 12'-wide roll of carpet, thus reducing waste and expense. The heating and cooling contractor could inform the designer early in the planning about the spaces needed for equipment and duct work, so he can install an effective system, 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 heating/cooling system might be possible, and the money saved could pay for the better windows. The owner could then enjoy greater aesthetics, comfort and a lower utility bill every single month.
B. Selection of a good team

You want team members who are committed to working cooperatively; willing to spend the time this requires; compatible and trusting of each other; open to new ideas; knowledgeable about green building; experienced in the kind of building you want (or capable of learning quickly), as demonstrated by their previous work. Be prepared to pay a little more for such building 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 seven 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 developments in the field, and most importantly, what aspects of green building they have been able to incorporate in their previous work. If you have a local green building program or organization, either public or private, ask for recommendations.

If you live in an area where building professionals are not very familiar with green building practices, you will have to do a little more homework yourself. Then hunt for team members with a reputation for high quality building who are willing to work with you.

In all cases, check references thoroughly. Look at a number of projects in person, and ask former clients if they had a satisfying building experience and would choose the same building professionals again.

Resources

www.nahbrc.com
Guide to Developing Green Builder Programs
Lists most of the green building programs in existence in the U.S.

www.@ci.austin.tx.us/greenbuilder
Information about the City of Austin, Texas Green Building Program with a list of member building professionals

www.greenbuilder.com
Information about green building professionals throughout the U.S.
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 conditions 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.

For example, in a region with a lot of seismic activity, buildings must be constructed to better withstand such movement. In a very cold climate a lot of insulation is needed to keep you comfortable and exterior materials need to be able to withstand freezing and thawing. In a very hot climate, wall insulation has a negligible effect on comfort. Freezing won’t be a problem, but ultraviolet rays from the sun may be very destructive to some materials.

This map shows the likelihood of termite risk in different parts of the country. Are they a special problem where you live? If so, maybe you should choose construction materials termites won’t want for their dinner.

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. The more detailed the information you have about your conditions—both of region and site, the better your design can be.
A. Understanding your region

Different parts of the country have different conditions, so an ideal site and building under one set of conditions may be disastrous in another. The climate zone map pictured here shows fifteen general zones. Ultimately, it would be best to have even more precise information on which to base your design.

This map shows 15 different climate zones in the U.S. The kind of building that is comfortable, efficient, and durable in one zone might not be in a different zone.

Here are some things you need to consider about your regional conditions.

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.

      For example, if you need a lot of heat in winter, a sunroom may be a good idea. It heats up due to the green house effect, and can provide free heat to the rest of the house. In a hot climate, sunrooms tend to overheat the house.

   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 can store 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.

For example, 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 to make your home more comfortable.

*In the U.S., the sun makes a high arc in the sky in summer and a lower arc in winter. We can take advantage of this difference by designing buildings that keep out the sun’s heat in summer and let it in in winter.*
For example, in a hot climate, a west facing window without a large overhang would take in too much solar heat. However, the same window in a northern climate would help make the most of heat gain and help lower winter heating costs.

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 as fast as possible, 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.

For example, 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 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.

Notice how the overhang of this house will shade the windows on the south side in summer, but not in winter, when the sun’s heat is needed.
5. **Prevailing winds**

Understanding the wind patterns of your region helps you design to take advantage of refreshing breezes and avoid harsh winds. This will affect your choices about window size and placement, and roof shape.

For example, in areas that get a lot of pleasant gentle breezes, windows can be placed to maximize cross ventilation. In areas with cold winter winds, window area can be reduced on the side of the house the wind hits the hardest. In most places that’s the north side.

6. **Special conditions**

A good design also requires a deeper knowledge of the special conditions of your area, such as the risk of earthquakes, hurricanes, radon gas buildup, termites, soil stability, and the effects of nearby bodies of water or mountains. For example, in a region where tornadoes are prevalent, it’s a good idea to have a storm cellar.

*In some parts of the U.S., there is evidence of radon gas in the soil. It may pose a health concern to occupants if it gets into buildings. If you build in these areas, you may want to use building methods that keep radon gas out.*
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, Texas, for example, is split down the middle into two markedly different geographic regions (bioregions). Soil, plants, and even weather conditions are quite different in these two areas.

Once you know your site thoroughly, you’ll be able to make a design that exactly suits it—one that further enhances regional and site assets and reduces problem conditions. Think of your region, site and design as a single unit, working together to keep you comfortable.

Focus on getting the biggest bang for your building buck. Spend your time, effort and money on what matters most in your region and on your site.

If you live in Minnesota, your main concern is staying warm. Choose a site that is protected from northern winds and gets plenty of sun. Choose a design which lets in plenty of radiant heat from the sun. Stop heat loss with well insulated walls, ceilings, and floors. Invest in a high-efficiency heating system, since it will run many months of the year.

If you live in Florida, the sun is your enemy much of the time. Your focus should be on keeping the sun out with shade trees, overhangs, and covered porches. Invest in solar screens or southern low-e windows, a roof radiant barrier, and good ceiling insulation. Since losing heat in the winter is not a big concern, wall insulation, floor insulation, and heater efficiency are not where you should spend a lot of money. A high-efficiency cooling system, especially one that dehumidifies well, should be a top priority, however.

What site and design features work best in your conditions?

It is helpful to look at the historical styles of buildings in your area to see how people got comfort passively from the building design and site, in an era before they could get the additional comfort of 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. For example, 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.
Here are some samples from three different climate regions, that show you some smart site choices and design features for that region. The zone numbers correspond to the climate map above.

**Zone 1: Very Cold**

*(Severe cold in winter; moderate summer with brief hot spells)*

**Site:**
1. South side of slope to get warmth of winter sun
2. Evergreen trees on north/northwest to protect from winter wind

**House:**
3. Compact shape for less exterior surface area to lose heat
4. Most windows on south for sun’s warmth, fewest on north
5. Sunroom for solar heating
6. Roof slope to deflect winter winds
Zone 6: Hot Dry

(Summer hot and dry, both day and night; winter moderately cold)

**Site:**
1. Southern exposure for best sun control (hot west-facing slopes avoided)
2. Evergreen trees on the north side to protect from winter wind

**House:**
3. Masonry materials which change temperature slowly
4. Courtyard with fountain or pool for cooling effect
5. Overhangs or thick walls to protect windows from sun
6. Windows placed for good cross ventilation
7. Light exterior colors to reflect sun’s heat
Zone 10: Hot Humid

*(Summer hot and humid both day and night; moderate winter)*

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

**House:**
3. Long, narrow shape; long walls and most glass facing north and 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. Operable windows placed for good cross ventilation and heat exhaust
6. High ceilings, so hotter air rises above occupants
7. Light exterior colors to reflect sun’s heat

Consider this....

- What are the dominant conditions of your region that affect building?
- What kind of a site would mitigate the most negative conditions and maximize the positive conditions of your region?
- What basic house type would do the same?
Step 3  
Design for Your Conditions.

Resources

Web sites

www.ncdc.noaa.gov  
National Climate Data Center  
Climate data, including historical average climate data for 270 U.S. cities

mcc.sws.uiuc.edu/faq/dd.html  
How to calculate heating and cooling “degree days,” a measure of climate severity

www.ocs.ou.edu/glossary/glossary.html  
Weather and climate glossary

www.ok.nrcs.gov/gis/soils/us.precip.htm  
Map of average annual precipitation for the U.S.

www.ases.org/  
American Solar Energy Society  
2400 Central Ave. G-1  
Boulder, CO 80301

www.nrel.gov/  
National Renewable Energy Laboratory (NREL)  
1617 Cole Blvd.  
Golden, CO 80401-3393

Florida Solar Energy Center  
www.fsec.ucf.edu/  
Information for designing and building in hot, humid climates

Canada Mortgage and Housing Corp.  
www.cmhc-schl.gc.ca  
Information for designing and building in cold climates

Print materials

Texas Renewable Energy Resource Assessment  
Report for the Texas Sustainable Energy Development Council  
www.gsc.state.tx.us/

Regional Guidelines for Passive Energy Conserving Homes  
AIA Research Corp. for US Department of Housing and Urban Development (HUD)  
Superintendent of Documents: Washington D.C., July 1980  
HUD-PDR-355(2)

Heating, Cooling, Lighting  
Design Methods for Architects  
Norbert Lechner  
John Wiley & Sons  

Home Energy Checkup is a useful tool for showing you how you can prevent pollution and save money in your home through energy efficiency. Home Energy Checkup, as well as Business Energy Checkup are included in the “Resources” section of the Green by Design CD ROM.

Once you’ve selected a good site for your conditions 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.

It’s great that there are so many green building materials readily available now. But that can make it a bit overwhelming when you have to choose one over another. Be sure to keep your building goals in mind, then use the following seven criteria to help you sort out the options.

Seven criteria for choosing materials

1. Is the material effective in your conditions?

Most materials have a range of conditions in which they work best. There are good choices for every circumstance, so find out what works well where you are. For example, a material that functions well in the mild climate of Alabama may be unable to stand up to severe freeze/thaw conditions in Idaho. A material that works great on the cloudy northwest coast might deteriorate in the relentless sun of the desert southwest.

Steel (above) may be a wiser choice for your structure than wood (right) if you live in an area where termites are a threat.
2. Is the material healthy and safe?

Materials and products 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. For example, both painters and inhabitants will benefit from paints that don’t give off nasty toxic fumes. A ceramic tile floor is good for occupants because it won’t harbor allergy-causing dust mites and molds the way carpet sometimes can.

Above all, materials, their production, use, and disposal, must be safe for the planet. We don’t want our homes to add to such problems as pollution, ozone depletion, global warming, loss of habitat, and depletion of irreplaceable resources. For example, when clay tile is disposed of, it biodegrades easily, whereas pressure-treated lumber must be handled as a hazardous waste. If wood comes from a certified sustainably-managed forest, the forest remains viable for future tree harvesting, wildlife habitat, recreation, and other benefits. That’s not the case with a tree farm or clear-cut harvesting.

When you see these logos on a building material, you can be assured it has passed rigorous independent testing to gain certification as an environmentally sound material.

3. Is the material durable and easily maintained?

Using materials that last a long time saves the resources needed to replace them and reduces disposal problems and costs. Using materials which require little or no maintenance saves time, work, and money. For example, if the exterior of your home is brick or stone, it won’t rot and termites won’t eat it. You’ll never have to paint or replace it.
4. Is the material used efficiently?

There’s a lot to consider in regard to efficiency:

a. **Is the material from your region and 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, too.

b. **Can the material be used in a natural state, or with very little processing?** Processing resources into usable building products, such as carpeting or vinyl siding, tends to use a lot of resources, especially energy and water. But some materials, like 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?**

For example, a rammed-earth structural wall does not need to be insulated or covered with a finish material, inside or out, whereas a wood frame wall needs exterior siding, insulation in the cavities, an interior wall covering, such as sheet rock, and paint.
d. 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, or roof trusses designed so small-sized lumber can safely replace large sizes.

  Finger-jointed studs are just as strong as solid lumber and are much straighter, so they save time and material.

- **Products made with recycled-content**, such as steel framing materials made out of scrap steel, or carpet made of plastic bottles

- **Products that are easily recyclable**, such as glass blocks and concrete blocks (products made out of many different materials are hard to recycle because it’s difficult to separate them)

- **Reused and reusable materials**, such as salvaged beams or brick from a dismantled building

  This attractive retaining wall is actually made of broken up concrete side walk—sometimes called “urbanite.”
You probably won’t choose a material solely because it’s efficient, but because it has other qualities you like as well. For example, floor trusses made of 2x4’s allow duct work to pass through them, whereas solid-lumber floor joists don’t; finger-jointed studs are straighter than solid lumber studs; reused beams may be more beautiful than new ones. If a recycled product is equal to your alternative choice (e.g. carpet made of plastic bottles looks just likely carpet from virgin material), why not choose the recycled one? That helps all of us.

e. Does the design and/or construction method use material efficiently?

All of these kinds of construction reduce waste:

- Factory-built construction
- Modular design or design based on standard-size materials
- Minimum amount of material used that can properly do the job.

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. This doesn’t mean that you should never special-order a material or try something new—just that you should be aware of the potential for delays and installation 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. Real costs are based on all of the points above. For example, what maintenance will be needed? How long will a product last before it must be replaced? 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.

Applying these criteria is a challenge because there is seldom a perfect material choice. You have to keep examining the trade-offs, until you find the greatest number of positive qualities and the smallest number of negative qualities that fit your goals.

But some criteria do 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 doesn’t hold up well or provokes your allergies. Still, given all the choices available, there’s bound to be a good one for you.

Consider this....

Applying your own priorities and the criteria listed above, which material choice would you make for yourself in your region? Since you don’t have a team to advise you, where might you get help? Remember—there isn’t a “right” answer—just the best one for you.

1. Windows
   a. aluminum-clad wood frames with double-pane low-e glass
   b. aluminum frame, double-pane standard glass

2. Exterior wall-finish material
   a. local white limestone
   b. cement-based siding
   c. Western red cedar

3. Kitchen countertop
   a. plastic laminate
   b. local granite, slate, stone
   c. “solid surface” (e.g., Corian, Avonite)
   d. ceramic tile

4. Flooring for living, dining, hall area
   a. new, solid red oak strip flooring
   b. carpeting
   c. stained concrete (assuming this is your structural floor)
Resources

Efficient Windows Collaborative
All about windows and how to select the best windows for your location
www.efficientwindows.org

Green Building Resource Guide
John Hermansson
Available through
www.greenguide.com

Environmental Building News Product Catalog
122 Birge Street Suite 30
Brattleboro, Vermont 05301
Available through
www.catalog@ebuild.com

REDI Guide
Resources for Environmental Design Index
Iris Communications
PO Box 5920
Eugene, Oregon 97405-0911
(541) 4848-9353
www.oikos.com/redi/

Canada Mortgage and Housing Corporation
Publications and web site featuring healthy materials and building methods for homes
www.cmhc-schl.gc.ca

Prescriptions for a Healthy House
Baker, Elliott & Banta, 1998
Inwork Press
2530 Camino Entrada
Santa Fe, NM 87505-4835

The Healthy House

Healthy House Building
John Bower
The Healthy House Institute
7471 N. Shiloh Road
Unionville, IN 47468

The Natural House Book

The Natural House Catalog
David Pearson
Simon & Schuster/Fireside
Rockefeller Center
1230 Avenue of the Americas
New York, NY 10020

Step 4
Choose Green Materials
Step 5. Choose the Right Mechanical 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 about each of them, you’ll be able to get all these benefits for a reasonable price.

A. Mechanical systems: heating, cooling and ventilation

Feeling comfortable depends on a complicated mix of factors—not just the temperature of the air, but also the relative humidity, the rate of air movement, and the temperature of the materials around us.

Examples: A hot day in Santa Fe probably won’t feel as bad to you as an equally hot day in Houston, because Houston is humid as well as hot. If you sit under a ceiling fan on a hot day, you may not need any air conditioning. If you sleep on an unheated waterbed, you may feel it drawing the heat out of your body. If you go downtown on a hot summer day, you’ll feel heat radiating toward you from all the concrete and asphalt.

By incorporating many passive design features, such as super insulation, careful sizing and placement of windows, and air-lock vestibules, this house in Maine needs so little electricity, the need can be met entirely with active solar equipment.
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 perfectly comfortable all the time in most parts of the country. For that, you’ll need an active heating, cooling, and ventilation system.

Note: much of the following discussion applies only to a *forced-air system*—one in which heated or cooled air is blown by fans through a duct system, which distributes the air around the building. We’re emphasizing forced air systems here because central cooling requires them and they are still the most common system for heating, too. You may find a different kind of system better suited to your needs.

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 cold climate, choose equipment with the highest heating efficiency rating you can afford to purchase. If you get air conditioning too, but aren’t likely to use it much, don’t spend a lot to get high cooling efficiency. In a hot climate do just 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, the kind of windows and how they are shaded, the amount of insulation, etc.

   If the equipment is too small, it can’t heat or cool adequately. But in most homes, the equipment is too big to work right. Because an oversized unit reaches the temperature on the thermostat very quickly, it doesn’t run long enough at one time to reach the efficiency it was designed for. It’s like a car always driven in town and never on the highway: operating expenses are higher and it wears out faster.

   In a hot, humid climate, you cheat yourself *even more* with an oversized unit. To be comfortable in these conditions, you need the cooling system to dry out the air, as well as cool it. The system can only respond to the thermostat, however, and the thermostat only reads air 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 warm, moist air.

   In short, equipment that’s too big for the job costs more to purchase, more to operate, reduces comfort, and compromises health.
Step 5
Choose the Right Mechanical Systems.

**c. Effective placement**
The best location for equipment and ductwork is *inside the insulated space*, so conditioned air is less affected by outside conditions. If a house has an insulated basement, that’s a good location. In the south, however, houses rarely have basements, so systems are usually put in attics. Since an attic may get up to 160 degrees on a summer day, that’s the *worst* possible place to run ducts filled with cold air. (Ducts are insulated, but only minimally.)

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. For example, if the installer puts 90-degree turns in the ducts that weren’t allowed for in the 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 of the duct, or unconditioned air gets sucked in.

*In this home, the duct work is located right in the living space and the sleek metal fits the design of the house perfectly. This duct doesn’t need to be insulated and if any conditioned air leaks out, it will be right where you want it.*

*No duct tape here! Duct tape is good for lots of things, but not for connecting ducts, because it doesn’t make a lasting seal. For a tight, durable seal, you need latex mastic.*
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 or disintegrate over time.

2. Humidity Control

At moderate temperatures, if relative humidity drops below 20%, viruses proliferate; if it rises above 60%, molds grow. Mold is the leading cause of occupant health problems and rotting building materials. Mold didn’t used to be such a problem in old leaky buildings, but now that we build tightly to save energy, it is a serious problem (one of those unintended consequences).

How can you control relative humidity inside your home? In the north, relative humidity tends to drop uncomfortably low in winter when the heat is on, so you may need a humidification system. In humid areas, you need cooling equipment with an extra high capacity for dehumidification.

Reminder: be sure the cooling equipment is sized small enough to run a lot, since it can only dehumidify when it’s running. A smaller unit is cheaper to buy and cheaper to run.

If you live where there are lots of humid days in spring and fall when you don’t need heating or cooling, consider installing a separate dehumidification system. This is not yet very common and is often seen as an extravagance, but as more people understand the effect of moisture on both comfort and health, they will consider such a system to be a standard part of good building.

Note: In extra humid rooms of the house, such as baths, laundry and kitchen, be sure to install vent fans that exhaust air to the outside. You can connect them to a timer, or better yet, a humidity-sensor, so they’ll turn off automatically. Also, the quieter the fan, the more likely you are to use it.
3. Air Movement

It’s important for a heating and cooling 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. You’ll have to rely on a mechanical engineer or contractor to plan this, but let him or her know this is important to you.

4. Air quality and safety

When you turn on your forced-air system, huge changes in air pressure occur. Dangerous fumes from a gas furnace or gas 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 oxygen for combustion from outside the house instead of robbing it from the air you breathe.

A good filter improves air quality and protects your equipment (many filters do neither). Filter efficiency ratings are often wildly misleading. For example, a claim of 95% efficiency may only mean it’s good at filtering out marbles. 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.

For example, radiant heating may be a good choice in a cold climate, but it’s usually not cost-effective in hot climates. Air conditioning requires ductwork for the distribution of cold air, so you’ll probably want to use the ducts for heating too, instead of spending even more for a totally separate heating system. Evaporative cooling that gets cooling from the evaporation of water is efficient, but works well only in a dry climate. A geo-thermal heat pump, that uses the earth or water to heat and cool, is efficient, quiet, and long-lived, but installation is so costly in some parts of the country, the purchase price may outweigh the benefits for most people.
B. Lighting

If you compare a well-lighted building with a poorly lighted one, you’ll 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

There’s nothing like light from the sun for high quality and efficient light, but bringing it inside a building can be tricky. Be sure to consider this at Step 3, when you decide on size and placement of windows and overhangs, and at Step 4, when you choose the window units.

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.

2. Electric Lighting

When there’s not enough daylight, we must depend on electric lighting. Luckily, there is a wide selection of fixtures and bulbs to choose from, depending on what you need light for, the amount you need, the efficiency you want, the way you want colors to look, whether you need focused or diffused light, and where you intend to place light fixtures.
a. Purpose of the light

Your lighting choices should depend on what you are trying to accomplish with lighting. Do you need general lighting to get around easily and safely; indirect lighting to bounce off surfaces and 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 stick to 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 about 570 kilowatt hours or electricity (which saves over 1,300 pounds 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. For example, you might think you need a lot of light to see outside at night, but actually you need very little. A little seems like a lot because at night the contrast is so great.

A major reason not to use more than you need is the fact that lighting produces a lot of heat. An incandescent bulb turns only 7% of the electricity it uses to light—the other 93% turns into heat. In a hot climate that’s a big drawback (and even in a cold climate, not a very efficient way to heat your house). In a commercial building, the amount of cooling needed to counteract the heat from lighting may be greater than the amount needed to overcome heat from the climate.

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, without causing annoying glare. 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.

Note: Recessed can fixtures are very popular, but unless they are the sealed, energy-efficient type, they are an energy disaster. The unsealed kind produces so much heat, it can’t be safely insulated, and is like a hole in the ceiling. Also, recessed cans are frequently placed and finished out with useless and glaring down-lighting, when they could be used for effective and attractive wall lighting instead.

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### Comparison of kinds of lighting

<table>
<thead>
<tr>
<th></th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Incandescent</td>
<td>• Warm, full-spectrum color • Can be sharply focused • Easily dimmed • Low initial cost • Wide variety of bulbs</td>
<td>• Inefficient (less than 25 lumens per watt) • Short life (typically 1,000 hours) • High heat output</td>
<td>• Accent, atmospheric lighting • Decorative sparkle</td>
</tr>
<tr>
<td>Halogen Incandescent</td>
<td>• Same as standard incandescent, plus • More efficient • Longer life (up to 2,000 hours)</td>
<td>• Very high heat output • More limited bulb and fixture selection</td>
<td>• Accent lighting • Tasks requiring very high visibility</td>
</tr>
<tr>
<td>Fluorescent</td>
<td>• More efficient (up to 90 lumens per watt) • Very long life (10,000-20,000 hours) • Lower heat output • Wide variety of fixtures and bulbs</td>
<td>• Less precise focus control • Limited dimming options • Higher initial cost • Older models may flicker, hum and be slow to illuminate</td>
<td>• General, diffuse lighting • Indirect lighting • Task lighting</td>
</tr>
</tbody>
</table>
C. Appliances

Americans love the convenience of appliances. In spite of the increased energy efficiency of new appliances, households are using more energy than ever, however, because they are using more appliances, especially computers. That's all the more reason to look for efficiency of both energy and water when choosing appliances.

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 stoves. Be sure to compare the actual energy use of a given appliance with other sizes and models. For example, a larger refrigerator could actually have a lower energy use than a smaller one.

When purchasing appliances such as computers, look for the Energy Star label. Check the U.S. Department of Energy web site at www.energystar.gov to find out the energy efficiency of the models you are considering.
Life-Cycle Costs for 13-Year Operation of Different Types of Water Heaters

<table>
<thead>
<tr>
<th>Water Heater Type</th>
<th>Efficiency</th>
<th>Cost*</th>
<th>Yearly Energy Cost**</th>
<th>Life (years)</th>
<th>Cost Over 13 Years***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional gas storage</td>
<td>55%</td>
<td>$425</td>
<td>$163</td>
<td>13</td>
<td>$2,544</td>
</tr>
<tr>
<td>High-efficiency gas storage</td>
<td>62%</td>
<td>$500</td>
<td>$145</td>
<td>13</td>
<td>$2,385</td>
</tr>
<tr>
<td>Oil-fired free-standing</td>
<td>55%</td>
<td>$1,100</td>
<td>$228</td>
<td>8</td>
<td>$4,751</td>
</tr>
<tr>
<td>Conventional electric storage</td>
<td>90%</td>
<td>$425</td>
<td>$390</td>
<td>13</td>
<td>$5,495</td>
</tr>
<tr>
<td>High-efficiency electric storage</td>
<td>94%</td>
<td>$500</td>
<td>$374</td>
<td>13</td>
<td>$5,362</td>
</tr>
<tr>
<td>Demand gas</td>
<td>70%</td>
<td>$650</td>
<td>$140</td>
<td>20</td>
<td>$2,243</td>
</tr>
<tr>
<td>Demand electric (2 units)</td>
<td>100%</td>
<td>$600</td>
<td>$400</td>
<td>20</td>
<td>$5,590</td>
</tr>
<tr>
<td>Electric heat pump</td>
<td>220%</td>
<td>$1,200</td>
<td>$160</td>
<td>13</td>
<td>$3,280</td>
</tr>
<tr>
<td>Indirect water heater with efficient oil or gas boiler</td>
<td>75%</td>
<td>$700</td>
<td>$150</td>
<td>30</td>
<td>$2,253</td>
</tr>
<tr>
<td>Solar with electric back-up</td>
<td>n/a</td>
<td>$2,500</td>
<td>$125</td>
<td>20</td>
<td>$3,250</td>
</tr>
</tbody>
</table>

* Approximate. Includes installation.
** Energy costs based on hot water needs for typical family of four and energy costs of $.08/kWh for electricity, $.60/therm for gas, $1.00/gallon for oil
*** Future operation costs are neither discounted nor adjusted for inflation.
Source: American Council for an Energy-Efficient Economy.
Table from Consumer Guide to Home Energy Savings

2. Estimate the life-cycle cost.

What is the true cost of your choice over time, not just the purchase price?

Compare the purchase price column with the total cost column on the right. Any surprises? Notice that the electric water heaters are extremely efficient, but they are the most costly in the long run. How come?

For an excellent guide to the energy use of appliances, see The Consumer Guide to Home Energy Savings listed below.

Resources

Your Home Cooling Energy Guide
John T. Krigger
Saturn Resource Management

www.energy star.gov
Rating program for appliances, lighting fixtures, building products, etc.

The Pressure's On
Florida Solar Energy Center
(407) 638-1014
Interesting, informative video about air pressure and duct leakage

Consumer Reports
www.consumerreports.org/special/worksheets/reports/ac99wks.html
Sizing air conditioning

Alex Wilson, Jennifer Thorne, John Morrill
American Council for an Energy-Efficient Economy
(510) 549-9914
A comprehensive overview of home energy, appliance considerations, and comparative lists of current appliances.

Think of your house and site as a single unit and try to understand in the planning stage how they affect each other.

A. Potential benefits from good site use

1. Greater comfort and energy-efficiency

Your site affects your comfort and energy bills. If your site does not provide ideal conditions for your climate, you can modify it with appropriate landscaping. For example, in a cold climate, you can plant trees as protection against winter winds, and in a warm climate you can use trees to channel cooling breezes into your house. Vegetation has a general cooling effect because it transpires moisture, which cools the air as it evaporates.

One large shade tree can provide cooling equal to a four-ton air conditioner.

2. Enjoyment of plants and wildlife

Most everyone loves to look out on a beautiful landscape. Luckily, with all the easy-care, low-water native and well-adapted plants available at nurseries now, people with black thumbs and people concerned about maintenance labor and costs can have an attractive, thriving landscape. Such a landscape will attract birds, butterflies and helpful insects and be less likely to attract pests. If pests don’t come into your yard in the first place, they’re less likely to make it into your house.
3. More living space

Landscaping is more than vegetation. It can include playscapes for children, sport courts, decks and patios for outdoor living. All of these are appealing, functional, and cost-effective ways to have more living space. As well as being useful, they reduce the need for water.

4. Your own healthy food and water supply

Your yard can provide you with space to grow reliably fresh and healthy fruits, vegetables, herbs and nuts.

It’s a place to collect and store rainwater, too. Rainwater tastes good, has a pH balance that’s kind to skin and hair, and doesn’t have minerals that clog up plumbing pipes, fixtures and appliances. If you are not connected to a general water supply, if you must rely on a well (especially one with marginal water quality), or if you live where water is scarce and sometimes rationed, you’ll definitely want to consider collecting rainwater. Even if you have a good water supply, you might want rainwater to get the benefits listed above. There’s nothing complicated or newfangled about the technology.

In Central Texas, if you have a roof area of 2500 square feet and a yearly average rainfall of 32", you can collect almost 45,000 gallons of rainwater in a typical year.

Cisterns for rainwater collection are making a comeback. They can even be an architectural or functional feature of your landscape. This one serves as a patio and nice, smooth play surface.
5. Better stormwater and erosion control

Storm water can do a lot of damage to your site and foundation if it’s heavy and fast-moving, but you can grade and plant your site so water drains away from buildings to areas made to contain it. That enables storm water to seep slowly into the ground, giving your landscape a healthy drink, without washing away valuable topsoil.

This benefits your whole community because slow filtration through the ground gives water time to purify before entering the water table, streams and lakes. Otherwise it just speeds over the ground surface to the pavement, picking up a lot of contaminants, such as motor oil leaked from cars, along the way.

B. Ways to maximize benefits from your landscape

A good way to find out what vegetation thrives best in your area is to go out in the country (in the bioregion that you live in) and see what’s doing well with no care at all. Take note of the plants and trees that appeal to you most, look for them at your local nursery, and ask if they will do well with little or no watering in the conditions of your site.

This lovely rock garden will thrive in an arid landscape with little or no water once it is established.
If you must have some vegetation that’s not well-adapted for your area, it’s not a huge problem if you limit it to a small “oasis” in a convenient place where you’ll be sure to enjoy it and take care of it.

Choose mainly evergreens and perennials. You can enjoy them every year, winter and summer. Choose trees that have a long life span. It’s tempting to plant fast-growing trees for quick shade and beauty, but they are usually short-lived. If you take good care of slower-growing trees, you’ll be surprised how fast they develop.

If you want a lawn, choose turf grass on the basis of your climate, soil conditions, amount of sun available, amount of care you are willing to give it, and the use you plan to make of it. For example, once established in Central Texas, Buffalo Grass stays alive with almost no water, and may not even need mowing, since there are now dwarf varieties available. If you don’t want to do much weeding and want to enjoy a lot of sport activities in your yard, however, a different grass variety may be better for you.

Most turf grasses require huge amounts of water and fertilizer to thrive. In much of the country, half of all water used in summer goes just for lawns. If you don’t require much lawn, what about an attractive, easy-care, low-water groundcover? What about expanding your patio area?

Think of the amount of water it will take to keep up this huge lawn that’s located in a semi-arid region. Wouldn’t you hate to pay those water bills? Do you suppose the owners have a hand mower? If not, mowing is going to cause a lot of pollution as well.
Consider this....

Before planning your landscape, review Step 3 to see what factors are most relevant to landscaping in your area. Obtain a list of native and well-adapted plants for your area and find out which nurseries carry them. Identify the longest-lived trees in your area. Your county agent can probably help you.

If collecting rainwater appeals to you, try this little exercise: given a roof area of 2800 square feet and your average annual rainfall of _____ inches, how much rainwater could you collect in an average year? How much water do you estimate a household of four people need in a year? Would you be willing to make any changes in your water-use habits to enjoy the benefits of rainwater?

See The Sustainable Building SourceBook in the Resources Section to help you with your calculations.

Resources

J. Howard Garrett’s Organic Manual
J. Howard Garrett
Lantana Publishing Company, 1989
www.dirtdoctor.com/books.html

The Landscaping Revolution: Native Planting and the Natural Garden
Sally and Andy Wasowski
Gulf Publishing Co.
Applicable to the southern U.S.

Energy-Efficient and Environmental Landscaping
Ann Simon Moffat, Marc Schiler
Appropriate Solutions Press

Wild Gardening
Richard L. Austin
Fireside Book, 1998
ISBN 0 671 602 41 1

The Wild Lawn Handbook: Alternatives to the Traditional Front Lawn
Stevie Daniels, 1995
Macmillan
15 Columbus Circle, new York, NY 10023

Landscaping for Energy Efficient Homes
U.S. Department of Energy Fact Sheet 220, April, 1988

Cooling Our Communities—A Guidebook on Tree Planting and Light-Colored Surfacing
Step 7. Test and Maintain.

Once you’ve built your green home, you’ll want to make sure it’s safe for occupancy and able to perform as efficiently as you and your team intended. You’ll also want to maintain it properly to prevent deterioration, and keep it healthy, safe, and efficient in the future. Even though your house won’t be tested or maintained until after it’s built, you still need to address these matters in the planning stage, so you’ll make contracts and 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. Once people move in, they may find it difficult to do much airing—for security reasons, or because of the time of year. For example, you probably won’t want to leave the windows open in Wisconsin if you move in in January.

Your best bet is to avoid choosing materials containing unhealthy chemicals in the first place. Also avoid choosing materials that are 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
- b. Safety backdraft test
- c. Blower door test

This house is being tested for duct leakage. Leaks usually can’t be seen: they can only be found by testing. Even new houses lose over a quarter of their conditioned air to leaks, so testing and repair really pay off—usually in just a year or two.
a. **Duct leakage test**
If you have a forced-air heating or cooling system, you need to get the ducts tested for leaks. A well-sealed system has no more than five percent leakage. It’s possible that in the future better results can be expected if more leak-free equipment is available.

b. **Safety backdraft test**
If you have a gas water heater and gas furnace that don’t 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 heating and cooling 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 move out of the vent pipes and exhaust to the outside, instead of backdrafting to the living space where they could harm occupants.

c. **Blower door test**
This test tells you how much air is leaking in and out of the “envelope” or outer shell of the house. How much leakage is acceptable may depend on where you live. The more extreme your climate, the more important it is to control leakage, since air leaking out has been heated or cooled, and air leaking in may be very uncomfortable. As a general rule, leakage of more than 0.50 Air Changes Per Hour (ACH) is not energy-efficient.

Air leakage of 0.50 Air Changes Per Hour means that all the air in your house will be replaced by outside air every two hours.

For good health, you do need some fresh outside air coming into the house—at least 0.35 Air Changes Per Hour. Air will leak through any cracks it can find in the building shell, but you can’t control the temperature, humidity or the amount of incoming air. For control, 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

Just like your car, your home needs maintenance if it is to keep performing effectively. In fact, 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. That will depend on the kind of filter you have and the amount of particles in the air.

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 attract pests.

5. Site and landscaping
   Over time, soil builds up (because you haul it in, or it forms naturally by composting), 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 amount of solar access your house needs for heat and light. Avoid toxic fertilizers and pest control products. Compost household food waste to build healthy soil.
Resources

www.home-performance.org/
Affordable Comfort Housing Performance Association
For information about who can test your heating and cooling system and diagnose and/or repair problems

Common Sense Pest Control
Olkowski, Daar, Olkowski
Taunton Press, 1991
ISBN#0-9432391-63-2
Least Toxic solutions for your home, garden pets and community

The Healthy Household
Lynn Marie Bower
The Healthy House Institute
7471 N. Shiloh Road
Unionville, IN 47468

Closing

If you’ve established your goals thoughtfully, and assembled a good green team, that works effectively together to meet those goals, you will have a house that gives you convenience, comfort, health and safety. At the same time, it will be easy on your pocketbook, nourishing to your soul, and protective of the planet, so your descendants can have the same benefits and pleasures.