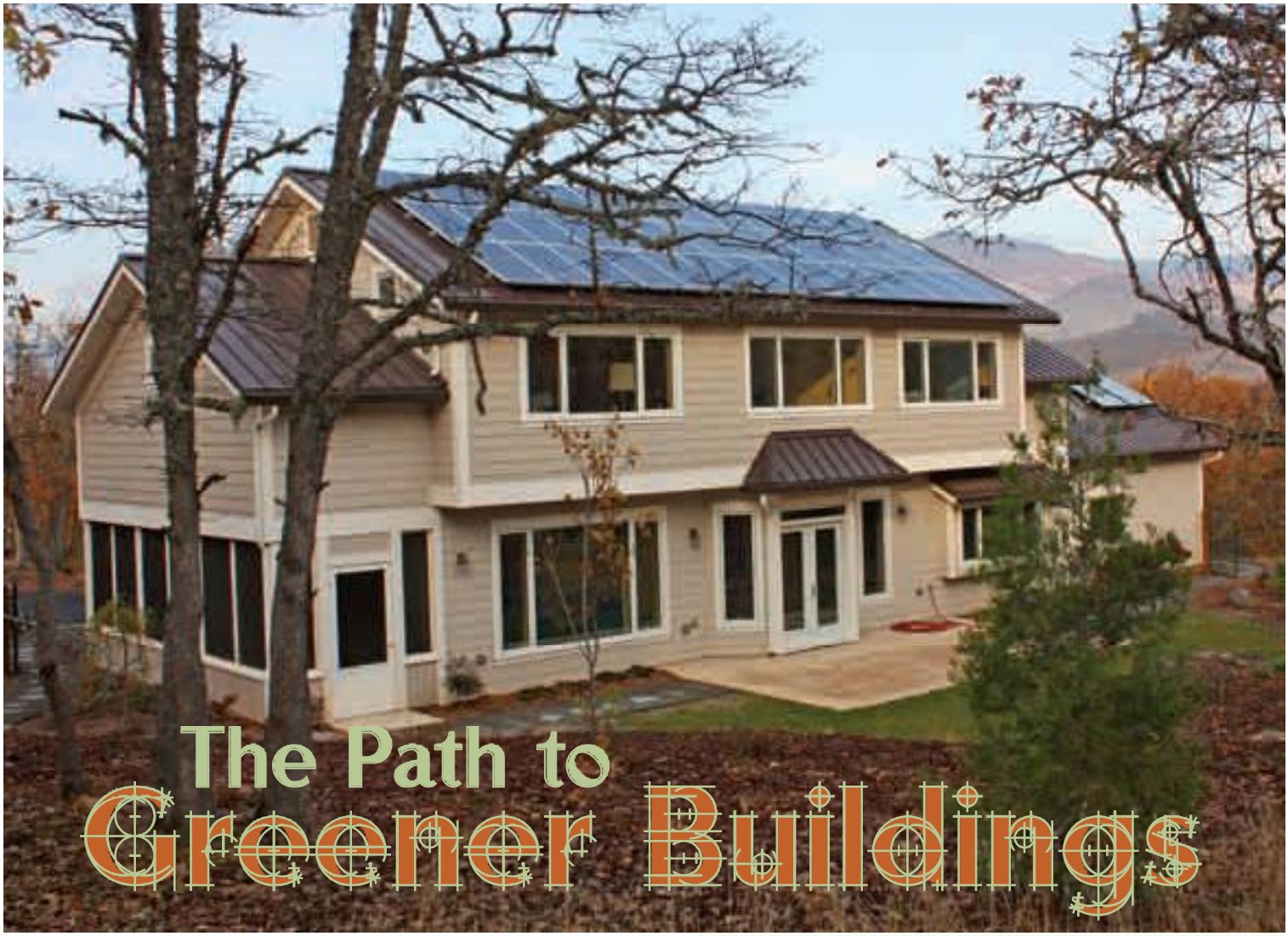


The Path to Greener Buildings

by Andy Kerr

Once you decide to build green, don't look back. But before you go this route, know where you're going—and who you'll be bringing along for the ride. Here are some tips for navigating along the ever-evolving path of green building.

Even if you've hired a good architect, designer, and/or builder, it will be helpful to know as much or more about green building than they do. They might know more about basic building design and construction, but you will need to become the green building expert. The more you know, the easier it will be for you to communicate your preferences and priorities effectively—and to observe whether your wishes are being carried out during construction.

Research Fully

Once I decided that building "green" was something that interested me, I hit the books and the Web. I read, and I read, and I read some more—probably 50 or more books altogether. (See "Green Building Resources" sidebar.)

However, when it comes to green building, books can fast become outdated, since new materials and designs are revolutionizing green building quickly. The single best investment in my learning process was a $199 annual subscription to www.buildinggreen.com, an independent source for information on green products and news about the green building industry.

Expect to build your green building library before you build your green house.

The author reviews the professionally customized home plans, which started as a standard, ready-made design.

What Green Means

Crack open a few books and scan some magazine articles and you'll quickly realize that what constitutes "green building" can vary greatly. For some folks, it means using recycled materials. For others, it can mean achieving a highly efficient building envelope. Alex Wilson, the publisher of www.buildinggreen.com, uses the term "green building" to describe building design and construction that has some or all of the following characteristics:

- Minimizes adverse impacts on local, regional, and global ecosystems
- Reduces reliance on automobiles
- Uses energy efficiently
- Conserves water
- Built environmentally responsibly, with low-impact, durable, and low-maintenance materials
- Helps occupants recycle "wastes"
- Comfortable, safe, and healthy for occupants

My research braced me for one of the realities of building a green home—the tremendous time commitment. Green building involves tailoring specific strategies to your individual project, climate, and location. Unless you have a green building consultant at your beck and call, you must be intimately involved in the process from start to finish.

Consult with Experts

Unless you have extensive drafting and design experience, there are two routes you can take when designing a home: hire an architect or hire a designer.

An architect usually has more credentials, but their fees tend to be higher because they stay with the project until completion and oversee the builder during construction. Some building codes require an architect's approval on plans, so you may not have a choice.

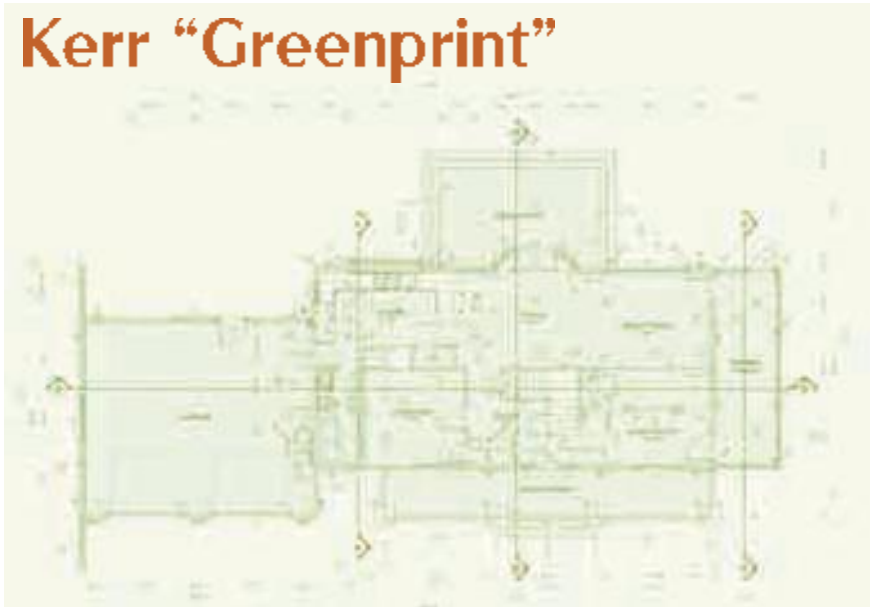
A designer draws the plans to the owner's specifications and to satisfy code compliance, but then hands off the plans to the builder and is no longer involved with the project. Designers are typically less expensive, but you'll be the one responsible for conveying necessary information to your builder once the plans are drawn.

Even though you've read through piles of books, you may also want to retain a green building consultant. Before you hire them, ask about professional certifications, academic credentials, and field experience. The U.S. Green Building Council's LEED Professional Accreditation and the National Association of Home Builders' Certified Green Professional are two examples of certifications. Expert forums can also be great resources. The forums of both www.buildinggreen.com and www.greenbuildingadvisor.com are popular sites where you can interact with experienced, knowledgeable experts.

Passive solar design was a key element of this green home. Large, south-facing windows admit winter sun, while adequate overhangs prevent summertime overheating.

Choosing a Plan

Ideally, you'll have chosen a building site with solar access. Numerous online purveyors tout "solar" house plans. But buyer beware: More than half of the so-called "solar" house designs that I looked at didn't even have a compass symbol on the plan that oriented the house toward the sun. By understanding simple passive solar strategies, you'll be able to find the plans that are likely to work. After surfing several Web sites, I purchased floor plans for a passive-solar home to use as a starting point, and turned over the electronic version to our designer, who brought it up to local code and modified it to suit our needs.



From my research, I came to accept one of the basic tenets of green building: Small is beautiful. Even a sloppily and unsustainably built small house can cause less environmental damage than a thoughtful and more sustainably built large house. A small house typically consumes fewer resources during its construction and requires less energy to operate. Although my house is not "small," at about 2,500 square feet, it's about average for residential construction in the United States. It serves as a home office for two people and includes an exercise room—two features that eliminate driving to work or the gym.

Seeking Certification

One path to a green home is to go through a certification process—the parameters defined by the program can help lead your design. Perhaps the most widely known program is the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED), which awards the home with an overall rating based on sets of criteria. Depending upon the number of points received, a LEED home is classified as Certified, Silver, Gold, or Platinum.

The LEED program, like most other green certifications, requires on-site evaluations and extensive documentation, which adds significant time and expense to the project. (For instance, LEED registration and certification for a single-family home costs about $525 and typically requires several site evaluations over the course of construction.)

There are benefits to participating in a certification program. First, you'll have another set of eyes on your project to spot any mistakes that could compromise the home's performance. Second, a home with an independent "green" certification may be more marketable and command a premium if you ever decide to sell. Third, certifications may be needed to qualify for incentive programs, which offer cash rebates or tax credits that help recoup some of your building costs.

LEED certification is most useful in assuring a buyer of a green home that it is indeed green. Because I participated at every step in the construction of my house, I felt that I did not need those assurances. However, I did review the LEED standards and sought to conform to most. While the certification standards and process are generally excellent, I think that the LEED new home certification system short-changes renewable energy by limiting that aspect to a total of 10 points, or roughly 1 point for each 3% of the home's power

Countertops made with recycled paper and energy-efficient appliances are just some of the home's eco-friendlier features.

A concrete block wall provides additional thermal mass to moderate temperature fluctuations in the home.

Triple-pane, argon-gas-filled windows with fiberglass frames were selected for their performance and durability.

that is renewably produced. If powering 30% of a new home by renewable energy is a green thing to do, then powering 100% of a new home should be 3.3 times "greener" and reflected as such in the standard.

While I decided against the time and expense of pursuing LEED certification, I did choose to pursue certification required for obtaining tax credits through Earth Advantage, a nonprofit green building program based in the Northwest.

Addressing the Envelope

The envelope is the house's thermal barrier between the comfortable and habitable inside and the vagaries of the weather. You'll want to prevent heat from radiating or conducting through the walls (out or in), and prevent convection losses by thoroughly sealing cracks, ducts, and penetrations.

No matter what construction method you choose—stick-frame, insulated concrete forms, structural insulated panels, straw bale—you'll want to make sure your house is well insulated and protected against air infiltration. Construction details, like minimizing thermal bridging, are vitally important.

Specify adequate levels of insulation in all parts of your home—and don't rely on just meeting the building code. Insulating beyond code requirements will save you energy *and* money.

Custom thermal shades reduce heat loss through the windows.

Green Building Resources

Books

- ***Builder's Guide to [X] Climates: Details for Design and Construction*** by Joseph Lstiburek (Building Science Press, 2009) • Not one book, but several different titles, with "X" being "Cold," "Hot-Humid," "Hot-Dry & Mixed-Dry" or "Mixed-Humid" climates, this series offers a general guide to good, *modern* (which includes green) construction techniques with lots of detailed construction drawings.
- ***Your Green Home*** by Alex Wilson (New Society Publishers, 2006) • A must-read book—some call it the bible of building green.
- ***The Sun-Inspired House: House Designs Warmed and Brightened by the Sun*** by Debra Rucker Coleman (Sun Plans Inc., 2005) • An excellent primer on passive solar homes and choosing the best plans for your site. Architect Coleman also sells house plans at www.sunplans.com.
- ***The Solar House: Passive Heating and Cooling***, by Daniel D. Chiras (Chelsea Green, 2009) • A detailed exploration of passive solar homes.

Web Sites

- **www.buildinggreen.com**—Examines a product's manufacture, life cycle, pollution, recyclability, quality, and price, and puts it in layperson's language. This Web site is widely respected as a trusted resource for accurate, unbiased, and timely information.
- **www.regreenprogram.org**—This green home remodeling site is sponsored by the American Society of Interior Designers' Foundation and the U.S. Green Building Council.
- **www.buildcarbonneutral.org** Lots of sites can estimate the carbon footprint of operating your home, but this site helps you estimate the carbon footprint of building.
- **www.buildingscienceconsulting.com**—Free information including construction details, moisture management, and green building practices.
- **www.efficientwindows.org**—Use their window selection tool to compare the U-values, SHGC, and energy costs for windows from various manufacturers, and get window guidelines from LEED and other programs.
- **http://windows.lbl.gov** Provides free, downloadable software that helps you calculate and compare windows.
- **www.greenbuildingadvisor.com**—An effort of *Environmental Building News* and *Fine Homebuilding*, this site provides a forum for answers by green building experts, a searchable green product guide, construction detail drawings, and downloadable construction strategy checklists.
- **www.pathnet.org**—Includes design and construction guides, a searchable technology inventory (maintained by the National Association of Home Builders Research Center), and field evaluations of various technologies.
- **www.ornl.gov/sci/roofs+walls/AWT/InteractiveCalculators/rvalueinfo.htm**—Calculate the whole-wall R-value of your building method.

Fiber-core interior doors with FSC-certified wood veneers are tasteful, sustainable choices.

Operable windows placed high in the second-floor rooms provide ventilation using natural convection.

An energy recovery ventilator introduces fresh, conditioned air into the well-sealed home, with little heat loss.

The envelope is a complex unit, typically made up of several materials—siding, sheathing, windows and doors, framing, insulation, and drywall—and whole-wall R-values will give a more accurate picture of the home's thermal performance than just looking at the value of the insulation within the walls. While Energy Star recommendations provide a starting point, Oak Ridge National Laboratories whole-wall R-value calculator can help you quantify your choices.

Well-constructed and super-insulated windows and doors should also be selected. Energy Star (ES) requirements are just a starting point as windows are available that trump the ES criteria. The three main values you'll want to consider are:

- Full-frame U-factor measures how quickly heat passes through the window unit and is the reciprocal of R-value (the resistance to heat flow). Energy Star guidelines can help you select the U-value for your climate.
- Solar heat gain coefficient (SHGC) is the fraction of heat from the sun that enters through a window. Until this year, ES specified an SHGC of 0.30 or below for all windows—no matter their location within the house. However, that recommendation has been revised to account for south-facing glazing on passive solar homes, which require a high SHGC to perform optimally. Finding affordable windows with high SHGCs can be challenging. Ask your window manufacturer about hard-coat low-E windows and what the highest SHGCs are for their various lines. Canadian fiberglass window manufacturers generally can provide glazing with higher SHGCs, and, so far, at least one U.S. manufacturer of fiberglass windows—Serious Windows—offers windows with higher-than-typical SHGCs.
- Air leakage (AL) measures the amount of air infiltration through the unit, and will vary by manufacturer and by window type. This information can be difficult to find in the manufacturer's popular literature. Typically, you'll want to choose a window with an AL less than 0.30 cfm per square foot. Leakage through windows and doors are only part of your worries—ensure that potential air leaks in the envelope are sealed during construction.

Be prepared to pay a premium for high-performance windows. My triple-pane, argon-filled, fiberglass windows cost 3.6 times as much as code-compliant windows, but I will recover the difference in energy savings over the long term. Plus, the fiberglass frames of my windows are durable, don't warp like wood, and don't have the toxicity issues associated with manufacturing vinyl windows.

Design for Passive, Then Add Active

A well-designed, well-insulated house is a starting point for saving energy. But the more passive strategies you employ, the more energy you'll save. I sited our home's long axis to receive the winter sun and then specified latitude-specific overhangs to keep the hot summer sun out.

Passive space heating allows the sun's warming rays to enter the house and warm the air and the thermal

The well-insulated, well-sealed house requires no central furnace. Twelve 500-watt radiant heaters do the job when passive solar can't.

mass—concrete, tile, etc.—during the heating season. Without adequate thermal mass, the sun over-warms the air in the house like inside a car. But properly sized and installed thermal mass provides a heat sink for solar gain and can also help keep a house cool in summer.

To estimate the supplemental heating load (the home's main heat source is the sun), I hired a professional engineer to evaluate my plan with Energy-10, a building analysis program that factors in passive solar heating and cooling, natural lighting and ventilation, windows, wall insulation, shading, mechanical equipment, and other variables. The house is designed well, and built and insulated well enough that it takes only a few strategically placed electric heaters to warm the house on the coldest days—no central heating system was needed. The energy load of those heaters is equivalent to running three toasters.

Good passive-heating design can also be good passive-cooling design, eliminating the need for air-conditioning. Here in Ashland, Oregon, summer days are often in the 90s and 100s. However, almost every night, the temperature drops into the 50s. Proper shading and insulation keep most of the sun's heat out of the house, and what does get in is mostly absorbed into the thermal mass, which helps moderate the inside temperature.

In the evenings, natural ventilation (high windows on the second floor placed just for that purpose) allow the warmed interior air to move outside, as cool outside air is drawn in from ground-floor windows. If additional ventilation is necessary, two whole-house fans move hot air out of the house through the attic.

My designer was nervous about foregoing air-conditioning, noting that there are some times when the nights don't cool off. However, I reasoned that the money I would have spent on central air-conditioning was better directed toward efficient design, conservation, and passive cooling strategies. If there are a few hot days where passive cooling isn't enough, I'll either head for the beach or the mountains or hunker down with mint juleps on the porch.

Besides the whole-house fans, one mechanical system that is important to a high-performance house is an energy (or heat) recovery ventilator (ERV or HRV). An efficient house is

What Makes My Home Green

Design Strategies

- Sited for solar access, with the long axis of house oriented east-west
- Passive solar floor plan with 10% south-facing glazing and 4 inches of thermal mass in the concrete floor, poured over 8 inches of XPS rigid-foam insulation (R-value of 40; local code is R-15)
- Sized-for-latitude overhangs allow winter sun in for solar heating, but keep it out in the summer
- Windows strategically placed to take advantage of natural ventilation
- Windows minimized on east and west walls to avoid heat buildup from early- and late-day summer sun

Construction Details

- 2 x 6 stick-frame construction, spaced 24 inches on center, Forest Stewardship Council-certified wood
- Walls insulated with polyurethane foam boards and spray foam within the walls; 1-inch-thick polyisocyanurate board serves as a thermal break between the outside of the studs and the siding for a total of R-40 (code is R-22)
- Ceiling insulated with 12 inches of polyurethane board and polyurethane foam for a total of R-71 (code is R-38)
- Standing-seam metal roof
- Triple-pane, argon-gas-filled, fiberglass-frame windows. South-facing windows have SHGC of 0.63 and a U-value of 0.16

Mechanicals

- No air-conditioning: Opening windows at night and closing them during the day is typically sufficient
- Two Tamarach Technologies whole-house attic fans can flush out hot air when needed
- Ceiling fans throughout aid cooling in summer
- Panasonic WhisperGreen bathroom fans
- High-efficiency energy recovery ventilator provides adequate exchange between indoor and outdoor air
- Solar hot water system offsets about 68% of the electrical water heating
- 7.2 kW grid-tied PV system with battery backup provides 100% of electricity needs

Finishes & Products

- PaperStone countertops made from recycled paper and nonpetroleum binders
- Cabinets of FSC-certified wood and formaldehyde-free plywood
- No-VOC paints, adhesives, and finishes used throughout
- FSC-certified Oregon white oak flooring
- Humabuilt (www.humabuilt.com) doors, made with wheat hull (interior) and wood veneer (exterior)
- FSC-certified wood trim and moulding
- Insulated WindowQuilt (www.windowquilt.com) shades
- Ridgeline, gable, and soffit vents keep attic area cool and dry
- Delta H_20 Kinetic technology low-flow showerheads
- Caroma low-flush (1.6 gpm) toilets

Two solar thermal collectors offset 68% of water-heating energy loads.

tightly constructed, with little air exchange between the inside and outside. The American Society of Heating, Refrigeration, and Air-Conditioning Engineering provides procedures for determining whole-house ventilation rates in its standards.

An ERV or HRV exchanges stale indoor air for fresh outdoor air, but minimizes the loss of heat (in winter) or gain of heat (in summer) in the process. The energy required to run these units is a tiny fraction of the energy saved by not losing heat or "coolth" to leaky construction.

My heating, ventilation, and air-conditioning contractor discouraged the ERV I'd specified, and tried to direct me to a less expensive HRV that he was familiar with. I wanted the more efficient ERV, because even though it cost more initially, its high-efficiency motor and heat-exchange design would save me money in the long run. He still wasn't convinced, but the unit I wanted qualified for a $300 state tax credit, and his recommendation gleaned only a $150 tax credit. In any case, since I was the customer, I won the argument.

SHW systems can round out a green home, and offer both up-front capital and ongoing operational savings and benefits, especially if you can take advantage of tax credits or other incentives. The cost of my SHW system was $3,150, rather than $1,190 for a "conventional" tank-style electric water heater installation. The higher initial cost of $1,960 for going solar was more than offset by the incentives: a $1,500 state income tax credit; a $1,000 rebate; and a $945 federal income tax credit. Factoring in these subsidies meant that I was $295 *richer*—even before factoring in energy savings. My 120-gallon single-tank system stores sun-heated water and also uses electricity to heat it when sunshine is inadequate. The oversized tank allows both optimum use of the sun and provides enough electrically heated water on cloudy days. Conventional tanks have two heating elements. In my system, the lower heating element was replaced by the heat exchanger from the solar collector.

Choosing Green Materials

Green building materials do not overcome the environmental sins of bad design. Thinking through all the major factors (orientation, shading, lighting, insulation, etc.) beforehand will result in an integrated and complementary design that doesn't have to cost much more than "conventional" designs.

Indoor air quality was a critical factor in our finish materials selection. A basic principle in green building is to avoid toxic chemicals. Paints with low or no volatile organic compounds (VOCs) are a good start, but read the material safety data sheets available for each product from manufacturers. Look for indicators of problems, such as special handling requirements and warnings about toxicity. For example, I used American Formulating & Manufacturing paint, which is zero-VOC and also free of formaldehyde, ammonia, crystalline silica, and other chemicals commonly found in paint. Even some low- or no-VOC paints still might contain lead—yes, in the United States, "lead-free" paint does not necessarily mean free of lead—it just means it's below the legal limit of 0.5% of a product's dry weight.

As you'll discover, every design detail in a green home requires significant research. For example, consider the kitchen and bathroom counters. There are lots and lots of options out there—many of which we quickly disregarded because of their toxic and/or unsustainable elements. After weighing various options, we chose PaperStone, which is made from Forest Stewardship Council (FSC)-certified post-consumer recycled paper and uses nonpetroleum cashew-nut hull oil as a binder. A friend questioned our decision, pointing out that we could buy Italian marble for as much as we were spending on the PaperStone. True enough, but the environmental value of the PaperStone was worth more to us than the finest Italian marble. We particularly appreciated that the product was manufactured just a few hundred miles to the north of us, and didn't need to be quarried out of the ground and shipped across an ocean and a continent to reach us.

Some of the bigger decisions come easier—once you accept that you will spend more for green materials. Specifying FSC wood throughout cost 1 to 2% more than conventional wood products. The 50-year-warranted metal roof cost more than a 20-year asphalt shingle roof, but will last more than twice as long. Plus, the metal can be recycled, while asphalt shingles would end up in the landfill someday. If I lived in a hotter climate, I would have chosen a more reflective roof to reduce heat gain in the summer. However, my roof insulation is nearly three times what the building code requires and the attic is vented so excessive heat gain through the ceiling is not an issue.

Having a home office cuts out the daily commute. When transportation is needed, the author drives his hybrid-electric car.

Probably the single-most exasperating factor I found in building a green house was the limited local availability of green products and competent subcontractors. There was no local insulation contractor that could spray the insulation I wanted (there now is). The windows I specified came from Canada, and the product was far better than their service (similar ones can now be had from Colorado and elsewhere). Many green products had to be special-ordered—a process that didn't always work smoothly.

Accounting for Going Green

Determining just how much it costs to go green is not easy. For example, spending more on an integrated design from the beginning means you spend more up-front on the building envelope (i.e., more insulation, better doors and windows, etc.). However, this also means you spend less on heating and cooling in the long run—both in terms of initial capital costs (no expensive equipment) and ongoing operational costs.

The estimates vary, but green building typically costs from 1 to 10% more than conventional construction. Think about it this way: The money you'll save later as a result of lower operating costs can be applied to greener materials and products today. I'm coming out ahead by going green, even without considering other benefits, such as indoor air quality. In making decisions for the home, I didn't worry as much about the cost-efficiency of each product choice as I did the cost-efficiency of the home's overall design and construction.

Depending upon your state, tax credits may help offset the additional costs of efficient building and green materials. In Oregon, I was able receive tax credits and utility rebates for purchasing a refrigerator, washing machine, and dishwasher that exceeded the minimal Energy Star ratings, as well as get credits for PV energy production, solar hot-water heating, passive solar heating, building a high-efficiency house, and installing an ERV. Your builder is also entitled to a federal tax credit (which should be reflected in their final bill) for building an Energy Star home, should you choose to go that route.

When it comes to building, being penny-wise often results in being pound-foolish. Putting your money into what counts—solar design and lots of insulation, plus high-performance windows and doors—will result in both short-term and long-term payoffs in overall comfort, livability, energy savings, and financial savings.

Access

Andy Kerr (andykerr@andykerr.net) is czar of The Larch Company (www.andykerr.net), a conservation organization that represents species that cannot talk and humans not yet born, with offices in Ashland, Oregon, and Washington, DC. All profits are dedicated to the conservation and restoration of nature. A deciduous conifer, the western larch has a contrary nature.