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THE HOMEOWNER'S HANDBOOK 4TH EDITION



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Located in Epcot® at the Walt Disney World® Resort

The VISION House® in INNOVENTIONS focuses on green living ideas in a fun and informative manner, empowering guests with the knowledge that a sustainable future is possible. The exhibit showcases a wide spectrum of environmentally appropriate products and provides homeowners with real solutions for contemporary green living. VISION House in INNOVENTIONS explores the major themes of green building, such as whole-home automation; energy generation and efficiency; water conservation; indoor environment quality; and high-performance materials and durability.



For more information about:

The project visit www.greenbuildermag.com/VISION-HOUSE

Sustainable living visit www.visionhousegreen.com

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Trimming the Decision Tree

EACH YEAR, we dedicate an issue of *Green Builder* to homeowners who want to understand what green building really means. The idea originated from an experience we had at the International Builders' Show about five years ago. Dozens of professional contractors approached our booth and asked the same question: "What does it mean to be green?" Does that mean keeping pollutants out of indoor air by installing better ventilation? Does it mean using more insulation? Specifying products that are locally produced?

The answer, of course, is "all of the above." But a house is not a kit that comes in a box that you can have drop shipped to your location from Ikea. It's a collection of thou-



sands of different parts, some of which are made to work together—but many of which have to be customized on site—before they become part of the whole. If professionals find the number of choices baffling, how can a homeowner hope to make good choices that accomplish the multiple goals of green building: lower energy costs, less

maintenance, healthier living spaces and less impact on the environment?

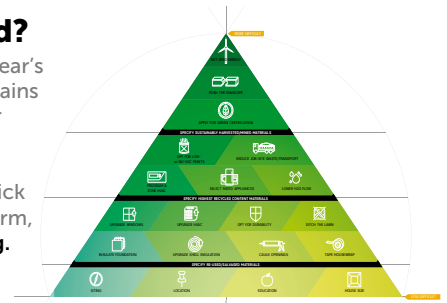
Over the years, our veteran staff at *Green Builder* has addressed all of these decision points in one way or another. We've looked at products both individually and as "systems" that work together. In effect, we have "trimmed the decision tree," and identified which choices have the greatest impact on a home's performance and eco-friendly aspects.

This *Homeowner's Handbook* is our chance to share some of that knowledge with a different group of readers—the "end users" who will live in the homes that our professional subscribers build and remodel. If you're a homeowner reading *Green Builder* for the first time, welcome. If you're a pro who struggles with educating clients and would-be clients about sustainability, here's a tool you can use. Send this copy around. Order some copies for your office, or send your clients to our Web site to download a free PDF of the issue (www.greenbuildermag.com). We hope you'll enjoy this, the 4th Edition, with all new graphics and information to help you achieve your eco-friendly dream home. —MP



The Lost Pyramid?

You may notice that this year's Handbook no longer contains our popular *Green Builder* pyramid. Fear not! A full resolution version of the pyramid is just a mouse click away, on our digital platform, at: www.greenbuildermag.com/GBM/media/pdfs/pyramid-spread.pdf





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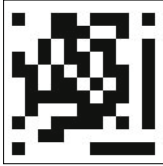
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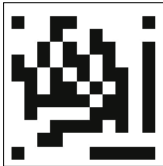
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"When in doubt, more ventilation is better than less, but you have to balance the resulting energy loss with the improved air quality." (p. 33)

ON THE COVER THE HOMEOWNER'S HANDBOOK

Artist: Sean O'Brien

Visit us at www.greenbuildermag.com for up-to-date news analysis, case studies, new green projects, code and reg updates, thought-provoking blogs, cutting-edge products and much more.

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The Inside Scoop

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THE HOMEOWNER'S HANDBOOK, 4TH EDITION

Our latest edition of the Handbook can help your clients understand that achieving sustainability goals in design and construction involves more than simply selecting the right products.

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Here's a graphic starting place, when you're ready to build or remodel your home, applying the most effective sustainability principles first.

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FROM THE TAILGATE

New Offerings for the Sustainable Minded

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* Research conducted by FM Global and the Home Fire Sprinkler Coalition, "Environmental Impact of Automatic Fire Sprinklers" FM Global, March 2010



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“Designing Spaces”, a popular nationally televised home improvement show on Lifetime Television®, recently featured Wiser home management in their “Think Green” episode. Watch today to learn how easy it is to sell an energy-efficient home!

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The Homeowner's HANDBOOK



Your annual, essential guide to building or remodeling a sustainable home.

Understanding the thousands of choices available when constructing or improving a home is daunting. Add in efforts to use "green" products, and the task gets even more complex. That's why we created this Handbook—to help you manage your project, by separating the really important choices from the rest. Here's the essential information you've been looking for, in one handy annually updated guide.

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WHAT'S NEW IN THE 4TH EDITION?

VISION House® Tucson Showcase

This edition features more than 15 new products that are being used in our Tucson demonstration home. These are tried and true green products from trusted companies. Scan this barcode for a complete roundup—or to learn more about VHT.



Graphic Pullouts

"What Makes It Green?" Pullouts

We've created informative graphics about sustainable features using real homes. From exteriors to cabinets, here's essential information to know before you build or renovate.

How-To: Window Repair

Tips on Fixing Old Windows

Here's a new article about window repair and maintenance, written especially for savvy homeowners (p. 42).



GREEN PROFESSIONALS: SHARE IT!

Green building professionals: Feel free to share chapters of this Handbook with clients, friends and prospective clients. Visit our website for a free download—or to purchase hard copies: www.greenbuildermag.com

What Makes It Green?

You can build or remodel your home to perform like a champ with readily available products. The secret? Focus on the big details: location, siting, weatherization, durability and quality workmanship.

Cover Concrete

Bare foundation walls (and slab perimeters) can reduce heating efficiency by 30%–50%. Cover these buried concrete walls and floors with rigid foam insulation.

Insulate with Care

The type of insulation you install is sometimes less important than the quality of the installation. Whether fiberglass, cellulose or foam, insulation should fill the cavity without leaving obvious gaps.

Glass Matters

At a minimum, windows in a new home should include insulated low-E glazings. Look for durable window frames made with materials that are renewable or recyclable, and seal and flash them meticulously.

Tighten Up

Caulking around windows, doors and pipe penetrations can keep out unwanted drafts. The whole structure should be wrapped with housewrap that is overlapped and taped at the seams.

The 50-Year (Plus) Roof

Select roofing materials that you will never have to replace in your lifetime (unless you outlive the rest of us). A good place to start is looking at the product warranty. Use 50 years as a benchmark. If a shingle or tile won't offer that promise, look elsewhere! For example, cement-based roof tiles from Boral should last for 50 years or more. At the same time, they promise to reduce heat gain in attic areas, saving energy on cooling.

PRO TIP:

Opt for Durability. Tough, low-maintenance materials won't need frequent painting or replacement. Side with fiber cement, cedar, brick veneer or other long-lived products. Build decks and patios with recycled plastic composites or long-lasting wood species.

Go Solar

The price of solar electric panels keeps dropping. Even if you don't install solar panels now, put in the wiring infrastructure for later. Many homes can quickly pay off a solar hot water system. You may want to start with that technology as you explore solar options.

Clear the Air

When you make a house "tighter," you MUST pay close attention to how much air moves throughout the home, along with expelling pollutants and excessive moisture. All kitchen ranges should be equipped with quiet range hoods, without exception. Bathrooms should include ventilation fans. If your home is very tight, you may need to involve a Heat Recovery Ventilator (HRV) in cold climates, or an Energy Recovery Ventilator (ERV) in hot ones. These devices exchange fresh air with stale air—yet don't waste the energy already used to heat or cool air indoors.

Farm Your Lot

Lawns are yesterday's approach to landscaping. Plant low-water native plants and use local stone and natural materials for hardscapes. Consider planting edible plants and herbs to further increase sustainability.

THE BIG 3:

LOCATE for Living

Studies have shown that some families consume as much energy commuting by car as they do in their homes! Build close to where you work, shop and play, and do your part to reduce carbon emissions.



SITE for Solar

Your home's relation to the sun will influence its performance for its entire lifespan. Take advantage of southern exposures with passive solar, but keep the heat out with overhangs in hot climates.



SIZE Modestly

When you double a home's size, you often triple its energy use. Build only as much space as you really need, and use it cleverly. Small, well designed homes are the way of the future.



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THINK GREEN®

Exteriors 01

Low maintenance with outdoor options.

The exterior of your house isn't just about good looks—it's important to think long term.

SIDING CHOICES ABOUND for today's homes. Aesthetics are important when choosing one option over another, and when you take the environment into account, some choices just look a whole lot better than others. According to research from the Freedonia Group (www.freedoniagroup.com), fiber cement, stucco and brick siding will see rapid advances through 2014. Vinyl siding will remain the largest segment. Although long lasting, it's a controversial material made with polyvinyl chloride (PVC), a plastic that until recently has had a poor recycling record. At least one company (CertainTeed) has now begun to recycle vinyl, and the industry is beginning to look more closely at vinyl's life-cycle impacts. We haven't included it here as a "green" option, but we will continue to monitor the industry's efforts to move in that direction.

BRICK

A Durability Leader

Made of clay and shale, brick is very durable. It is a solid barrier against weather, and the installation of brick creates a 1" air space

Virtues

- Recyclable
- Durable
- Resists termites, fire, mold and rot
- Made from abundant natural materials
- Low maintenance

Caveats

- Resources must be mined
- Not all brick manufacturers have taken steps to reduce emissions from their manufacturing plants
- Expensive
- Heavy weight

Why Pay More for Brick?

Because they last almost forever.

Bricks come in many colors, textures and other variations. Approximately 3" thick, brick veneer (Boral Bricks are shown) creates an armored shell for your home. The durability of brick is one of its greatest assets. Boral, for example, offers a "two lifetimes" warranty. More info:

www.boralbricks.com



between the brick and the interior housewrap. This provides insulation against temperature transfer and the transfer of sound, and it also prevents moisture from seeping into the home. Because of its thickness, brick provides thermal mass, making it slow to heat in the summer and slow to cool in the winter, which helps regulate a home's temperature.

Manufacturers such as Boral Bricks are making brick manufacturing less environmentally caustic. The company recycles waste and uses air scrubbers to make sure emissions from plants are clean and particulate-free.

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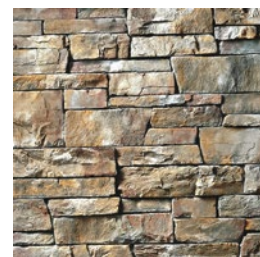


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SmartSide products deliver the warmth and beauty of traditional wood, plus the durability and workability of engineered wood. The manufacturing process creates products that are engineered for strength, performance and protection against fungal decay and termites. Four product collections are offered, with a 5/50-year transferable limited warranty. www.lpcorp.com/smartside

Cultured Stone Southern LedgeStone

Available in many shades and variations, this line of stone masonry veneer from Cultured Stone is easy to install, and offers a durable, timeless finish for exteriors. Made with 54 percent recycled content, it comes with a limited 50-year warranty. www.boralna.com



What makes an **EXTERIOR** green?

Outdoor Living

Areas such as covered patios can save energy. How? By encouraging outdoor activities that reduce demand for lighting, heating and cooling inside the home.

Durable Materials

Spend a little more on long-lasting siding materials such as cement stucco, stone or brick veneer or fiber cement, and you can reduce your long-term environmental footprint. Most paints and finishes are extremely resource intensive, (not to mention labor). If you do use wood for trim or siding, choose a long-lasting, sustainably harvested species such as cedar. Look for products with at least a 50-year warranty.

PRO TIP:

Even if you don't plan to install solar hot water or solar electricity now, if you pre-wire for it when building or remodeling, you can save yourself thousands down the road—and increase your resale value.

Solar Window Orientation

In cold climates, south-facing windows capture the sun's heat during the day. Be sure to specify high-performance windows with special glazings and gas-filled cavities. Otherwise, you may lose more heat at night than you gain during the day.

Seasonal Overhangs

When carefully planned, roof overhangs not only shade windows in summer months—they also protect siding from water damage over many years.

Natural/Edible Landscaping

Traditional monoculture lawns are not a sustainable choice. Opt for native, drought-resistant plants. Better yet, practice small-scale food production, using permaculture or other gardening techniques.

WOOD

Green to the Core

Wood siding is an excellent green choice (not to mention beautiful). Although people think of wood as a valuable natural resource we shouldn't use, it is a renewable product that can be recycled, and, if it goes into the waste stream, biodegrades quickly. If you use wood siding, look for certification by either the Sustainable Forest Initiative (SFI) or the Forest Stewardship Council (FSC).

Wood products don't require a lot of energy to produce—when compared with brick or fiber cement siding. In fact, although wood makes up nearly half of all raw materials manufactured in the United States, its share of energy consumption is a small 4%.

In addition to new wood siding, you can buy reclaimed wood, though more people opt for pre-primed pine or weather-resistant cedar.

Virtues

- Renewable
- Recyclable
- Little energy used in its "production"
- Biodegrades quickly in a landfill

Caveats

- Not perfectly straight, which can cause install problems
- Attracts pests like carpenter ants and termites
- Doesn't offer insulative benefits (R-1)
- Requires maintenance, and can shrink and expand
- Can be twice as expensive as engineered wood or fiber cement

ENGINEERED WOOD

Most Improved

For people who like the look of wood, engineered wood products are a good green option. They are made from wood strands that are coated with a resin binder and compressed to create a strong board. The products look like wood. They are free of knots, resist warping and cupping, and are factory pre-primed to take paint well, which reduces field and labor time once installed.

LP *SmartSide Trim & Siding*, as one example, offers a special manufacturing process that helps protect against termite damage

Virtues

- Product is straighter than wood siding
- Superior stability keeps the building envelope crack-free
- Lower cost than wood
- Low-maintenance product; may hold stain or paint for for several years longer than wood (7–15 years)
- Won't rot, buckle or warp

Caveats

- Heavier than most sidings, and can crack
- Negligible R-value
- High embodied energy because of manufacturing process
- Moisture problems can result from installation errors
- Requires special safety training and special gear to protect against airborne silica—and specific cutting tools

Glossary of Terms

Know the Lingo

- **Exterior Insulation Finish System (EIFS):** A building product that provides exterior walls with an insulated finished surface and waterproofing in an integrated composite material system.
- **Embodied Energy:** The energy consumed by all of the processes associated with the production of a building, from the acquisition of natural resources to product delivery.
- **Engineered Wood:** Cladding made from wood strands that are coated with a resin binder and compressed to create a strong board.
- **Fiber Cement Siding:** Cladding made from a mixture of Portland cement, cellulose or wood fiber material, sand and other components.
- **Lap Siding:** Siding that looks like individual boards, typically 8'–12' long. Each piece of siding is lapped over the piece below it to provide a waterproof covering for the house.
- **Portland Cement:** Found in stucco and fiber cement siding, it requires intense heat (and thus energy) to produce.

and fungal decay. The product also comes with a self-aligning edge design to make installation faster and easier. Another engineered product, KlipTech's *EcoClad* is made from bamboo fibers, recycled paper and recycled wood fiber. According to its manufacturer, it is as durable as brick or stucco, and resists bacteria and fungus growth. Look for engineered wood products that are certified.

FIBER CEMENT

Tough Stuff

Fiber cement siding is a low-maintenance product made from sand, Portland cement, clay and wood pulp fibers. It's very strong, long-lasting, termite-proof, fire-resistant and rot-proof. The product has the look of wood siding, and comes in either a smooth or wood-look finish.

The rub against fiber cement is its high embodied energy, though manufacturers are moving toward using more recycled content in their products. At least one brand contains fly ash.

For extra R-value, fiber cement siding can be installed over foam insulation board, as on an ICF house, but caution must be taken to ensure proper installation. If you decide to go this route, follow manufacturers' recommendations closely. **GB**

Virtues

- Lighter weight than fiber cement or brick
- No special cutting tools or fasteners are required—takes nails and screws

- Factory pre-primed
- Less costly than real wood

Caveats

- Moisture problems can result from installation errors

Roofing 02

Start at the top.

21

The roof is a home's first line of defense against the elements. Replacing or repairing it is a resource intensive, costly process. Why not get it right the first time?

IT WASN'T LONG ago that roofing wasn't much more than an afterthought, chosen for a house mostly for economic and occasionally for aesthetic reasons—if you could afford it.

But lately, roofing is recognized among the materials that can make a significant difference in a home's energy and resource efficiency, spurring debate (and propaganda) about issues ranging from recycled content and recyclability to reflective values and durability—all of which work into a thoughtful consideration of which roofing material makes the most sense for your house.

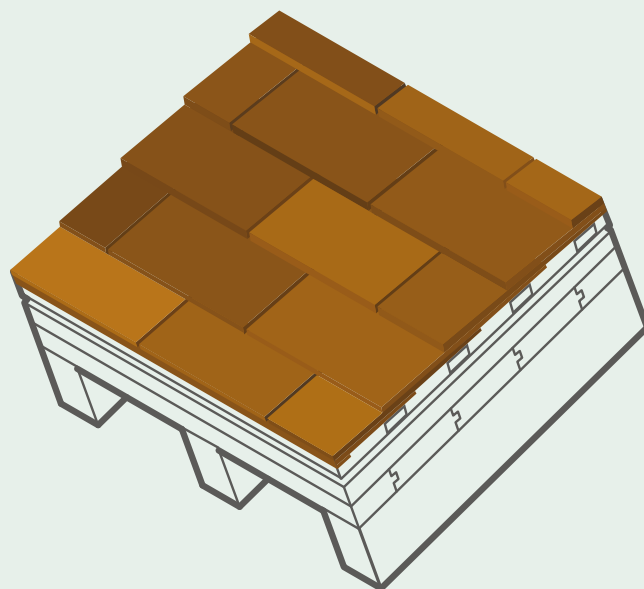
ASPHALT

Cool Roof Shingles

Commanding an 83% share of the residential roofing market is no accident. Asphalt composition roofing (right), includes conventional three-tab and newer, thicker fiberglass and laminated types. These products offer affordable options generally designed to last a maximum of about 25 years.

Asphalt's biggest environmental bugaboo is that it's derived from petroleum processing, feeding fossil fuel demand. It's also tough to recycle. But the industry has responded to the call for better eco-performance with colors and granular formations that better reflect the sun's heat, reducing the amount that is absorbed into the roof and attic or living spaces below, and

Asphalt Composition Roofing



Virtues

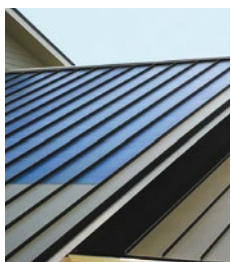
- Affordable and widely available
- Familiar to installers
- New Finishes increase heat reflection

Caveats

- Petroleum by-product
- Low recycling potential
- Relatively short lifespan
- May leach chemicals into runoff

reducing demand on the home's heating system—and therefore the energy it consumes.

Recent “cool roof” asphalt composition shingle offerings, in fact, *continued on next page*



Custom-Bilt Metals Roofing

The *FusionSolar* series from Custom-Bilt Metals combines a durable standing-seam metal roof panel system with factory-applied thin-film solar laminate collectors for integrated renewable energy generation. Solar collectors require no fasteners or additional structure; several compatible heavy-gauge roof profiles available.

www.custombiltmetals.com



Gaf Timberline Cool Roof

Timberline Cool Series fiberglass-asphalt shingles from GAF feature reflective surface granules to reduce attic heat gain and cooling energy use. The Energy Star-qualified shingles also contain patented algae protection with a 10-year warranty.

www.gaf.com

have achieved federal Energy Star status for their reflective values, helping reduce peak cooling demand by up to 15%. At the same time, cooler shingles last longer, so they've increased their likely service life.

METAL

Decades of Performance

Set aside any visions of cheap tin roofs. Today's metal roofing—most of it made from recycled steel—is a lot tougher and aesthetically appealing than the corrugated sections that shelter shacks and barns.

That said, metal roofing (right) still makes a distinct fashion statement. Long rows of sleek metal, separated by slight ridges (called standing seam) are a departure from tiles and shingles. Metal's market share in single-family housing has more than tripled (to 7%) since 2004.

That's partly because metal roofing has a strong environmental story, when you consider the amount of recycled steel it contains, its durability (usually 50 years or longer), and the fact that the material can be 100% recycled at end of life.

More recently, the metal roofing industry has introduced cool roof finishes that reflect the sun's infrared light to reduce heat absorption into the structure by as much as 36%; some manufacturers have also partnered with thin-film solar electric suppliers to create integrated solar arrays within the panel channels, to generate renewable energy.

The industry has also expanded its styling, forming, and coloring panels to simulate curved clay tiles or individual shingle shapes, for a broader range of housing styles.

WOOD

Natural, to a Point

Wood shingles and shakes are the only roofing material that can claim to come from a renewable resource (trees), although it's important to find out how and where that timber is harvested. A wood roof can easily last 50 years if installed and maintained properly. Wood shingles applied over a vented roof deck will remain cooler, dry out faster, and generally last longer.

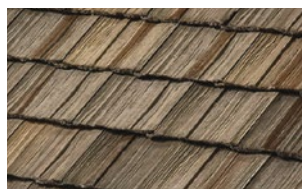
Wood's only serious drawback is its inherent flammability and susceptibility to moisture-related damage over the years. Because of these qualities, fire- and rot-resistant chemical finishes are often applied—and may need to be re-applied in later years.

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VISION HOUSE® TUCSON PRODUCT

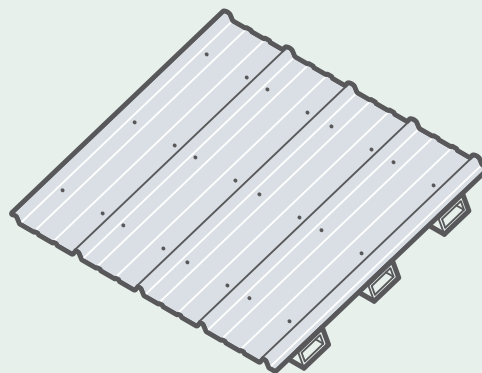
Boral Madera 900 Concrete Tile Roofing

This energy-efficient, lightweight cool roof system keeps a home cooler than a typical tile roof. The tile not only reflects the sun, but also helps hot air rise and vent out. The tiles also last longer than a traditional roof. The style shown is *Autumnwood*.



www.boralna.com/rooftiles/rooftiles.asp

Metal Roofing



Virtues

- High durability
- Infrared finishes reflect heat
- High recycled content
- 100% recyclable
- Fireproof

Caveats

- Higher initial cost
- Susceptible to impact or walking damage
- Colors may fade

Glossary of Terms

Know the Lingo

- **Deck:** The substrate over which roofing is applied. Usually plywood, wood boards or planks.
- **Drip Edge:** An installed lip that keeps shingles up off the deck at edges, and extends shingles out over eaves and gutters to prevent water from wicking up and under the shingles.
- **Exposure:** The area on any roofing material that is left exposed to the elements.
- **Flashing:** Materials used to waterproof a roof around any projections.
- **Granules:** Crushed rock that is coated with a ceramic coating and fired, used as top surface on shingles.
- **Ice Dam:** Formed when snow melts on a roof and re-freezes at the eave areas. Ice dams force water to "back up" under shingles and cause leakage.
- **Laminated Shingles:** Asphalt-based shingles made from two separate pieces that are laminated together. Also called dimensional shingles or architectural shingles.
- **Soffit Ventilation:** Intake ventilation installed under the eaves or at the roof edge.
- **Steep-Slope Roofing:** Refers to slopes steeper than a 4" rise for every 12" of length (expressed as 4:12).
- **Tear-Off:** Removal of existing roofing materials down to the roof deck.
- **Valleys:** Areas where two adjoining sloped roof planes intersect on a roof, creating a "V"-shaped depression.

SOURCE: GAF MATERIALS CORP.

What's a GREEN roof?

You've probably heard of green roofs. In the past couple of years these multi-layered systems have begun to be taken seriously, particularly in urban settings. Especially suited for buildings with flat roofs, such as multifamily apartments, they create welcoming spaces far above the street, reduce heating and cooling costs in a building, and can be used to grow edibles as well. If you're interested in a green roof, consult a local company that specializes in their construction. They can assess your building's structural suitability and make recommendations. For general information, try www.greenroofs.org.

- Plant Material
- Stone Mulch
- Soil Mix
- Drainage Board
- Insulation Board
- Waterproofing Assembly
- Concrete Roof Deck



IMAGE: BRIAN DAVIS: NOAA



Outbuilding Garden.

Garages and sheds are often an easy way to introduce roof gardening to your property.

PHOTO: GREENROOFS.COM

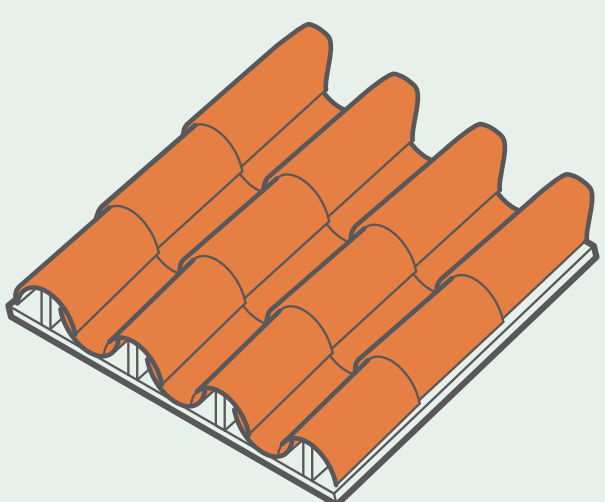
CLAY/CONCRETE

Almost Forever

Clay or concrete roof tiles (right) would appear to have it all: good looks, fire resistance and extreme durability. Recent innovations also address issues of stormwater management, and enable cool roof capability. But the high cost of buying and installing masonry tile roofing has relegated its use to regional styles and high-end housing. Since 2004, its share of the residential roofing market has plummeted by more than half, to about 7%.

Nonetheless, a quality tile roof that is installed over a heavy-duty underlayment and screwed to the roof deck (not just mortared) should last for decades—if not a century or two—before it's time to remove them, replace the underlayment, and put the tiles back on. **GB**

Clay or Concrete Tile



Virtues

- Durable
- Abundant resource and low embodied energy
- Natural insulating qualities
- Class A fire rating

Caveats

- High cost (materials and installation)
- Heavy
- Some types may be susceptible to freeze-thaw damage

Wood Roofing



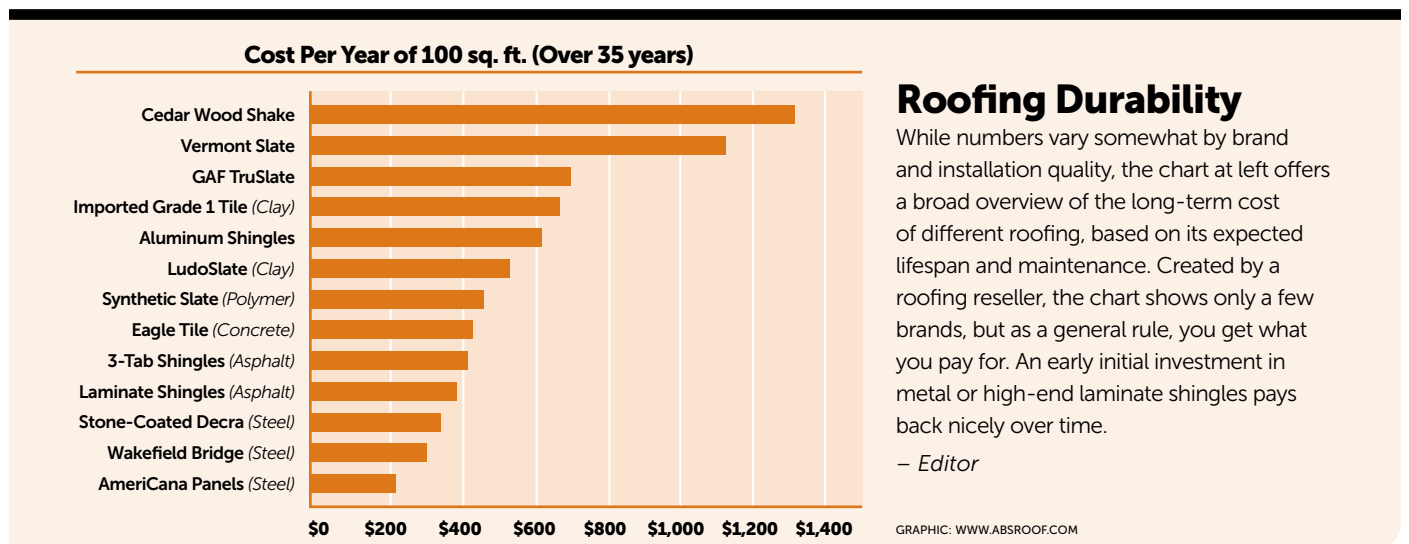
Virtues

- Renewable
- Some natural rot resistance
- High natural insulating value
- 100% recyclable and biodegradable

Caveats

- High cost (materials and installation)
- Flammable
- Requires chemical treatment for fire safety and durability

If you're planning on rainwater harvesting, a smooth, non-leaching surface may be best.



Structure 03

More than just sticks and bricks.

Before you build a new home or add an addition to your current house, size up your structural options. Each has ecological and economic pros and cons.

WHILE WOOD FRAMING is the most common and familiar type of home structure, you have other options, including insulating concrete forms (ICFs), structural insulated panels (SIPs) and lightweight concrete blocks. Of course, if you're adventurous, many other systems have been around for decades, including log homes, straw bale, cordwood and even Earthships. Not every method of construction may be right for your geography, but most technologies can be modified to accommodate your taste and your region. For the purposes of this primer, however, let's stick to the structural systems your builder is most likely to know and understand.

WOOD FRAMING

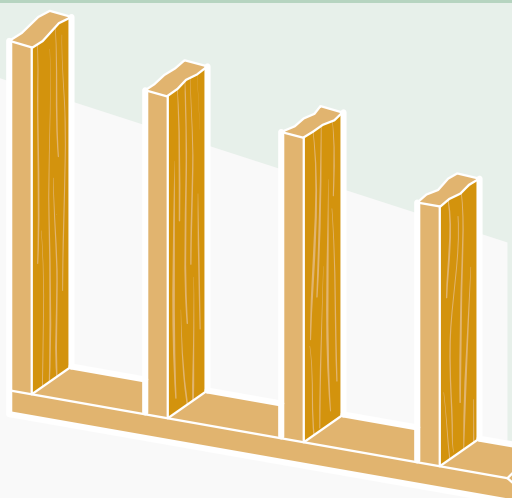
Old and New

Wood, by its very nature, is a green product. If forests are managed properly, trees grow back. How do you know if forests are being treated with respect? Look for lumber that is certified by the Forest Stewardship Council (www.fsc.org) or the Sustainable Forestry Initiative (www.sfiprogram.org). Typically, energy-efficient builders prefer 2"x6" lumber for vertical studs in wall cavities, because the wider space allows for more insulation.

Another more recent wood framing technology is called engineered wood products (EWP). Products such as studs and joists are created in a factory with special water-resistant glues and fibers from leftover mill lumber or fast-growing tree species. They are pressed and glued into lightweight floor joists, rafters or other structural pieces. The green advantages? First, engineered products use more of the tree—there's virtually no waste. Second, they tend to be more stable and straight than dimensional lumber. The downside? Certain products need to be stored carefully and installed exactly as intended, or they can lose their structural integrity.

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Dimensional Lumber



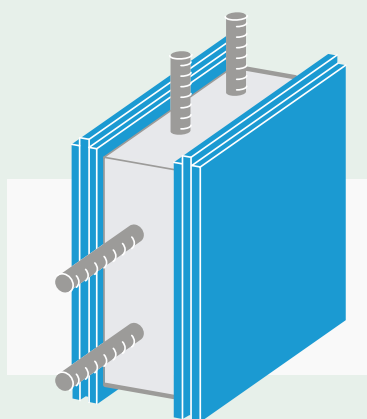
Virtues

- Renewable (if forest is well managed)
- Familiar to contractors
- Excellent durability

Caveats

- May create unwanted thermal bridging
- Requires skilled labor

Insulating Concrete Forms



Virtues

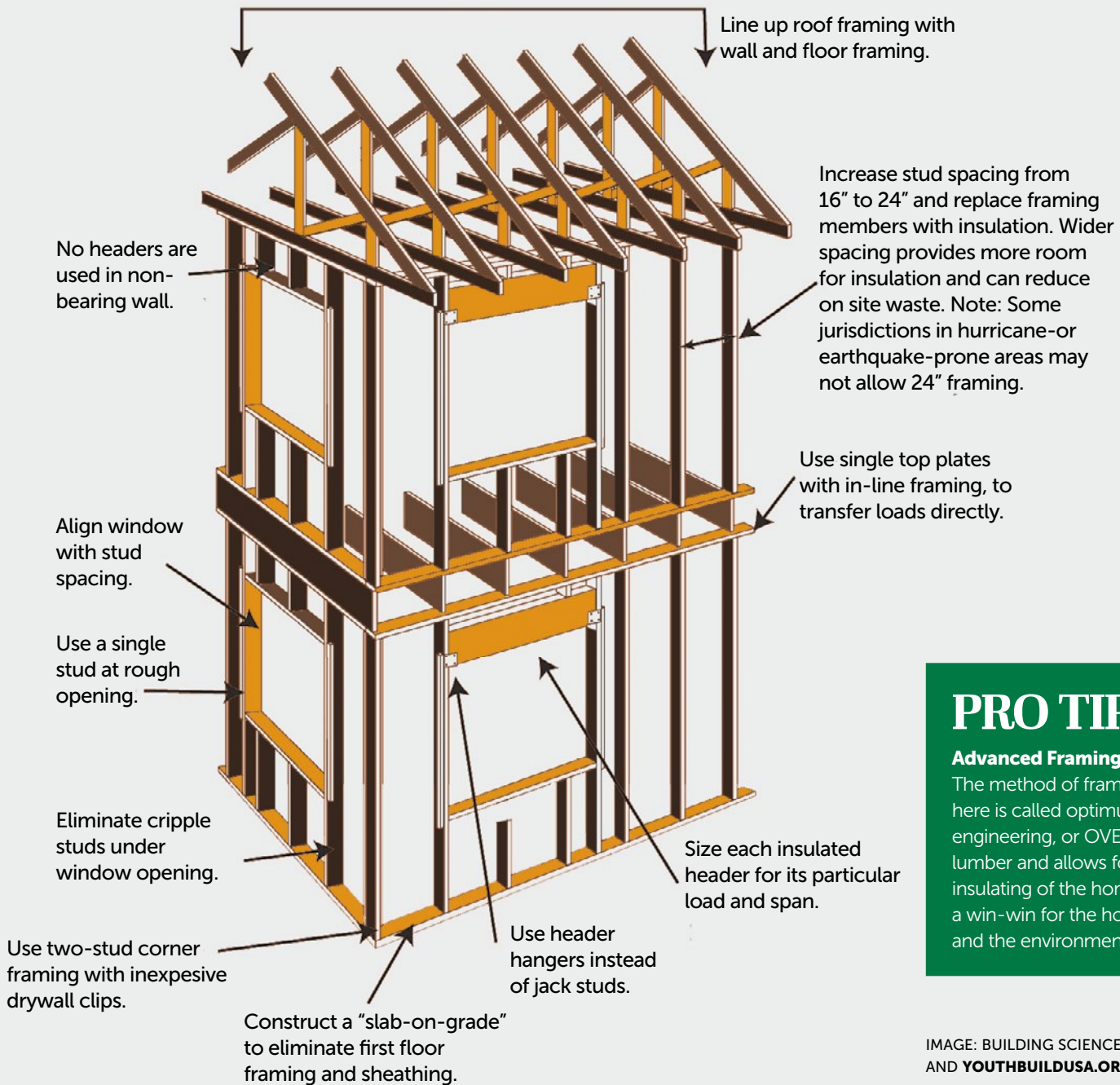
- Very little air infiltration
- Lightweight forms assemble easily
- Thermal mass of concrete slows temperature swings

Caveats

- Exposed foam may need protection
- Some brands require additional furring strips to attach drywall and siding

What makes FRAMING green?

Use a two-foot modular construction. A building design based on two-foot increments makes sizing more predictable and framing easier to install. It also minimizes the amount of waste produced when cutting framing materials.

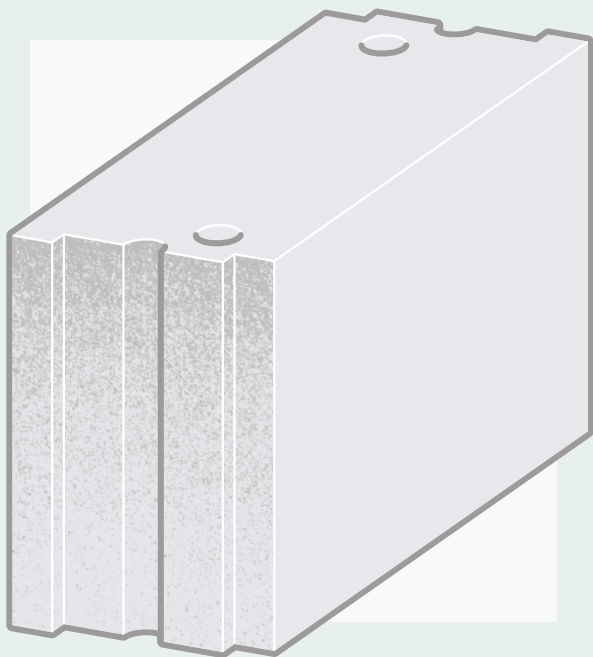


PRO TIP:

Advanced Framing:

The method of framing shown here is called optimum value engineering, or OVE. It saves lumber and allows for better insulating of the home—a win-win for the homeowner and the environment.

Lightweight Concrete Blocks



Virtues

- Easy to handle
- Less energy intensive than concrete
- Durable and termite proof

Caveats

- May not be locally manufactured
- Contractors/masons may need training
- Waste components should be tested/verified

INSULATING CONCRETE FORMS

Light and Tight

Poured concrete walls alone have very little insulating value. Yet concrete can last forever, or nearly so, if it's protected from erratic moisture changes and freeze-thaw cycles. That's what makes ICFs an excellent structural system. They enclose both sides of a poured cement wall within a water-resistant cocoon of rigid foam. Another advantage to ICFs is that their assembly is quite simple, and the completed walls have an average insulating value of about R-22.



R-Control SIPs

Made with OSB laminated to a termite-resistant EPS insulation core, R-Control SIPs are state-of-the-art. The core is also treated with EPA-approved mold resistance. A 6 1/2" panel is a respectable R-23. www.r-control.com

Glossary of Terms Know the Lingo

- **Dimensional Lumber:** Wood that has been cut and shaped from a single tree, typically used for framing.
- **Load-Bearing Wall:** A wall that helps hold up the house. Interior walls may not be load bearing, but external ones almost always are.
- **Engineered Wood Products (EWP):** Structural products made in the factory from industrial wood scrap or fast-growing species, assembled with resins under extreme pressure.
- **Oriented Strand Board (OSB):** A type of engineered wood panel. The thickness of OSB used in most SIPs is 7/16".
- **Fly Ash:** Controversial waste by-product from coal-fired power plants. Used as a filler in some—but not all—brands of lightweight concrete blocks.
- **Sound Transmission Class (STC):** Refers to how well a wall partition attenuates sound. Products such as ICFs have high STC ratings and greatly reduce noise levels inside the home.

LIGHTWEIGHT CONCRETE BLOCKS

Lasting Value

Lightweight concrete is a structural material that's been around since at least the 1920s. To create these blocks, the manufacturer replaces a portion of the concrete with something lighter and better insulating, such as an industrial waste product like fly ash or petroleum-based polystyrene. Some companies such as Cresco Concrete, creator of *Liteblok* (www.crescoconcrete.com) use a temporary agent that leaves nothing but air gaps behind. If a product does include fly ash make sure the manufacturer provides data showing that they have carefully tested and screened the material to keep heavy metals and other toxins out of the end product.

STRUCTURAL INSULATED PANELS

Many Strengths

The concept here is simple. Two sturdy panels—typically oriented strand board (OSB)—are glued under pressure to a super insulating layer of plastic-based rigid foam (either polystyrene

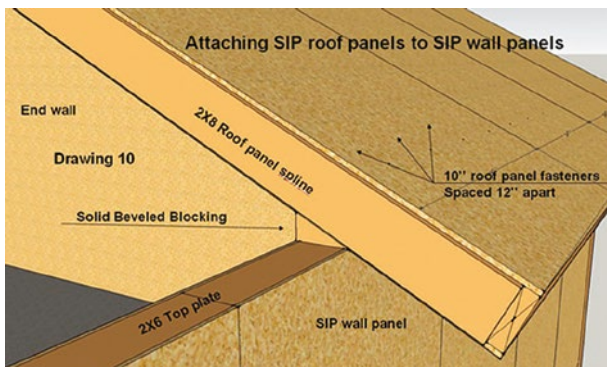


Boise Cascade Conditioned Airspace HVAC Framing

Boise Cascade's new framing system keeps mechanicals in conditioned space, removing a major source of household energy waste. A slick suite of software creates a custom plan for your project. www.bc.com

or polyisocyanurate). SIPs address air infiltration, R-value and vapor permeability, while at the same time creating the home's structure, and providing a nailing surface for siding and drywall. So why aren't they seen everywhere? Because they tend to cost more up front than stick framing, and aren't widely understood by contractors. But if you figure in the benefits in labor savings (up to 60% in some cases), plus the ongoing energy payback to homeowners, you can argue that SIPs come out on par with or lower in cost than wood framing. **GB**

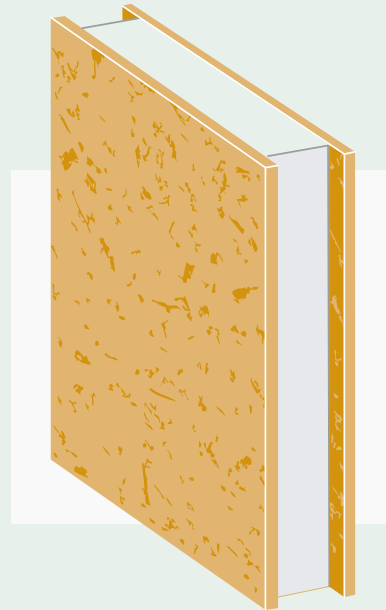
SIPs on the Roof?



The point where wall panels connect to an SIP roof is one of the trickier details when building a complete home shell with these pre-made panels. Get it right, and you'll have a super-strong, super-insulated structure.

IMAGE: WWW.THERMALSHHELLHOMES.COM

Structural Insulated Panels



Virtues

- Reduces labor time/cost up to 60%
- Excellent insulating and air infiltration barrier

Caveats

- Storage on site must be dry and flat
- More expensive material costs than stick framing
- Skilled installation recommended (for the wall to roof transition especially)

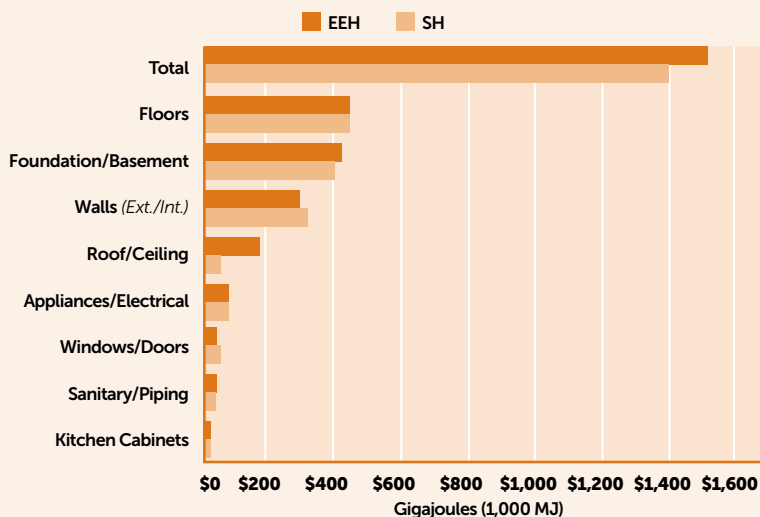


LP Solidstart I-joists

The wood used to create these sturdy engineered joists comes from small, fast-growing trees, not old growth timber, and the resins used contain no urea formaldehyde. The product is available in long lengths, and can be a major labor saver.

www.lpcorp.com

Study: Embodied Energy in the Home



Materials with higher embodied energy need to last longer to justify their cost to the environment. This study from the University of Michigan compared an energy-efficient house (EEH) with a standard house (SH)—and measured the energy costs for construction, maintenance and improvement of a home within a 50-year lifespan. The EEH does slightly better on these measurements, but greater savings (not shown) will come from energy savings in the more efficient structure.

– Editor

SOURCE: WWW.UMICH.EDU

Insulation 04

Without it, you can only lose (energy).

The cost of heating or cooling your home is probably your biggest energy expense. A one-time investment in insulation will save you money every year, and will also keep out unwanted noise.

IF YOU'VE EVER opened up the wall of a home built before about 1950, you've probably been shocked to find little or no insulation—or at best some crumpled newspapers. And even the earliest serious attempts at insulation with fiberglass look quaint now. Cavities were often only partially filled. Water from outside often leaked in around windows and doors and damaged the insulation. Of course, homes were so leaky prior to the 1960s that walls dried out quickly, so mold wasn't a big problem. The rules of the game are very different today. Homes are built tight—with no tolerance for sloppy insulating.

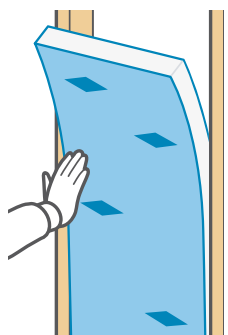
Building scientists (a new breed of experts) now have a deep understanding of how insulation works. They've learned that factors such as air infiltration, dampness and age can dramatically affect performance.

But they also recognize that insulation is part of an energy saving system, not a standalone solution. Good results can be achieved with any insulating material, if it's combined with the right housewraps, tapes and construction details. Here's an overview of the latest advances in insulation technology.

FIBERGLASS

Installer Friendly

Fiberglass insulation in batt form is probably the most familiar insulating product. Changes in recent years have affected the



Fiberglass Insulation Virtues

- Renewable and recyclable
- Familiar to contractors
- Field proven for decades

Caveats

- Requires careful installation
- May need an additional air infiltration barrier

Glossary of Terms

Know the Lingo

- **R-Value:** A measure of how effectively a material resists heat flow. Thus, higher numbers are better. For a full list comparing various types of insulation, visit www.coloradoenergy.org.
- **Batt:** A length of insulation that is precut to fit certain wall cavity dimensions. Typically sold in a pre-packaged roll.
- **Unfaced/Faced Insulation:** Faced insulation (typically a fiberglass batt) includes a vapor retarder on the interior face that restricts movement of moist air into wall cavities. Unfaced is simply a batt without a vapor retarder.
- **Ridge Vent:** An opening covered by a rainproof vent that follows the peak of the roof, typically required by code. Some insulating methods, however, negate the need for a ridge vent. Clear it with your local code official first.
- **Blow-In:** Method of introducing loose fiberglass, cellulose or mineral wool to framing cavities or attic space, typically using a machine with an attached hose.
- **Blower Door:** Equipment used to test the effectiveness of a home's insulation and air sealing systems.
- **Stud Cavity:** The space between the vertical members of a conventionally framed wood or lightweight steel home. Common stud spacings include 16" and 24" on center (of stud).

composition of chemical binders that hold the product together, along with the size of the glass fibers. Many brands have removed or reduced toxins such as formaldehyde from their products. Some of the largest manufacturers of fiberglass products now offer hybrid systems that include an air-sealing component. They have improved the performance and handling of blown-in fiberglass, and added to the percentage of recycled content in all product lines (up to 40%).

SPRAY FOAM

Filling Every Void

Insulating walls and ceilings with spray foam is relatively expensive, typically more than twice the cost of fiberglass batts, and most often it's a job best handled by pros. Why is foam green? Not because of what's in it. Even the most eco-friendly brands replace only a small percentage of their petroleum-based

continued on page 31

What makes INSULATION green?

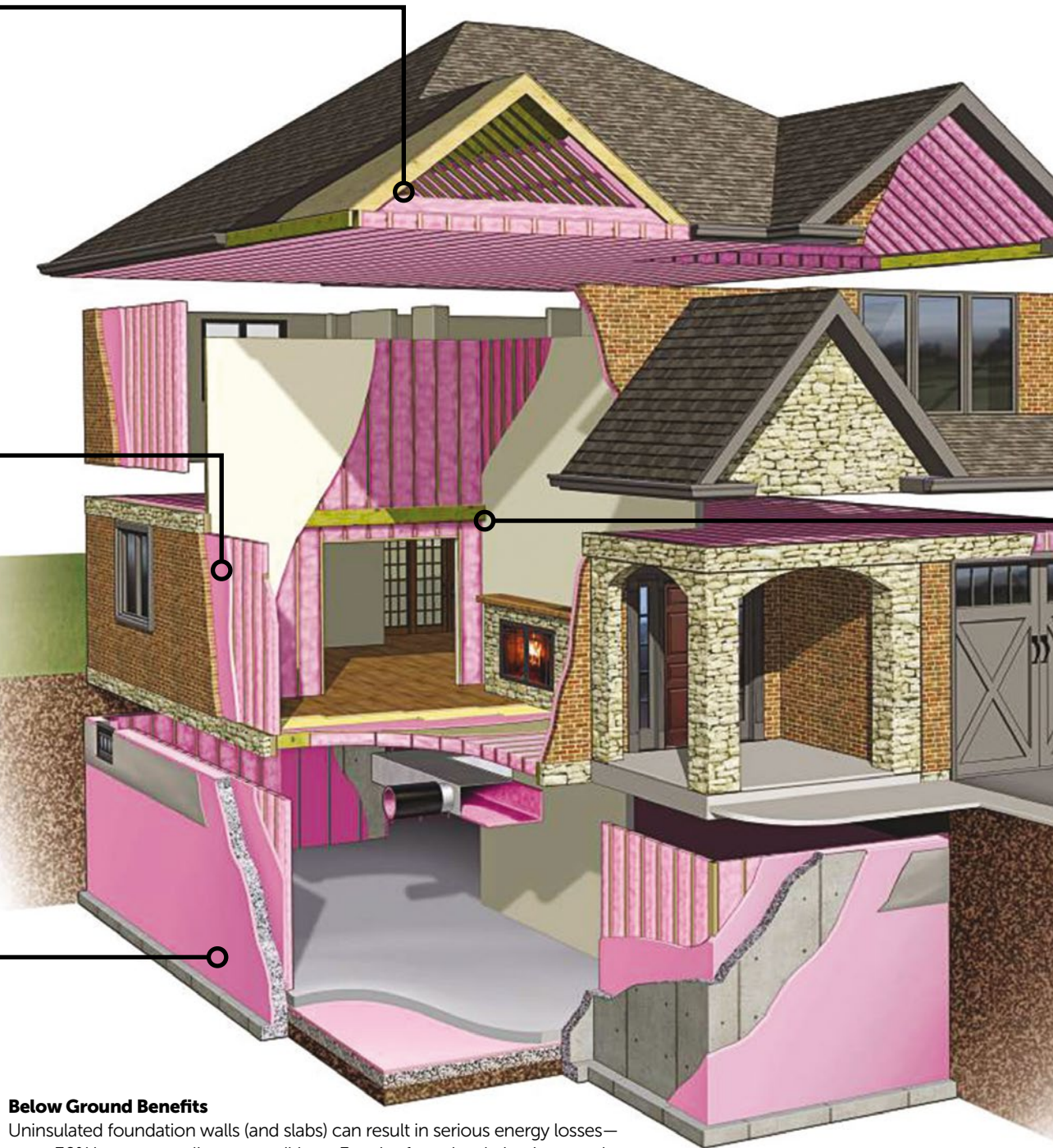
Hats and Batts

Insulating attic space is relatively easy and offers immediate payoff in both the home's comfort and reduced energy bills. Think of attic (or rafter) insulation as a thermal "hat" for your home, keeping warm (or cool) air from escaping out the top. Also, not every roof needs venting, although some building codes require it. New research shows that unvented attics can be highly efficient, if designed and insulated properly.



Double Defense

To maximize the R-value of walls, consider using a "hybrid" insulation system, combining two or more types of insulation. Think of walls as a "system." You might combine foam board and insulating batts, or incorporate products such as *EnergyComplete Sealant* (www.ocenergycomplete.com), which is part of a whole-home insulation and air sealing system from Owens Corning, designed to help increase a home's overall comfort and energy efficiency.



Below Ground Benefits

Uninsulated foundation walls (and slabs) can result in serious energy losses—up to 30% in extreme climate conditions. Exterior foam insulation is a good choice in new construction. It not only insulates, but reduces moisture transfer from outside to inside the home. For retrofitting, foam or fiberglass batts can be placed on interior walls.

Interior Control

Many new homes include interior wall insulation—in part because it makes walls more soundproof. But it also has energy advantages. It allows you to “zone” different parts of the home so that only the areas of the home being used are fully heated or cooled.

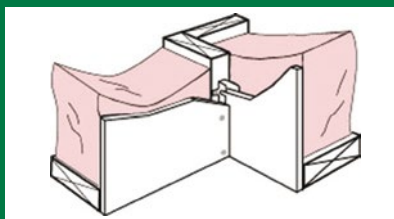
Rim Armor

The point where the first floor of a home meets the second has historically been tough to insulate. New products and systems include this part of the house in the insulated envelope, greatly reducing energy loss.

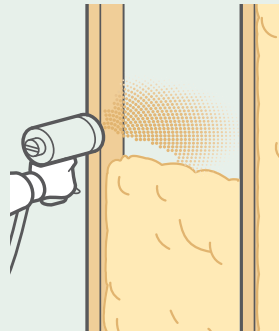
IMAGE COURTESY OF OWENS CORNING (WWW.OWENSCORNING.COM). THE COLOR PINK IS A REGISTERED TRADEMARK OF OWENS CORNING; TEXT BY GREEN BUILDER STAFF

PRO TIP:

Clip It. Corners are one of the toughest parts of a structure to insulate. You can allow for more insulating at corners by using drywall clips on the inside walls. These effectively remove an unnecessary piece of lumber. Image: Oikos.com



Spray Foam Insulation



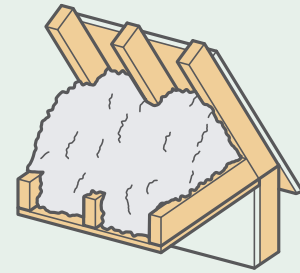
Virtues

- Fills gaps and cavities completely
- Provides its own air barrier
- High R-value per inch

Caveats

- More expensive than competing products
- Requires special equipment/skills to install

Cellulose Insulation



Virtues

- High percent of recycled content
- Little or no toxic offgassing
- Relatively easy to install

Caveats

- Must be installed carefully to fill all gaps
- Wet products can be problematic if not allowed to dry properly

chemical mix with biological products such as soy. But the energy performance of foam is hard to beat. Some brands offer insulating value of more than R-6 per inch, at the same time sealing against air infiltration. This makes spray foam a dual-duty system, ideal for both new and retrofit construction.

CELLULOSE

Paper Trail

Cellulose has a good green story to tell, especially from the manufacturing side. It's made primarily with recycled paper, typically newspapers, and most brands are treated with boric acid as a fire retardant. Research on the health effects of boric acid suggest that it is a minor irritant in small doses. Cellulose can be installed wet or dry. If installed wet, it should be allowed to dry properly before covering with drywall (typically less than 48 hours). The insulating value of cellulose is about the same as blown fiber glass (roughly R-3.7 per inch).

MINERAL WOOL

Nothing to Burn

Although mineral wool looks like fiberglass, it's made from basalt rock and slag, not glass. The resulting product, either batts or loose fill, is non-flammable, requiring no chemical flame retardants. As a result, offgassing emissions tend to be low. Mineral wool includes high levels of post-industrial recycled content waste (up to 90%), reducing the environmental impact of its production.

continued on next page

RIGID FOAM

Water Resistive

You may have seen contractors in your area putting green or blue insulation right over the wood siding of an old house. Chances are, they're applying extruded expanded polystyrene (XEPS) or polyisocyanurate closed cell foam. Both products are dense and durable. Some building experts suggest that foam used this way can act as water resistive barriers (WRBs), negating the need for housewrap, but we recommend playing it safe and using housewrap as well. Rigid foam also is a good choice for insulating basement walls. **GB**



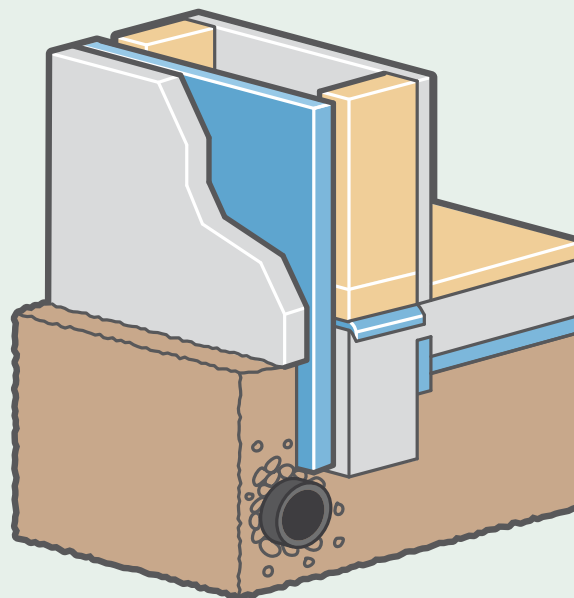
VISION HOUSE® TUCSON PRODUCT

JM Climate Pro

A premium alternative to cellulose, JM's *Climate Pro* is a formaldehyde-free blow-in loose-fill fiber glass insulation that can be blown into attics and hard to reach spaces. It provides better indoor air quality, outstanding thermal and acoustical performance, healthier and safer buildings and contains an average of 25% recycled content—including at least 20% post-consumer recycled glass.

www.specjm.com/sustainable.asp

Rigid Foam Insulation



Virtues

- High R-value per inch
- Seals against air infiltration
- Good solution for basement walls

Caveats

- Some brands may shrink over time
- Producing synthetic foam is a resource-intensive process

Insulation R-Values (per inch)

Type of Insulation	R-VALUE
Fiberglass (<i>batt</i>)	3.14
Fiberglass (<i>blown-attic</i>)	2.2
Fiberglass (<i>blown-wall</i>)	3.2
Rock Wool (<i>batt</i>)	3.14
Rock Wool (<i>blown-attic</i>)	3.1
Rock Wool (<i>blown-wall</i>)	3.03
Cellulose (<i>blown-attic</i>)	3.13
Cellulose (<i>blown-wall</i>)	3.7
Vermiculite	2.13
Air-Entrained Concrete	3.9
Urea Terpolymer Foam	4.48
Rigid Fiberglass (<i>>4lb/ft³</i>)	4
Expanded Polystyrene (<i>beadboard</i>)	4
Extruded Polystyrene	5
Polyurethane (<i>foamed-in-place</i>)	6.25
Polyisocyanurate (<i>foil-face</i>)	7.2



SOURCE: [HTTP://CHEMISTRY.NEED.ORG](http://chemistry.need.org)

This chart shows the approximate R-value per inch of various products. Note, however, that not all product brands have exactly the same performance. More importantly, however, many methods of insulating lean heavily on what goes into the rest of the wall system to achieve good results. For example, blown-in fiberglass or cellulose can provide great results at a very reasonable cost, as long as plumbing and other penetrations are properly sealed, windows are caulked and sealed, and overall air infiltration is minimized with building wrap or (in the case of some types of rigid foam) carefully taped seams.

Air Control 05

Fresh air, yes, but manage the flow.

Controlling the flow of air in and out of a building is a key principle of eco-friendly construction. A combination of strategies is the best approach.

ONE OF THE confusing characteristics of green building certification programs is the way they lump together two different aspects of building science: saving energy and keeping indoor air safe and clean. Is a green home one that saves energy, or one that has healthier indoor air than a conventional home? The answer is both. How did the two concepts get mashed together this way? Blame tight houses. As windows, walls and basements have become less leaky, the stuff that pollutes air inside the home—glues, carpets, paints, pressed board cabinets—suddenly became a lot more dangerous. So here's the deal. If you want to build or retrofit your home to be greener, you'll have to control the air quality at the same time. There are three ways to do this: first, by eliminating pollutants at the point source; second, by keeping moisture levels healthy indoors; and third, by mechanically "cleaning" the air.

Here are some key products whose attributes help provide healthier indoor air:

HOUSEWRAP

Passive Resistance

Some modern building products operate passively. Housewraps fall under this description. These weather-resistant barriers allow water vapor to escape living spaces and wall cavities (where it might condense and encourage mold or mildew), at the same time preventing unwanted outdoor air from creeping into the

Keep Walls Under Wraps



Housewrap is only as effective as its installation. For example, metal flashing above doors or windows should be installed before the housewrap, not on top of it.

Virtues

- Reduces air infiltration
- Repels wind borne rain
- Long service life

Caveats

- Can't be left exposed indefinitely
- Requires careful installation

home. Housewrap is only as good as its installation, however. The Department of Energy says that housewrap must be taped at every seam. Otherwise, it may be 20% less efficient. It's also important that housewrap not be left exposed to sun and wind for too long, factors that can degrade its effectiveness over time.

continued on page 35

VISION HOUSE® TUCSON PRODUCT

Panasonic WhisperGreen with LED

This new ventilation fan is up to 871% more energy efficient than Energy Star standards. A super energy-efficient DC motor powers the fan. SmartFlow technology provides a constant cubic-feet-per-minute (CFM) output, and the SmartAction motion sensor automatically activates when someone enters the room.

<http://tinyurl.com/23sg9kj>



VISION HOUSE® TUCSON PRODUCT

BEAM Alliance Central Vacuum

The BEAM Alliance Power Unit and Cleaning Set by Electrolux boasts advanced technology, such as: a high-efficiency motor that uses 30% less energy than other central vacuums; two-way communication between the power unit and hose handle that keeps you informed as to how the system is performing; sound suppression technology; a 3-in-1 cleaning tool; the BEAM Alliance HEPA filter; and a collection receptacle that snaps into place to assure a perfect seal—to help keep dirt and allergens from re-entering your home. <http://tinyurl.com/o46sbfc>



What makes **INDOOR AIR QUALITY** green?

Poor indoor air quality can cause or contribute to the development of infections, lung cancer and chronic lung diseases such as asthma. In addition, it can cause headaches, dry eyes, nasal congestion, nausea and fatigue. People who already have lung disease are at greater risk. The American Lung Association recommends that the first line of defense against indoor air pollution is finding ways to keep the pollutants from being added to the air in the first place.

Some of the most common pollutants include:

Biologicals

These include molds, bacteria, viruses, pollen, animal dander and particles from dust mites and cockroaches. These may cause infections, provoke allergic symptoms or trigger asthma attacks. Means of control include washing bedding to kill dust mites, keeping animals out of areas affected persons frequent, and practicing careful cleaning.

Secondhand Tobacco Smoke

A major indoor air pollutant, it contains some 200 known poisons, such as formaldehyde and carbon monoxide, and at least 60 chemicals known to cause cancer. It causes an estimated 3,000 lung cancer deaths and up to 50,000 heart disease deaths among U.S. non-smokers each year.

Combustion Pollutants

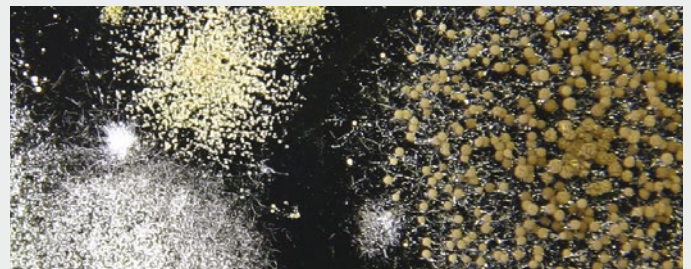
These come from sources such as fuel burning stoves, furnaces, fireplaces, heaters and water heaters, equipment that uses gas, oil, coal, wood or other fuel. The most dangerous pollutants are both colorless and odorless gases: carbon monoxide (CO) and nitrogen dioxide (NO₂). CO interferes with the delivery of oxygen to the body. It can produce fatigue, headache, confusion, nausea and dizziness. Make sure combustion appliances are installed and maintained by reliable professionals, and properly used. A UL-listed CO monitor should also be installed.

Formaldehyde

This common chemical is found primarily in adhesive or bonding agents, and is used in carpets, upholstery, particle board and plywood paneling. The release of formaldehyde into the air may cause health problems, such as coughing; eye, nose and throat irritation; skin rashes, headaches and dizziness. The best control is to avoid using products that emit formaldehyde. As a second line of defense, allow new, potential sources of formaldehyde to air out thoroughly before bringing them indoors.

ALSO: Hundreds of potentially harmful chemicals are emitted by household cleaning agents, personal care products, pesticides, paints, hobby products and solvents. Such chemicals can cause dizziness, nausea, allergic reactions, eye/skin/respiratory tract irritation and cancer. Minimize your use of such sources of dangerous chemicals.

SOURCE: AMERICAN LUNG ASSOCIATION: REPRINTED FROM WWW.LUNG.ORG



Mold



Secondhand Smoke

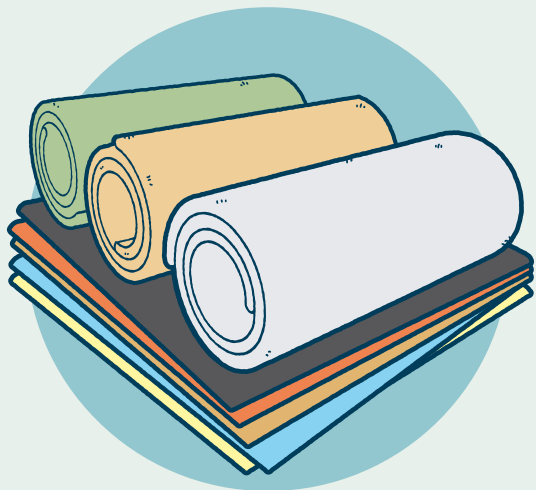


Combustion Gases



Carpet Offgassing

Carpet



Virtues

- Popular and comfortable
- Greener products are now available

Caveats

- Most synthetic carpets are petroleum based
- Rubberized backings are often loaded with VOCs
- Only a few carpet companies take recycling seriously

CARPET

Look Below the Surface

Carpets have only in the last decade or so come under close scrutiny for their environmental impacts—both in and out of the home. Most commercial carpets are made from some variation of synthetic, petroleum-based material. This material is often treated with other chemicals to improve stain resistance, wear or color retention. To make matters worse, many carpets are installed over highly toxic rubberized pads. They may also be glued to the floor with pungent adhesives. That new carpet smell you recognize is not something you want in your home. It's a sign that your floor is releasing unknown chemicals into your living space. A few of the larger carpet makers—notably Mohawk (below), Interface and Shaw Industries (www.shawfloors.com) have begun to approach carpets from a more eco-friendly perspective, not only



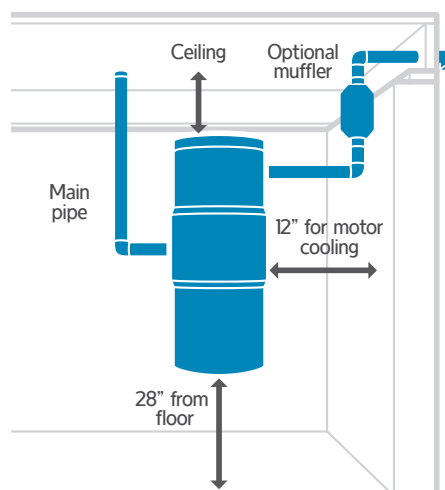
DuPont Tyvek HomeWrap

Tyvek's approach to housewrap is to focus on how the product contributes to overall HVAC performance by reducing air infiltration. Additional tapes and accessories ensure a tight, durable air barrier around the whole home. www.tyvek.com

Glossary of Terms Know the Lingo

- **Felted Backing:** A type of carpet underlayment that can be made greener if produced with natural fibers and less toxic binders. Other harder-to-green types include polyurethane foam and sponge rubber.
- **Natural Fiber Carpets:** Products made with sisal, wool or other natural fibers.
- **Energy Recovery Ventilator/Heat Recovery Ventilator (ERV/HRV):** Device that exchanges stale air from inside the home with fresh air from outside, also exchanging some energy in the process.
- **Vapor Barrier:** Typically a synthetic material or coating that restricts or halts the flow of airborne moisture. Not to be confused with housewrap, which is vapor permeable.
- **Housewrap:** Synthetic material that allows water vapor to pass from interior to exterior of a home, yet protects the building from rain and reduces drafts.
- **Particulates:** Airborne particles that may be a hazard to human health, particularly if they are very small. They should be HEPA-filtered or removed from living areas.

Centralized vacuum systems take even the hardest-to-capture dust particles away from living areas.



Mohawk SmartStrand Carpet

One of the few large carpet companies to make major steps toward sustainability, Mohawk developed *SmartStrand* in a joint effort with DuPont to add renewably sourced polymers (from corn sugar and other sources) to a synthetic weave. The product has integral stain resistance, eliminating the need for toxic chemical treatments. www.mohawkfloors.com



recycling old carpets—but offering less toxic installation systems and products that have lower levels of offgassing.

CENTRAL VACUUM SYSTEMS

Dust Deniers

The carpet industry suggests that the average American family uses a vacuum cleaner at least once weekly, while about 10% of us vacuum our homes once or more per day. But the typical upright household vacuum cleaner may not be the solution to clearing the air in a home. These upright units are not created equal. Most lack an effective HEPA filtering system—the only reliable way to capture the fine particles that have been shown to be harmful to human health. On the contrary, a vacuum with a non-HEPA filter may simply toss tiny particles back into the air. A whole-house vacuum solves this problem by actually taking unwanted particles outside the living space—into a garage or unfinished basement.

What Makes One Carpet Greener than Another?

The EPA offers a few guidelines:

- Low or no volatile organic compounds (VOCs)
- No toxic dyes
- Recyclable
- Recycled content
- Reduced energy use (during manufacturing)
- Reduced or improved air emissions (during manufacturing)
- Minimum 10-year warranty

Recent EPA research found that carpet tiles can be a more sustainable alternative than wall-to-wall products. If you stain a section, for example, you can remove and replace it. Also, you can “rotate” tiles from heavy use areas to light use areas. The EPA’s test building used Milliken 36”x36” tile carpet and low-VOC adhesives to test these principles.

ERV Transfers

An ERV transfers heat and moisture in hot climates. It dries incoming moist outdoor air and transfers some of that unwanted heat into the exhaust air stream that’s leaving the home.

ENERGY AND HEAT RECOVERY VENTILATORS

Key Component

You may have heard of energy recovery ventilator (ERVs) and their northern cousins, heat recovery ventilators (HRVs). This heat transfer technology is a key component of any modern “tight” house. Without them, modern houses would probably not be worth the foam, tape and caulking they’re sealed with. These mechanical wonders take hot, unconditioned fresh air from outside, pass it over a heat collecting medium, where it gets a partial cooldown before entering the home. A study by John Bower (visit www.healthyhouseinstitute.com) found that using a heat recovery ventilator with continuous ventilation cost a Minnesota homeowner just \$86 a year. It cost \$188 to do the same ventilation without an HRV. **GB**

Ventilation Air Requirements (CFM)

Floor Area (ft ²)	Bedrooms				
	0-1	2-3	4-5	6-7	>7
Less than 1500	30	45	60	75	90
1501-3000	45	60	75	90	105
3001-4500	60	75	90	105	120
4501-6000	75	90	105	120	135
6001-7500	90	105	120	135	150
Greater than 7500	105	120	135	150	165

Fresh Air Formula

Indoor air tends to concentrate pollutants quickly. As a result, building codes typically have certain requirements for the amount of fresh air that must be exchanged with stale indoor air over a given period. Typically this is expressed as cubic feet per minute, or CFM. An organization called ASHRAE provides guidelines for how much ventilation is needed, although the best means for achieving that ventilation are often debated. When in doubt, more ventilation is better than less, but you have to balance the resulting energy loss with improved indoor air quality.

SOURCE: ASHRAE 62-2-2003

Windows 06

The high-tech advantages are transparent.

Window manufacturers are producing ever more efficient glazing systems, plus adding new features that enable passive ventilation and increase durability.

WINDOW TECHNOLOGY HAS improved by leaps and bounds over the past few years. Today, you can get a high-performance window that looks good and performs well at any price point.

The windows you select for your house—whether retrofit or new—must meet your local energy code requirements at a minimum, and ideally should be Energy Star-qualified for your home’s climate.

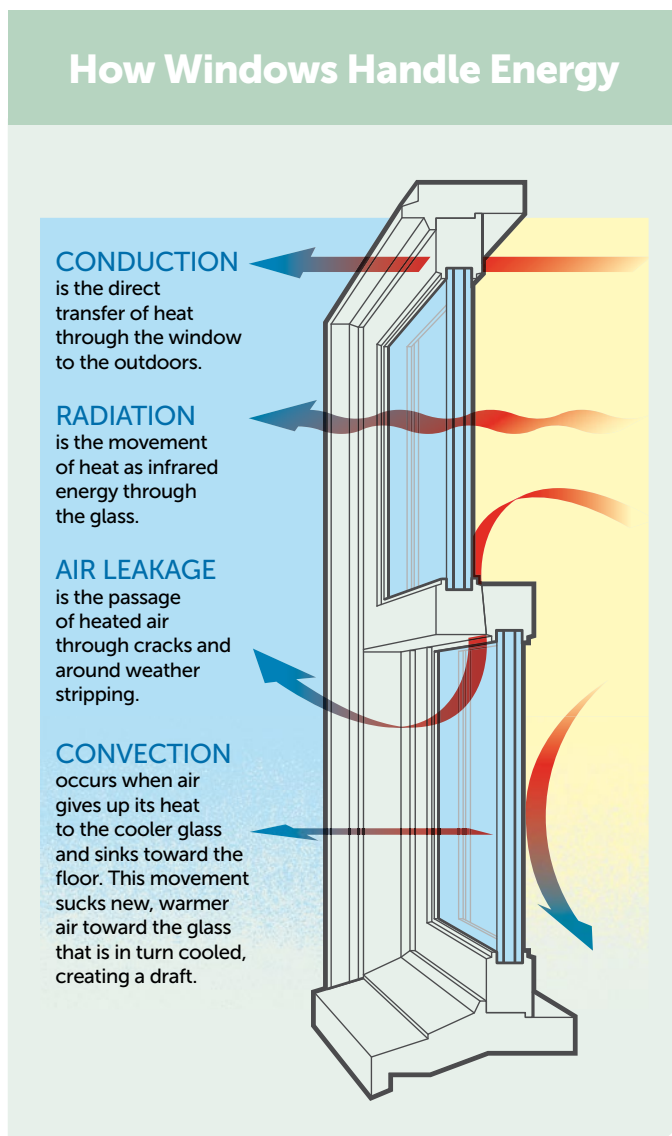
ENERGY COSTS

The Right Window

If you want to reduce utility bills, you need to consider the impact of windows. In climates with a significant heating season, windows have represented a major source of unwanted heat loss, discomfort and condensation problems. But today it is possible to have lower heat loss, less air leakage and warmer window surfaces that improve comfort and minimize condensation.

Similarly, in climates that mainly require cooling, windows typically represent a major source of unwanted heat gain—but low-E finishes that reject solar heat without darkening the glass have changed the rules. These glazings significantly reduce solar heat gain and improve comfort, at the same time providing clear views and daylight.

continued on next page



www.greenbuildermag.com 11.2013



VISION HOUSE® TUCSON PRODUCT MI EnergyCore Windows

These super-efficient, argon-filled, double-pane glass windows from MI Windows and Doors are patented with AirCell PVC material that is co-extruded and thermally bonded to create a fully insulated, corner-welded, strong frame. Additional strength is achieved through internal aluminum reinforcements at the lock rails for maximum security. www.mienergycore.com



Andersen 100 Series Window with SmartSun Glass

The 100 Series of windows features an economical price and energy-saving performance. Frames are made of Fibrex, a composite of sawdust and polymer, and the SmartSun low-E glass qualifies for tax credits. www.andersenwindows.com

As an example, a study by the Efficient Windows Collaborative (www.efficientwindows.org) shows that the annual heating cost of a typical house in Boston drops from about \$750 a year to \$550 (24%) by switching from double-pane windows to triple-pane with high solar gain, low-E glass. Keep this in mind when you are assessing the “first cost” of new windows.

COMFORT

Know the Science

For homeowners, how comfortable a house feels can be just as important as its energy efficiency. An older window with a lower glass temperature feels colder because more heat is radiated from a person’s body to the window.

Cold glass can also create uncomfortable drafts as air next to the window is cooled and drops to the floor. This sets up an air movement pattern that feels drafty and accelerates heat loss.

High-performance windows with lower U-values will result in a higher interior window temperature in winter and thus greater comfort. Proper installation along with weatherstripping designed

Exterior Doors

Both the type of “skin” and the core of an exterior door affects its energy performance, as does the type of glazing. Strike a balance between looks and efficiency.



Feather River Doors Fiberglass Door

DOOR TYPE	R-VALUE
Wood Hollow Core Flush	2.17
Wood Solid Core Flush 1 3/4"	3.03
Wood Solid Core Flush 2 1/4"	3.70
Wood Panel Door 1 3/4"	1.85
Wood Storm Door 50% Glass	1.25
Metal Storm Door	1.00
Metal Insulated Door – Average	7.00
Metal Insulated Door – 2" Urethane	15.00

SOURCE:
WWW.GREEN3DHOME.COM

Glossary of Terms
Know the Lingo

- **Air Infiltration:** The amount of air that passes between a window sash and frame, measured in cubic feet per minute per square foot of frame area.
- **Argon Gas:** A colorless, odorless, inert gas that fills the otherwise empty space within an insulating glass unit.
- **Efficient Windows Collaborative:** Organization that provides detailed reports and studies on the value of using high-performance windows. Visit the Web site at www.efficientwindows.org for more information on the studies cited in this article.
- **Insulating Glass (IG):** Glass units constructed of two or more glass panes separated by a hermetically sealed space.
- **Low Emissivity Coating (low-E):** Low-E finishes reduce energy transfer through insulating glass units, and thereby achieve one of the highest levels of energy performance possible for glass.
- **Solar Heat Gain Coefficient (SHGC):** Measures the fraction of solar energy admitted, and indicates how well the product blocks heat caused by sunlight.
- **U-Value:** The escape of BTUs per square foot per hour, per degree Fahrenheit.
- **Warm Edge Technology:** The use of low-conductance spacers to reduce heat transfer near the edge of insulated glazing.

to seal tightly will also improve comfort by reducing cold air leakage.

During the summer, direct sunlight strikes people and surfaces, creating overheating and discomfort. Windows with low solar heat gain coefficients will reduce the solar radiation coming through the glass. That’s where low-emissivity (low-E) glass comes in—reducing heat gain while still providing sufficient light and view.

LESS FADING AND CONDENSATION

Block the Rays

High-performance windows with new glazing technologies make homes more comfortable. They create warmer interior glass surfaces, reducing frost and condensation. High-performance windows with warm edge technology and insulating frames have such a warm interior surface that condensation on interior surfaces is significantly reduced under all conditions.

Another concern for homeowners is the effect of sunlight on the home and its contents. Many organic materials, such as carpet, fabrics, paper, artwork, paints and wood may fade upon exposure to sunlight. Window selection can influence the type and intensity of transmitted radiation.

Ultraviolet (UV) rays are the most harmful radiation in sunlight. They are the most energetic and thus most likely to break chemical bonds, leading to fading and degradation.

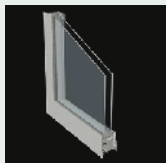
Finishes on glass can reduce the UV transmitted by up to 75%. UV absorbers can be incorporated into thin plastic films

continued on next page

What makes WINDOW GLAZINGS green?



EXAMPLE A
 double glazing
 clear glass
 aluminum frame w/ thermal break



EXAMPLE B
 double glazing
 low-E coating (low solar gain)
 argon gas fill
 aluminum frame w/ thermal break



EXAMPLE C
 double glazing
 clear glass
 vinyl/wood frame



EXAMPLE D
 double glazing
 low-E coating (high solar gain)
 argon gas fill
 vinyl/wood frame



EXAMPLE E
 double glazing
 low-E coating (low solar gain)
 argon gas fill
 vinyl/wood frame

Climate Affects Performance

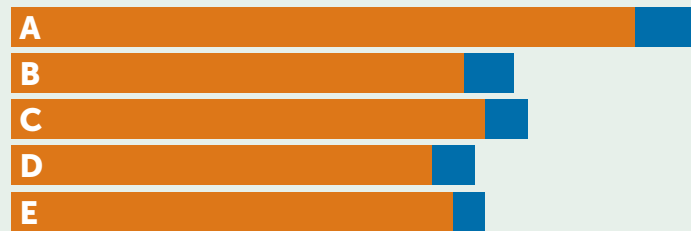
The annual energy performance figures shown here were generated using RESFEN for a typical (new construction) 2000-sq.-ft. house. The costs shown here are annual costs for space heating and space cooling only, and thus will be less than total utility bills. The mechanical system uses a gas furnace for heating and air conditioning for cooling. Energy prices were projected for the period of 2006-2030, the typical effective lifetime of a window installed in 2005.

Note: The graphs at right are intended to show how regional variations in climate affect the relative advantages of window types, not as specific cost comparisons.—editor

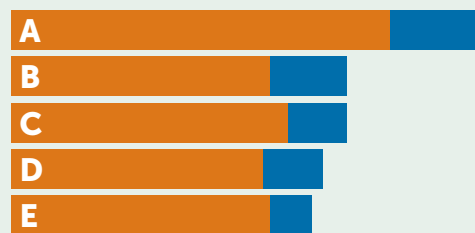
Annual Energy Performance of Glazing Types by Climate

Heating Cost Cooling Cost

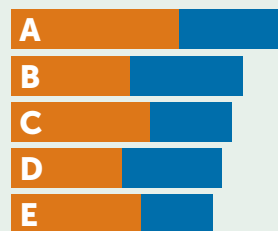
Boston, Massachusetts



Chicago, Illinois



Atlanta, Georgia



Phoenix, Arizona



in multilayer windows or as an interlayer in laminated glass. In both cases, the UV transmission can be reduced to less than 1%. However, it is important to note that the remaining visible light that is transmitted can still cause fading in some materials. Using low-E coated glass or windows incorporating plastic layers rather than clear uncoated glass will reduce fading.

ANOTHER WINDOW PERK

Smaller HVAC Equipment

High-performance windows can reduce utility bills, and they also reduce peak heating and cooling loads. The peak load for a building is the maximum requirement for heating or cooling at a given time. This load is important, because it determines the size of the furnace, heat pump, air conditioner and/or ventilating fans that must be installed. Reducing the peak load may allow homeowners to install a smaller HVAC system, which costs less up front—and less to operate.

Properly sized HVAC systems offer a number of advantages to homeowners. First, by running more constantly, smaller equipment provides the best air quality and comfort. Second, HVAC systems that are more closely matched to peak cooling loads achieve better dehumidification, which prevents mold. Several calculating procedure can be found to help with proper sizing of HVAC equipment. That's really the HVAC installer's job, but if you want to do your own calculations, there's a simple piece of software out there called the *HVAC-Calc Residential 4.0*, which costs \$49 (available at www.hvaccomputer.com). You enter in some information about your home (or proposed new home), and it helps you figure out the optimal size and type of equipment you need for best performance and energy efficiency. **GB**

Replace or Repair?



It's one of the most common homeowner questions:

Should you fix up those old, single-pane windows in your home—adding storm windows, for example, and caulking and sealing around the old unit—or buy completely new windows? Consider the following:

- **Climate:** If you live in an area with very cold winters or hot summers, new windows will pay for themselves in energy savings more quickly than temperate climates.
- **Condition:** Are your old windows structurally sound? If they're rotted like the one shown, repair may not be an option.
- **Value:** Another key aspect to consider is how your current window "look" impacts the value of your home. Will replacing them help or hinder a future resale?
- **Cost vs. Labor:** Are you prepared to switch out storm windows with the seasons? What about maintenance? Old windows will need ongoing, occasional TLC. Be sure to think about your lifestyle—not just your wallet.

New Emphasis on Window Installation

To keep pace with increasingly advanced glazings, window and door makers have fine-tuned the science of installation. That's a good thing, because you can put the best-made, highest-rated window in a new home and still feel a cold draft next to the frame. But if that happens, chances are it's your fault—not the window maker's. You didn't follow the precise instructions they provide, free of charge.

It used to be that window installation tips were often simplistic—or considered the builder's responsibility. But companies such as Milgard and Marvin have poured a lot of research, experience and money into educating end users about their products.

The Internet, of course, has made that process much easier. But the building science of installation has improved alongside new flashing systems, expanding foam sealants, and clad and composite window frames.

Take a look at the websites at right (and the sample instructions we've pulled directly from their pages), and you're likely to learn some best practices that will save you labor, keep you from having to reinstall a window, and even improve energy efficiency.

They also include tips that will help increase the product's durability.

Milgard

Sample Instruction: "In removing existing materials [for retrofit installation] it is important not to disturb the existing weather barrier, as it will still be used."

<http://pro.milgard.com>

Marvin (Integrity Line)

Sample Instruction: "If a flexible adhesive membrane is not used to pan the sill, be sure to properly seal the bottom corners of the rough opening."

www.integritywindows.com



VISION House[®] TUCSON



VISION House Tucson has a projected HERS Rating of -17

Imagine a world in which the average American family can affordably and comfortably live in a green home. The home is optimized for performance and it includes the most efficient features, materials, and technologies available on the market, without sacrificing style or increasing the cost of ownership. The homeowner can rest assured that the home is safe, healthy, and durable, and that energy and maintenance costs will be much lower than a conventional home. The home is a part of a sustainable community that carefully addresses the specific ecological concerns of the surrounding natural environment and appropriately mirrors adjacent historical buildings.

Builder: John Wesley Miller Companies **Architect:** H.J. Krzysik Architect
 Located in Armory Park del Sol, America's greenest community

For more information visit: www.greenbuildermag.com/VISION-House/Vision-House-Tucson

THANK YOU TO OUR NATIONAL SPONSORS:



How-To Repair Old Windows

42

BY JULIET GRABLE

Restoring old wood windows and pairing them with low-E storms can make them as energy efficient as new ones—with less impact to your wallet.

WINDOWS ARE AN essential part of an historic home, and most windows built before 1950 were extremely well-made, utilizing first-growth, tight-grained wood. Restoring them preserves the home's character and saves resources, including the embodied energy of manufacturing and transporting new windows and recycling the old ones.

Lorri Sipes is a Michigan-based architect who specializes in historic architecture. During the recession, she took advantage of a state-sponsored program that paired job creation, historic preservation and energy conservation—and learned the art of wood window restoration. Today she and a business partner run the Wood Window Repair Company, and teach workshops themselves.

In 2010, the Clean Energy Coalition, a Michigan non-profit, and *Greenovation.tv* hosted a workshop at Matt and Kelly Grocoff's historic Victorian in Ann Arbor, where Sipes schooled students in the art of wood window restoration. A blower door test performed by CEC before the workshop revealed air leaking at a rate of 4,400 cubic feet per minute (CFM) at 50 pascals. After the home's 16 windows were restored, a second blower door test showed the rate had slowed to 1,530 CFM at 50 Pa. Later the Grocoffs added low-E storms from

Trapp, a Michigan company. A third blower door test yielded 1,330 CFM at 50 Pa, for a 70% overall reduction in energy leakage.

Repairing old windows is labor-intensive, but the tools and materials are inexpensive. Included here is a step-by-step to the dirty business of restoring sash, paint and glass—along with less intensive measures.



BEFORE Restoration



AFTER Restoration



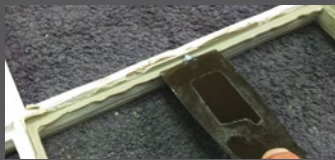
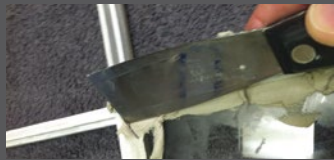
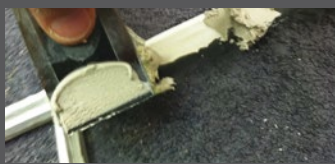
1. RESTORE THE SASH. "Ninety percent of our repairs are to the bottom sash and sill," says Sipes. Even if rot is extensive, sashes can often be saved. Removing the sash from the jamb requires first removing at least one stop and freeing the sash cords. If the old glazing isn't too compromised you may choose to leave the glass in, but removing it makes working on the sash easier and reduces the likelihood of breakage. To do this, dried glazing putty must be carefully chipped away and the glazing points—small triangular pieces of metal that hold the glass in place—eased out of the wood. A putty knife or chisel in combination with needle-nose pliers works well.



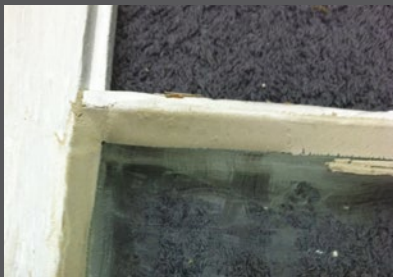
2. REMOVE PAINT. Sipes uses the *Silent Paint Remover* (by Viking Sales, Inc.) on flat surfaces, which uses infrared heat to soften paint, and a regular heat gun for on-site stripping of jambs. Neither requires chemicals or creates dust—an important consideration with older windows, which almost always include lead paint. Sipes scrapes away softened paint with a carbide blade, and follows up with a light sanding with 150-grit sandpaper.



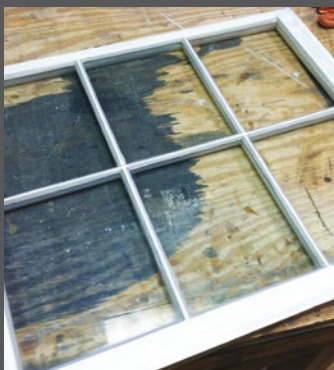
3. REPAIR WITH EPOXY and REGLAZE. A Dutchman in combination with epoxy can be used to fill large voids; for smaller areas of rot, epoxy alone works well. Sipes uses marine-grade epoxy from West System. After repairing rot, prime the sash with oil-based primer before reglazing to condition the wood. Glazing points hold the window in position and glazing compound provides a watertight bond between the glass and sash. To reglaze with the original glass, first clean it by using hand tools to scrape away old residue. Linseed oil can aid in removing old putty.



4. BED THE GLASS. Apply a layer of new putty on the rabbet. Sipes uses *Dual Glaze* (natural color) by Sarco Putty Co. Place the pane of glass on the bed of putty, and secure by installing glazing points into the wood—one on each side for small sashes, two or three per side for larger ones. Use a glazing knife to push the glass down and drive the glazing point into the muntin.



5. CREATE A BEVEL. Once the pane is bedded, apply putty generously on all edges of the glass. Draw the glazing knife down each side to create a 45 degree bevel between the glass and the muntin. The putty has a long working time and any excess can be reused.



6. PRIME AND PAINT. The new glazing should last a generation. Two coats of oil-based paint, and the sash is ready to go.

WEATHER IMPROVEMENTS AND DETAILING



SILICONE TUBE FIX. Round silicone tube seals must be partially compressed to create an effective seal. The seal includes a flange that slips into a slot in the sash; you will have to cut a kerf in the sash edge to accommodate it. Sipes installs 1/4" tube seals on the head and sill, and 3/16" seals on meeting rails.



SMOOTH AS BRONZE. Installing 1 1/8" bronze spring weatherstripping on jambs helps sashes run smoothly and completes a weather-tight seal. The strips are attached just inside the stop, with copper-plated steel nails spaced every 1 1/2". The angle of repose (which controls the tension between the bronze and the sash) can be adjusted with a screwdriver or putty knife.



CLEANING HARDWARE. Beautiful brass hardware is often buried under layers of paint. To strip hardware, Sipes uses an unusual tool: a crock pot. Place the hardware in water with a squirt of liquid dish soap and cook on high for half a day. The paint should fall off easily.

REPLACING A SASH CORD



THE RIGHT TENSION. A double-hung window is an elegant machine. Each half runs on a separate track driven by a pair of weights that run on pulleys and nestle in pockets inside the jambs. The sash cords are often broken in neglected windows, but even if they're not, you should replace them with quarter-inch diamond-braided cotton cord. Make sure the tension is correct, so the weights don't rest on the floor of the jamb pocket when the sash is open. Clean and oil pulleys with silicone or graphite—not oil or WD-40—before running new cords. The new cords should last fifty years, as long as they aren't painted.

Home heating products that are kind to everyone's home.

SCHOTT ROBAX® glass-ceramic creates a more energy-efficient, eco-friendly and safe environment for your customers. When used in a closed fireplace system, ROBAX glass-ceramic transfers more heat into a room and reduces the amount of firewood needed, as compared to an open heating system. It also allows the fire to burn more completely, preventing other particles from being released into the air.

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**SCHOTT
ROBAX®**

Heating/Cooling 07

A home's biggest energy users.

An efficient heating/cooling system lowers utility costs *and* makes a home more comfortable.

AT THE HEART of most home heating systems is a furnace, a boiler or a heat pump. A furnace burns fossil fuel to heat air that's forced by a blower fan through a series of ducts to the living spaces; a boiler heats water that's then pumped to a hydronic, or water-based, distribution system. Most heat pumps run on electricity. They don't create heat, but rather extract it from the air or the ground. Heat pumps are available for use with forced-air and hydronic distribution systems. If you want to minimize your fuel bill, an Energy Star rating is a minimum standard for these appliances.

GAS FURNACE Super Efficiency

A modulating gas furnace is the most technologically advanced fossil fuel-burning furnace you can get, with efficiencies as high as 97% (that's the percentage of the fuel's potential energy delivered as heat). It achieves this feat with a series of technical innovations. Gas is not as clean as we once believed, however, now that dirty methods of "fracking" are used in some extraction. The pollution may simply be happening at the front end of the process. No fossil fuel gets an environmental free ride. It's a finite resource, not a renewable one.

One way that new technology squeezes more heating power from gas is with an exhaust heat exchanger. This exchanger steals back heat from the furnace's waste byproducts. Another feature, flame modulation, adjusts the flame size, based on demand. These furnaces include variable-speed blower fans with high-efficiency

continued on next page

High-Efficiency Boiler

The diagram shows a cross-section of a boiler. At the bottom, a burner is shown with a flame. Above it is a boiler chamber containing a heat exchanger with red and blue coils. A red arrow labeled 'Hot water' points upwards from the top of the chamber. A blue arrow labeled 'Cold water' points downwards from the side. A grey arrow labeled 'Flue gases' points to the right from the side of the chamber. A burner assembly is shown at the bottom left.

Virtues

- Quiet operation—no air blowing
- Relatively easy to zone
- Lack of fan means lower electric use than a forced-air system
- Distribution system takes up much less space than ductwork

Caveats

- Up to 50% more expensive than a conventional boiler
- There are fewer high-efficiency boilers to choose from than there are high-efficiency furnaces

Uponor Manifold System
As the central hub of a radiant hot water heating system, this *Engineered Plastic (EP) Heating Manifold* from Uponor is designed to resist corrosion and chlorine. It comes in several sizes (from 2 to 8 loops), includes attached flow meters, and accommodates 15.4 gallons per minute (gpm) of water flow.
www.uponor-usa.com

VISION HOUSE® TUCSON PRODUCT

Rheem Net-Zero System
At the Green Builder VISION House® Tucson, Rheem is piloting its *Net-Zero Air and Water System*. This first-of-its kind, residential net-zero system delivers air conditioning, heating and water heating by uniting some of Rheem's most efficient technologies, and leveraging photovoltaic cells (PV) to harness solar energy.
www.rheem.com

What makes HEATING and COOLING green?

Heat Pumps

A heat pump is a device that uses a small amount of energy to transfer heat and store it. This technology has become increasingly available in both water- and space-heating equipment. Heat pumps are typically selected based on which source of heat will be most efficient. Some household systems (such as the one shown) include both air- and water-source pumps that condition air, before distributing it through ducts to the home. The water-to-air unit, for example, might be better for heating in the winter months, while the water-to-water unit will efficiently provide cooling in the summer.

Water-to-Water Ground Source Heat Pump

Water-to-Air Ground Source Heat Pump

Recirculating Pump

In large or multi-family homes, if the heating unit is far from the point of use, you can waste a lot of water waiting for the hot water to reach your faucet—as much as 40 gallons a day or 14,000 gallons a year for the average U.S. household. Recirculating pumps move hot water from the source and back again, creating a hot water “loop.” This allows you to have instant hot water access from any faucet. The pump can be activated by a motion sensor, then automatically shut off after a few minutes. No water is wasted, and the cost to run the pump is minimal. The Uponor *D'Mand* Hot Water Delivery System is shown here.

Insulated Water Tank

The best hot water storage tanks lose only about half a degree of water temperature every hour. That amounts to big savings, because water that's not used immediately doesn't have to be reheated all day. Standard boilers used with insulated tanks are sometimes called “indirect” water heating systems—and are sometimes a good retrofit option or a more affordable choice than on-demand boilers.

PRO TIP:

Sprinklers Pay Off. Installing home sprinklers has environmental as well as safety payoffs. Research has shown that by reducing the damage caused by home fires (or preventing them altogether), automatic fire sprinklers can reduce greenhouse gas emissions by 98%. They can reduce fire damage by up to 97%; reduce water usage to fight a home fire by as much as 91%; and reduce water pollution caused by runoff from debris. More info: www.vikinggroupinc.com/en/products



IMAGE: UPONOR (WWW.UPONOR-USA.COM)
PHOTO BY JOEL SILVERMAN

Duct Diligence

An often overlooked factor in heating and cooling performance in homes with forced-air systems (vents and registers) is heat loss through ducts. By some estimates, duct leakage accounts for up to 70% of a home's air leakage when the furnace blower is operating. To prevent this, all duct seams and joints should be carefully sealed. Ducts that pass through unconditioned or partially conditioned spaces such as attics and basements should be insulated.

Modulating Boiler

The boiler shown here is for a very specific purpose—to keep two hot water tanks at the ready for a radiant floor heating system in the home. As such, the water produced is not intended for drinking. It's part of the heating loop. This type of boiler has been around a long time, but the science of "modulation" keeps improving. Modern, high efficiency boilers have computerized controls that adjust performance based on demand—to produce the most hot water at the lowest energy cost.

Bosch "Instant" Hot Water

An alternative to storing hot water is an "instant" on-demand boiler. These units typically create only as much hot water as is needed, rather than storing it in tanks. Before you buy, however, check how much hot water the unit can produce. If you plan to run a shower and a dishwasher simultaneously, you'll need the right fire power. The Bosch *Greentherm Model C950 ES* is shown. Bosch also offers a "Bosch ProSizing" app you can use on a smartphone, available on Google Play at

<http://tinyurl.com/mk6w33e>

Glossary of Terms Know the Lingo

- **Annual Fuel Utilization Efficiency (AFUE):** The percentage of a fuel's potential energy that a furnace or boiler converts to usable heat. Government standards that take effect in 2015 require AFUE levels of 82% for gas boilers, 83% for oil boilers, 80% for gas furnaces and 82% for oil furnaces.
- **Air Handler:** In a forced-air heating or cooling system, the air handler unit moves heated or cooled air through the home's ductwork.
- **British Thermal Unit (BTU):** The unit of measurement for heat, whether it's the heat given off by burning fuel or extracted from a home for cooling. Technically, one BTU is the energy required to raise one pound of water one degree Fahrenheit.
- **Combustion Chamber:** The part of a furnace or boiler where the fuel is burned.
- **Compressor:** That part of the air conditioner or heat pump that compresses and pumps refrigerant.
- **Condenser Coil:** The part of an air conditioner or heat pump that releases heat from the surrounding air in cooling mode and collects it in heating mode.
- **Distribution System:** The network of air ducts or hot water pipes that delivers heat from a furnace, boiler or heat pump to the home's rooms.
- **Evaporator Coil:** The part of an air conditioner or heat pump that exchanges heat with the air in the home.
- **Heat Exchanger:** Located in the furnace or boiler, it transfers heat from the combustion chamber to the air or water in the heat distribution system.
- **Heating Seasonal Performance Factor (HSPF):** The heating efficiency of a heat pump. It's a ratio of the heat it generates over the heating season, in BTUs, to the watt-hours of electricity it consumes. Heat pumps manufactured after 2006 have to have an HSPF of at least 7.7, but the best units have ratings as high as 10.
- **Seasonal Energy Efficiency Ratio (SEER):** The cooling efficiency of an air conditioner or heat pump. It's the ratio of cooling output to electricity used. The minimum SEER requirement for units manufactured beginning in 2006 is 13.
- **Zoning:** A method of partitioning a home's hydronic or forced-air distribution system into independently controlled comfort zones.

electric motors. The ability to vary airflow and flame intensity also allows for nearly constant room temperatures and better air circulation.

HIGH-EFFICIENCY BOILER

Hot Water Wiz

A boiler burns oil, natural gas or propane to heat water. That heated water is then pumped through a system of pipes to radiators, baseboard heaters or a radiant floor.

A good boiler will offer efficiencies of 90% to 95% and will include many of the same technologies as a high-efficiency furnace. These include a modulating burner that matches the heat output to whatever the thermostat is calling for at the moment, advanced heat exchangers to extract more heat from the same amount of fuel, and the ability to recover heat from the exhaust gas by condensing it. The resulting exhaust is cool enough to be vented out of a plastic pipe. In the best cases, this condensing process can squeeze 10%–12% more usable energy out of the fuel.

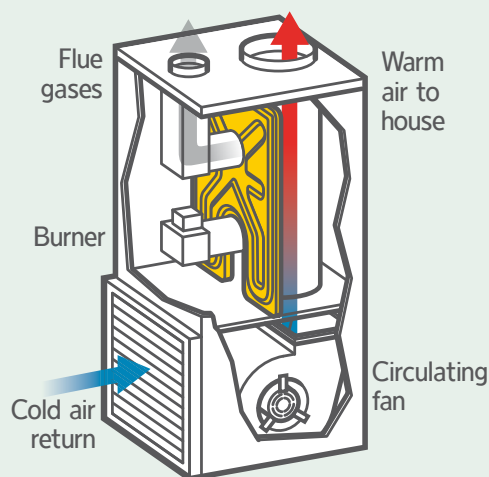
AIR-SOURCE HEAT PUMP

Reverse Motion

A heat pump is basically an air conditioner that works in reverse to provide heat. The heat pump captures and concentrates heat from one area, then releases it to another.

In heating mode the heat pump takes heat from the outdoor air and delivers it to the home's distribution system. In cooling mode, it reverses direction to work like an air conditioner, extracting heat from inside the house and blowing it outside. In cooling mode, this waste heat can also be used for water heating. The most common type is the split system, which uses separate indoor and outdoor units, but you can also get packaged systems that place everything in a self-contained outdoor unit. While air-source heat pumps can offer efficiencies of 200%–300%, they're most efficient in the southern part of the country. A backup electric or gas heater may be needed when the outside air drops below a certain temperature. Although different versions are made for forced-air and hydronic distribution, the forced-air type is the most common. Heat pumps don't get air as hot as a furnace or boiler, so may require more airflow to maintain the same temperature.

Air-Source Heat Pump



Virtues

- Can provide heating and cooling
- No need for a chimney or exhaust flue
- More fuel-efficient than a fossil fuel furnace or boiler

Caveats

- Not practical in very cold climates
- Does not get air as hot as a furnace

GEOTHERMAL

Earth Energy

A geothermal heat pump (GHP) uses refrigerant-filled underground piping loops, installed horizontally or vertically, to exchange heat with the earth. These systems work well in both warm and cold climates. A good GHP is able to move three to five times more energy than it consumes. Models are available for use with forced-air or hydronic distribution systems. While the hydronic models don't get water as hot as a conventional boiler (122 °F, compared to 150 °F or more) their low temperature output is a perfect match for radiant floor heat. **GB**

Heating Technology Pollutant Comparison

Outdoor Wood Boiler	80 grams
Fireplace	40 grams
Non-Certified Wood Stove (traditional)	15 grams
Certified Wood Stove	8.2 grams
Pellet Stove	2.4 grams
Corn Stove	1.5 grams
Oil Boiler	.02 grams
Gas/Propane Boiler	.001 grams

Newer, solid fuel-burning heating equipment produces far less pollution than unregulated wood fireplaces or outdoor wood boilers. Fossil fuels are still the cleanest burning alternative, but they depend on non-renewable resources. It's clear that interest in cleaner ways to burn wood, corn and other biomass will rise with market demand.

SOURCE: CLEAN AIR REVIVAL AND EPA

Appliances 08

Machines for more efficient living.

Dishwashers, refrigerators and other labor-saving devices can be even more efficient if used properly.

HOME APPLIANCES SAVE time, make our homes more comfortable, and increase our quality of life. However, there is more to choosing an appliance than simply selecting the finish, features and price.

Finding a washer, dryer or refrigerator that gets the job done while using less energy and water has become much easier, thanks to programs such as Energy Star and the EnergyGuide label. These labels help you select an appliance that performs well, yet conserves natural resources.

REFRIGERATORS

The Big Energy Hogs

Of all the appliances in the home, the refrigerator can be the most wasteful of electricity. Unlike other appliances that you can turn off, the refrigerator is always on. Fortunately, modern refrigerators are more than 75% more energy efficient than ones built just 15 years ago.

Upgrading your 1970s-era fridge to a modern Energy Star option can save you over \$200 annually in energy bills. Rebates from local utility companies, manufacturers, federal, state and local governments are often available. Visit www.dsireusa.org to see what's available in your area.

Besides saving energy, some manufacturers are producing refrigerators that simply do a better job of storing food. Smart refrigerators are able to moderate the humidity of different bins within the unit, which reduces food spoilage and waste. Fruit and vegetables, for instance, require higher levels of humidity and a constant circulation of air to retain their freshness, color, flavor and vitamins. Meats, on the other hand, should be kept in dryer,

Don't overlook the familiar yellow EnergyGuide sticker. It holds a host of information that can help you find the most efficient appliances available.

more air-tight compartments. While this technology can help you preserve your food, it does come at a higher price.

What to Know

- If you have a refrigerator that's more than 15 years old, replace it!
- Energy Star-rated refrigerators can save you hundreds of dollars over the life of the appliance.
- Size matters: One big refrigerator in the kitchen is better than two small ones (i.e., one in the kitchen, one in the garage).

WASHERS AND DRYERS

Advances in Conservation

The average American family does more than 400 loads of laundry a year, so even modest energy and water savings can greatly impact overall natural resource conservation. Reducing water while doing the laundry has gotten easier in the past decade, thanks in large part to the advancement (and acceptance) of front-loading washing machines.

While top-loading machines still have their place in the market, front-loading units use up to one-third less water, reduce the wear

continued on next page

Whirlpool Gold Energy Star Qualified Refrigerator
This 25-cubic-foot French door bottom-mount refrigerator boasts energy-saving technology and offers an adaptive defrost system (ADS), Accu-Chill temperature management system and humidity-controlled crispers. It comes in black, white and monochromatic stainless steel.
www.insideadvantage.com

VISION HOUSE® TUCSON PRODUCT
Whirlpool Smart Front-Load Washer
The Duet stainless-steel front-load washer features the Quiet Wash Ultra Noise Reduction System as well as the 6th Sense Live technology, which allows owners to monitor and control appliances from smart phones or tablets. When connected to the smart grid used by utility companies, you can optimize energy usage by tracking how much energy your appliance is using. www.whirlpool.com/smart-appliances/

What makes a **DISHWASHER** green?

Tough Interiors

Better units have stainless steel interiors that will not stain or catch food. Durable interiors greatly extend the lifespan of a dishwasher.

Full Loads

A dishwasher works most efficiently when completely full. Newer models such as this one from Bosch include a third rack that allows you to wash more utensils and dishes using the same energy.

Flexible Cycles

Smart dishwashers include several modes that can save even more water, electricity—or both. For example, this unit has a "Half Load" setting that reduces water waste.

Quiet Operation

Excessive noise isn't just irritating. It's been shown to raise stress levels in humans—adversely affecting health. Quieter machines make better living companions.

PRO TIP:

Air Drying. Some green experts advocate letting your dishes dry naturally as a way to save additional energy. Assuming your home can handle the moisture, just open the door and let your dishes cool and dry after washing.

on clothes, and require less detergent. By using gravity to move the clothes inside the drum instead of a spindle, front loading washers also conserve electricity while providing more effective spin cycles.

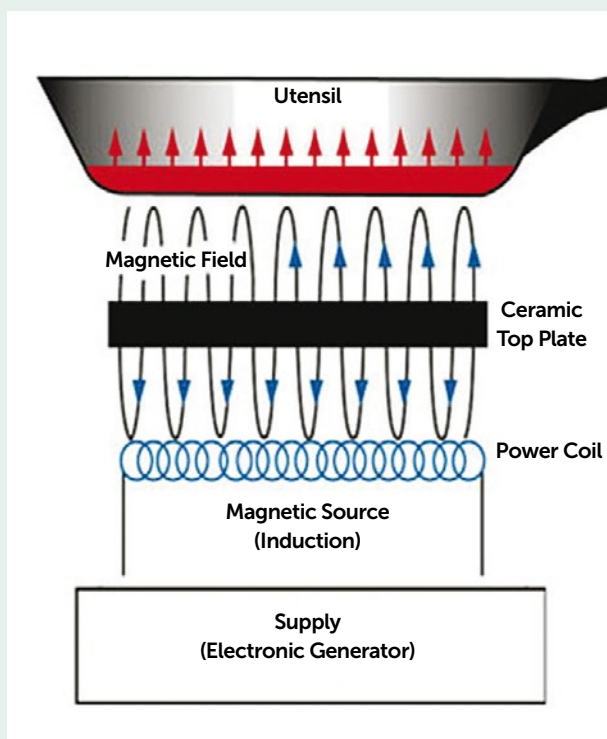
Two terms to be familiar with when evaluating washing machines are modified energy factor (MEF) and water factor (WF). The higher the MEF, the more energy efficient the model. This rating takes into account not only the energy used during the course of cleaning the clothes, but also the energy used to heat the water and run the dryer. The WF rates the water efficiency of the unit based on its size. The lower the WF, the more water efficient the washer.

Using the MEF and WF, along with an Energy Star label and the EnergyGuide label can help you determine which washer set will conserve resources yet still perform well.

What to Know

- Dryers with moisture sensors can greatly reduce energy use.
- Most HE (high efficiency) washers use special low-sudsing detergent.
- Energy Star does not rate clothes dryers.

How Induction Cooking Works



More energy efficient than traditional electric coil heating, induction stoves heat ferrous metal pans directly. An oscillating magnetic field creates an electric current that heats the pan without making the cooktop surface hot. Food is heated by contact with the pan.

Glossary of Terms Know the Lingo

- **Modified Energy Factor (MEF):** MEF is the official energy efficiency metric used to compare relative efficiencies of different clothes washers. MEF considers the energy used to run the washer, heat the water and run the dryer. The higher the MEF, the more efficient the clothes washer.
- **Water Factor (WF):** WF is a measurement of water efficiency that is calculated as gallons of water used per cubic foot of capacity. The lower the number the more water efficient the clothes washer.
- **High Efficiency (HE):** HE is used to describe clothes washers that typically use 50% less water than traditional units. Special low-sudsing detergent is used with these models.
- **EnergyGuide Label:** This yellow label created by the U.S. Federal Trade Commission is on most home appliances, and will help you compare the energy use (and cost) of operating one appliance relative to another.
- **Induction Cooking:** Induction heating elements heat only the pan and its contents, and offer energy efficiency by reducing wasted heat when compared to radiant and gas cooktops. The actual induction element stays cool, while the metal pot or pan up rapidly making induction heating safer and more energy efficient than traditional cooking methods.
- **Consortium for Energy Efficiency (CEE):** The CEE is a consortium of efficiency program administrators from across the United States and Canada, who evaluate and rate appliances, electronics and HVAC systems on energy efficiency. www.cee1.org
- **Hydrochlorofluorocarbon (HCFC):** HCFC-based refrigerants are the most common type of refrigerant used in the United States today and are considered significant contributors to greenhouse gas emissions and global warming.

DISHWASHERS

Quiet and Efficient

Energy savings and water savings are closely linked; the more hot water you use in your appliances, the higher your energy bills. Dishwashers produced before 1994 typically use 10 gallons per load more water than modern units. Considering that the average home washes over 300 loads per year, reducing the amount of water used can quickly lower utility bills. Dishwashers that offer cycle selections and energy-saving options can help reduce the amount of water you use.

To dissolve detergent and remove grease, dishwashers require extremely hot water. Many dishwashers now come with a “booster” or internal heating element that raises the incoming water temperature to the required 140 degrees.

continued on next page

This can allow you to lower the temperature on your water heater and still allow your dishwasher to operate at optimum levels. Some dishwashers offer the booster cycle, but only if you select “heavy duty.”

Along with energy and water savings, noise is a factor in choosing a dishwasher. Measured in decibels (dB), the amount of sound produced can vary dramatically by make and model.

Normal conversation levels range around 60dB, so choosing a unit that is quieter than that is important. Because of advances in insulation and sound proofing, some dishwashers can be “whisper quiet,” creating as little as 41dB during operation. That is the just slightly louder than the hum of your refrigerator.

What to Know

- Dishwashers have two *EnergyGuide* cost labels: one for consumers who use electric water heaters and one for natural gas users.
- Boost heaters generally increase the cost of the unit, but the energy savings can pay for the upgrade in about one year.
- Dishwashers fall into two categories—compact and standard.

RANGES AND OVENS

Smart Cooking Saves Energy

Refrigerators, dishwashers and laundry units may be considered “major” appliances, but they aren’t the only units you may have to purchase or replace. Thoughtful selection of ranges, ovens, cooktops, microwaves and range hoods can help reduce energy use while improving the quality of life around your home.

Ranges. The kitchen range is a dual oven/cooktop, and is available in electric, natural gas and dual-fuel. The benefit of a dual-fuel range is that it has the benefits of gas burners on the cooktop, but offers the stable temperatures of oven cooking with electricity. Cooktops are also available using electrical induction, which creates a magnetic field that heats pans directly, unlike traditional electric resistance coils, which use conduction to transfer heat.

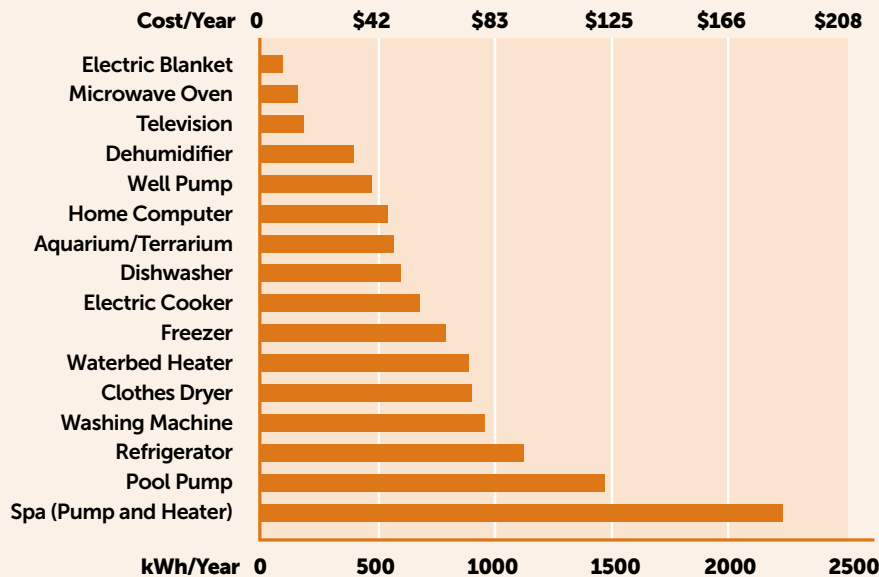
Microwaves. Often an afterthought when finishing a kitchen, microwaves can create a more energy efficient and comfortable kitchen when used properly. Energy consumption can be reduced by up to 80% when smaller portions are heated up in the microwave instead of the oven. Also, using a microwave instead of the oven will reduce the amount of heat generated in the kitchen.

Range Hoods. These are important in the kitchen for several reasons. First, the ventilation removes unwanted moisture, which could lead to mold issues in the home. It also exhausts heat, smoke and cooking odors from the home. A quality hood also offers task lighting above the range, which will increase safety around hot burners.

What to Know

- Induction ranges are more energy efficient than traditional ranges, but can only be used with ferrous (steel or iron) cookware.
- Flat cooktops are not necessarily induction ranges.
- Most flat-surfaced cooktops simply use electric resistance heaters under a ceramic cover.
- There is no Energy Star label for residential ovens, ranges or microwave ovens at this time. **GB**

How Much Electricity Do Appliances Use?



This chart shows how much energy a typical appliance uses per year and its corresponding cost, based on national averages.

For example, a refrigerator uses almost five times the electricity the average television uses. Not surprisingly, pools and spas are energy hogs.

Visit www.energysavers.gov for instructions on calculating the electrical use of your appliances.

SOURCE: DOE

Faucets & Fixtures 09

Making the most of every drop.

Water-saving devices have become reliable, affordable and widely available. Now it's your turn to slow the flow.

THE FAUCET AND fixture industry has consistently delivered the eco-friendly goods. Their products get more efficient and more durable almost every year, yet remain remarkably affordable. Every year, bath, kitchen and laundry gadgets help us reduce water usage by about 5%. But as a nation, we're still slipping—using about the same volume of fresh water every year. Why? Because the U.S. population grows at about 5% per year.

The problem, says author and water expert Robert Glennon, is that the total amount of fresh water available is getting smaller. Some sources have become polluted. Groundwater that takes decades to replenish is being drained like there's no tomorrow. Dry times lie ahead, unless we all change our habits along with our fixtures. It's time to treat fresh water like blue gold.

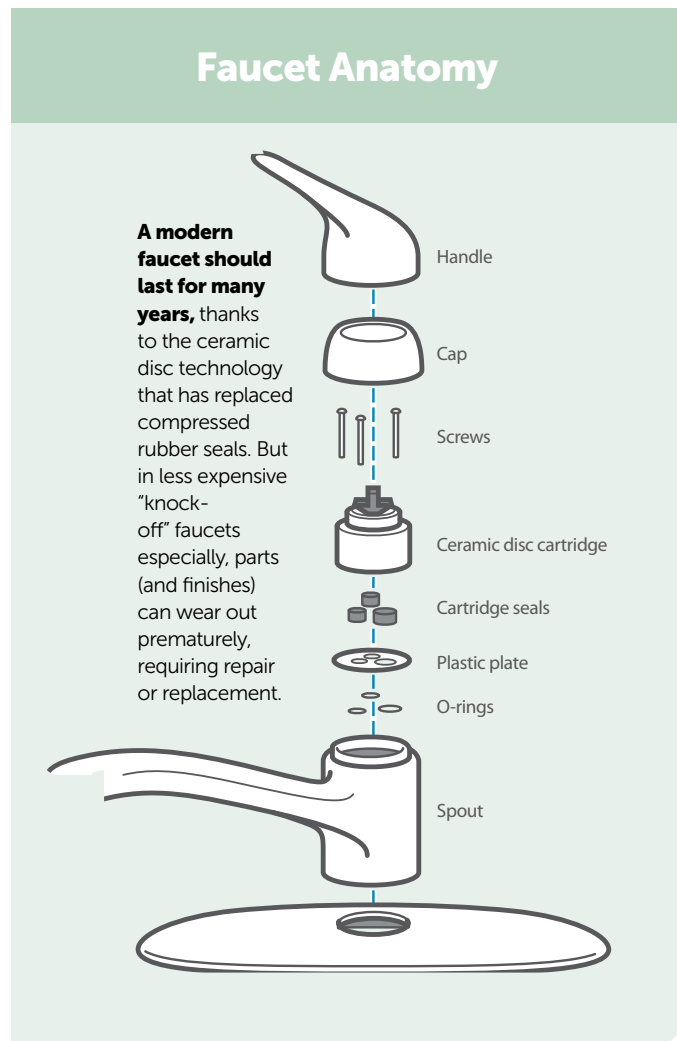
It's important to make sure all the faucets, fixtures, and showerheads in your home are on their best behavior. That means installing the most durable, water-stingy, appropriately priced models available. If you're not sure how to recognize these parameters, here's a quick overview.

FAUCET FUNCTION

Better Technology

In modern faucets, ceramic washers have largely replaced rubber ones. These diamond-hard discs should last forever. But in our

continued on next page



www.greenbuildermag.com 11.2013



VISION HOUSE® TUCSON PRODUCT KOHLER Moxie Showerhead and Speaker

This showerhead comes with *Bluetooth* technology and a wireless speaker that can be played in or out of the shower. Available in both a 2.0-gpm and a 2.5-gpm spray, it not only looks great, but also helps save on water usage. The silicone sprayface makes it easy to wipe away mineral buildup.

<http://tinyurl.com/nhdlw2o>



Delta Transitional Water Efficient Showerhead

This modestly priced showerhead comes with a lifetime faucet and finish warranty. It reduces water flow to just 1.6 gpm, but uses proprietary technology to keep water pressure comfortable. www.deltafaucet.com

experience, that's not always the case. We've seen less expensive faucets and shower handles, even ones with ceramic discs, develop leaks within a year or two of installation, possibly because other parts of the assembly are not as tough. Fortunately, many faucets—even low-cost ones—now come with limited lifetime warranties that cover all part failures for the original owner. Still, who wants to chase down warranties? The easiest solution: Spend a little more up front for a brand that cares about its reputation, and chances are you'll get a better made, more durable product.

FAUCET FINISHES

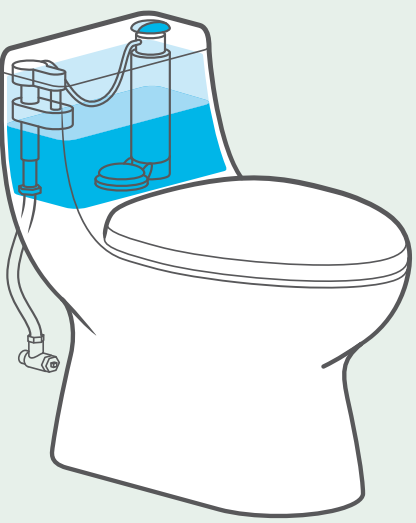
New Durability

Ever heard of physical vapor deposition finish? It's just one of the high-tech finishes being used on faucets. With these advanced surface treatments, alternatives to chrome (one of the longest lasting finishes) make more sense. In some cases, metals such as bronze and brushed nickel are simply protected with a polymer coating. In others—Delta's "Brilliance" finish comes to mind—the coating emulates a metal such as brass.

The green angle? Durability. When faucets corrode, people throw them away, whether or not the mechanics still perform properly. Tossing functional hardware in the landfill is not a green choice.

continued on next page

How Much Water?



SINGLE FLUSH	
5 gpf	= 36,500 gallons/year
3.5 gpf	= 25,550 gallons/year
2.5 gpf	= 18,250 gallons/year
1.6 gpf	= 11,680 gallons/year

DUAL FLUSH	
HydroRight Retrofit Kit	
1.6/0.8 gpf	= 7,000 gallons/year




IMAGE SOURCE: WWW.HOMEDOSH.COM

The introduction of dual-flush technology is the latest leap forward for toilets. It's part of a new trend in water saving that puts the onus on the end user to save more water. Existing low-flow toilets can be retrofit with a dual-flush kit relatively easily. For example, the *HydroRight* system (shown above) installs in about 10 minutes.

www.gomjsi.com



Optimized Showering

A good showerhead should restrict the flow of water, yet provide what feels like a thorough soaking. If you feel like the flow is too slow, you may waste more water by taking a longer shower, so it should be "short and sweet."

Waterproof Tile Installation

Standard grout is not waterproof! It must be coated every two years or so to keep water—and mold growth—out of walls. Behind the walls and floors, a waterproofing system such as the one shown below from Schluter (www.schluter.com) can add many years of leak-proof performance to a shower and/or floor.

Dual-Flush Toilet

The best new low-flow toilets allow the user to choose between two flushing modes (#1 and #2, if you will). Non-solids can be flushed with half the water waste. The model shown here is a *Reve*, from Kohler.

IMAGE: VISION HOUSE® LOS ANGELES (LATHAMARCHITECTURAL.COM)

What makes a BATH green?

Moisture Removal

Trapped moisture is the major cause of mold and mildew in bathrooms. Installing a quiet ventilating fan (not shown) is essential. New models have moisture sensors that turn the fan on automatically.



Water Saving Faucets

Well-designed faucets contain ceramic washers that outlast the rubber washers of past decades. They're not as likely to develop leaks, and they restrict water flow without feeling stingy. High-tech finishes prevent corrosion.

Avoid Toxic Cleaners

Keeping highly toxic cleaners such as bleach and clog removers under your sink is a good way to pollute your bathroom air. Purchase non-toxic cleaners instead, and make your bathroom a friendly place for kids and pets—as well as adults.

PRO TIP:

Epoxy Grout. One way to reduce the maintenance requirements for grout in a custom shower or bath floor is to apply epoxy grout. Much more resistant to mold and mildew than standard grout, it costs more and requires more skill to apply, but has major durability advantages. A Laticrete product is shown.



PLUMBING

Think Flexible

Flexible PEX (crosslinked polyethylene) plumbing has become widely accepted as a substitute for other standards of household plumbing. Fittings have improved, problems are rare, and most plumbers have come to embrace the technology.

From a green perspective, tubing made from high-grade plastic is a welcome alternative to vinyl-based PVC pipe. And from a practical perspective, PEX is ideal for tricky retrofit jobs, because the flexible tubing can snake around obstacles, so you can avoid unnecessary demolition.

SUPER TOILETS

Water Misers

The toilet efficiency race has been a big win for the environment. We've seen models with water usage of less than .8 gpf in dual-flush models, and a 1 gpf single-flush model. Flush technology is probably approaching its bottom limit.

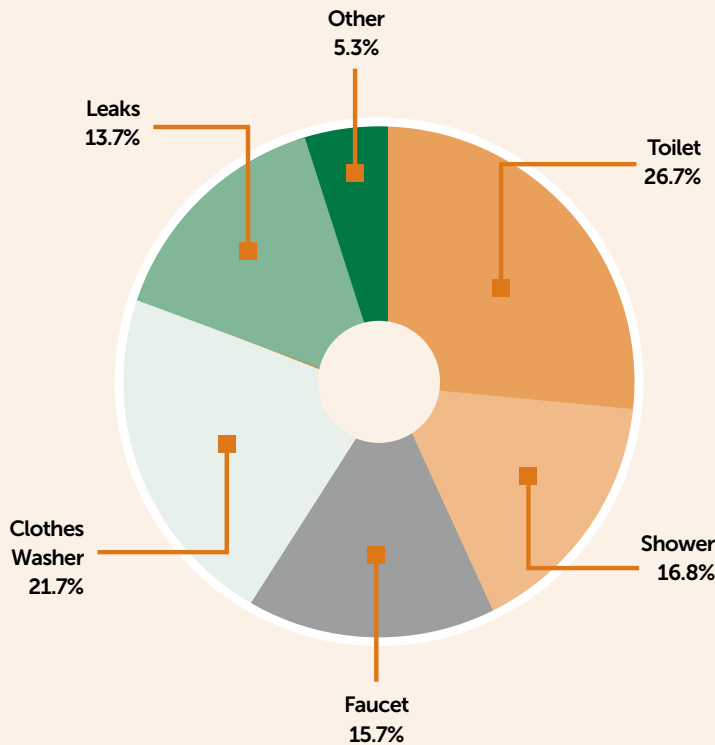
But other approaches may squeeze water savings. For example, graywater-fed toilet tanks are now on the market (ones that use lavatory water to fill the toilet tank), along with hand-washing faucets built right into the top of the tank.

Manufacturers will continue to tweak toilet efficiency, no doubt, but the biggest gains could probably be made by simply adjusting our behavior: "If it's yellow, let it mellow." **GB**

Glossary of Terms
Know the Lingo

- **Low-Flow Toilet:** Also known as a low-consumption toilets, these fixtures typically using a maximum of 1.6 gallons per flush.
- **Ultra-Low Flush:** Another term to describe low-flow fixtures, this may also refer to a single- or dual-flush model that uses as little as .8 gpf.
- **Aerator:** Small screened device that fits inside a faucet nozzle, mixing air into water so less is required to do the same chore.
- **Widespread Lavatory Faucet:** Refers to the style of faucet, typically one with two separate handles, 8" apart.
- **Physical Vapor Deposition (PVD):** High-tech finishing technique that allows for faucets with many different looks, including "metal on metal" surfaces that are extremely corrosion- and wear-resistant.
- **PEX Tubing:** Crosslinked polyethylene plastic pipe. Increasingly popular as a replacement for PVC or copper plumbing.
- **Cartridge Faucet:** Most modern faucets contain ceramic cartridges that allow water to flow, whereas older faucets used compression—squeezing a rubber o-ring that would eventually wear out.

Daily Residential Indoor Water Use (before conservation measures)



If all U.S. households installed water-saving features, water use would decrease by 30%. This would save an estimated 5.4 billion gallons of water per day, resulting in daily dollar-volume savings of \$11.3 million, or more than \$4 billion per year.

The largest daily user of water in the home is the toilet. By replacing this one product with a high-efficiency toilet (HET) you can greatly reduce a home's total water use.

SOURCE: AMERICAN WATER WORKS ASSOCIATION RESEARCH FOUNDATION, "RESIDENTIAL END USES OF WATER"

Finishes¹⁰

More than meets the eye.

57

It's much easier to find paints and adhesives that contain fewer VOCs and metals than their predecessors, but make sure you read the fine print.

PAINTS AND ADHESIVES in the United States have come a long way. They no longer contain lead or other heavy metals. Most contain only a fraction of the volatile organic compounds (VOCs) they did ten years ago. Oil-based (alkyd) paints have largely been replaced by water-based latex products. But the conversion hasn't always been smooth, and it's far too early to declare "mission accomplished."

Some of the first brands of ultra low-VOC products got a bad rap a few years ago. These new paints were not as stable, harder to apply, and almost impossible to find. They set back the transition to "green" paint, especially among contractors.

But those quality problems have been solved. Most of the latest generation of low-impact paints and adhesives perform almost as well as their solvent counterparts. But beware of exaggerated green claims. Some companies like to hint that their paint brands are eco-friendly, when they're really just doing the bare minimum—meeting regulatory standards. The same consumer caution should apply to adhesives. Remind yourself that the color of a product's container or labeling may have nothing to do with what's inside.

As you consider low-VOC, no-VOC and other emissions claims, here are some points to consider.

Glossary of Terms

Know the Lingo

- **Volatile Organic Compounds (VOCs):** Toxic ingredients common in paints, adhesives, and many household items that are released into the air.
- **Hazardous Air Pollutants (HAPs):** These substances were listed in the 1990 Clean Air Act Amendments. Here's the EPA list: <http://www.epa.gov/ttnatw01/187polls.html>
- **Alkyd:** Commonly referred to as "oil based," this type of coating is typically higher in VOCs than water-borne paint, containing a petroleum-based solvent and a binder of synthetic resin.
- **Acrylic Latex:** This widely used finish uses water as a solvent, and tends to be lower in VOC content than alkyd products, although it may offgass more slowly.
- **Breathe:** How well a paint allows water vapor to pass through it without blistering or failing.
- **Back Priming:** Coating the back or hidden face of siding or trim prior to installation as an added measure of protection from moisture.

VOCS

They're Not the Only Villains

Just because a paint is low in volatile organic compounds, doesn't mean it's safe to apply it in your home without wearing property safety gear—or that it won't release other dangerous pollutants. VOCs are just one category of paint ingredient. Even if a paint contains no VOCs at all, it may contain hazardous airborne pollutants (HAPs). These take the form of both gases and tiny particles that have been shown to cause respiratory trouble,

continued on page 64



Mythic Paint

Mythic has been a leader in the no-VOC category of paints. The company also offers some information about other toxins such as formaldehyde that are not in its products, although it could go further to identify other ingredients.

www.mythicpaint.com



Olympic Premium Interior Paint

Widely available in retail outlets, Olympic's premium line of paints and primers contains no VOCs. We'd like to see the company raise the bar higher by publishing a disclosure about the ingredients that have replaced the toxic binders and solvents.

www.olympic.com

What makes FINISHES green?

Clean-Air Paints

Use only low-VOC paints in the home. Bear in mind, however, that low-VOC products can still contain toxins. Sometimes, VOCs are replaced with something worse. If you want truly toxin-free you'll have to go with something such as a milk-based or organic paint.

Caulking Considerations

Certain types of caulking can contribute to indoor air pollution. But in our view, caulking *quality* matters too. If you use a 100% silicone product, it will offgas quickly. Once it dries, you're in the clear.

Floor Finishes

Whenever possible, order pre-finished floors, whether hardwood or bamboo. Finishing them at home without creating a lot of air pollution is tough.

Formaldehyde Free Millwork

It's more challenging than you might think to find cabinetry and shelves that are not loaded with chemicals and other ingredients harmful to human health. Ask for CARB-approved plywood or real-wood shelves and sides. If the only products available are Medium Density Fiberboard, make sure you choose a brand that has very low formaldehyde content. Seal unfinished sides with *Binz* or some similar product to contain the offgassing.

PRO TIP:

Tile Is Always an Option. Floor tiles, installed carefully produce almost no harmful offgassing. Some brands, such as Crossville's Virtue line, contain 4% recycled content and are Green Square certified. The porcelain tile also can be treated with *Hydrotect*, a fired-on coating developed with Toto Corporation, that's comprised of a triple silver-copper-titanium dioxide mixture. The coating has antimicrobial, dust-repelling, self-cleaning and even air-purifying effects. *Origins* glass tile is shown. www.crossvilleinc.com/residential

Exterior Paint: Making It Last

UNFORTUNATELY, PAINTING YOUR home is not a green activity. Why? Because products such as acrylic latex have a very high embodied energy—producing them takes a toll on the environment. It's key, therefore, to maximize paint durability. You might think that switching to vinyl siding is a more "permanent" solution, but vinyl products come with a different set of environmental drawbacks. There's no perfect solution. You can, however, take several steps to make sure paint lasts as long as possible on your new siding. Old siding is a bigger challenge, but in general, the same rules apply.

Order Pre-Primed Wood or Fiber Cement

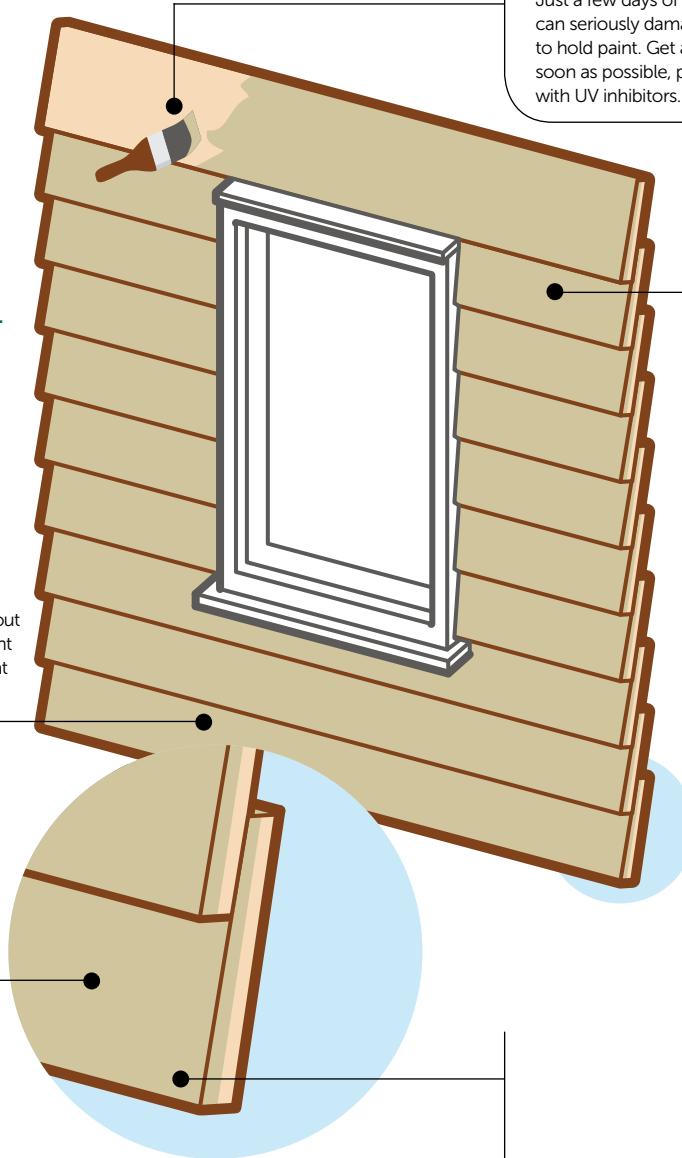
Boards that are pre-primed in a factory tend to hold their paint longer than siding that's painted in place. This is true for several reasons. First, if handled properly, factory-painted wood tends to be coated only when the wood reaches an optimal level of moisture saturation, typically about 15%. Also, the primer is usually applied to the front side, back side and ends of each board. Note that it's key to recoat primed ends after cutting.

Play Rough

Research has shown that boards with a slightly rough texture tend to hold paint much better than smooth sanded surfaces. If ordering cedar, pine, or other natural finishes, ask about different texture options.

Choose Cool Colors

Paints exposed to regular cycles of extreme heat undergo more stress, shortening their useful lifespan. One simple solution is to specify lighter colors on wood exteriors, especially in hot climates on the sides of the home that get several hours of sun each day.



Cover Up Quickly

Just a few days of exposure to UV rays can seriously damage the ability of wood to hold paint. Get a coat of primer on as soon as possible, preferably a product with UV inhibitors.

Use Durable Fasteners

It's easy now to find exterior fasteners that will not rust and stain wood. Spend a little extra for the best fasteners you can find. You may add years to the viability of each paint job.

No Freezes Please

Water-based paints that have been stored too long may lose their chemical consistency. Worse, if they're allowed to freeze, their performance may suffer. Don't risk painting with a compromised can of paint. The amount of labor versus the price of new paint makes that a bad deal.

Seal End Grain

Often, siding and trim boards weather and crack on the ends—for a simple reason: They were not coated properly when the rest of the home was primed and painted. If possible, coat them with a good sealer before installation.

especially for people with asthma. Household cleaners and bath products often contain both VOCs and HAPs as well, so you can't blame paint for all your indoor air quality issues, but when selecting a finish or an adhesive or caulk, make sure the manufacturer gives a full account of all potential pollutants, not just VOCs.

FACTORY FINISH

A Green Idea

For certain painting and finishing projects, doing the job at home may not be the best option if you want to limit the volume of pollutants released inside. For cabinets, shelves and flooring, you often have the option of a "baked-on" factory finish. This may require an extra day or two for delivery, but it's well worth the time and cost for people sensitive to paint fumes. At the factory, high heat speeds the paint or stain's release of VOCs and other toxins. That accelerated pollution happens in a controlled environment, not inside your home.

ADHESIVES

The Fine Print

Like paints, adhesives are now marketed as low-VOC and eco-friendly. But as with paint, it's important to get all of the facts—not simply to accept the branding pitch. For example, Gorilla

brand last year released *Gorilla PVC*, an adhesive for use in PVC plumbing—a product it markets as "eco-friendly." But if you read the fine print, the glue contains contains N-methylpyrrolidone (NMP), "a chemical known to the State of California to cause birth defects or other reproductive harm."

CAULKING

Seal the Deal

For the most part, latex-based caulking tend to release less toxins during application and initial drying than their solvent-based counterparts.

But the verdict is still out about how latex products impact air quality over the long term. It's important, however, with both paints and caulking, never to use exterior products indoors. They tend to contain more volatiles.

There's also the question of durability. While 100% silicone caulk produces strong initial offgassing (some of which is from vinegar in the mix) it's also likely to perform better than an acrylic-latex based product, particularly in wet areas.

As you can see, choosing a green paint or adhesive is not always as easy as reading a label. You have to shop carefully, understand how and when this product should be applied, and weigh whether the product's air quality benefits are as good as they sound. **GB**

Low-Emitting Materials: Paints and Finishes Requirements

For architectural paints, finishes and primers applied to interior walls and ceilings, these are the Green Seal standards for VOC content limit (in grams per liter).

Flat finishes:	50g/L
Non-flat finishes:	150 g/L
<hr/>	
For anti-corrosive and anti-rust paints applied to interior ferrous metal substrates, the limit is somewhat higher:	250 g/L

For clear wood finishes, floor Finishes, stains, sealers and shellacs applied to interior elements, the VOC content limit is as follows:

Clear wood finishes:	350 g/L for varnish
.....	550 g/L for lacquer
<hr/>	
Floor Finishes:	100 g/L
<hr/>	
Sealers:	250 g/L for waterproofing sealers
.....	275 g/L for sanding sealers
.....	200 g/L for all other sealers
<hr/>	
Shellac:	730 g/L for clear
.....	550 g/L for pigmented
<hr/>	
Stains:	250 g/L

SOURCE: WWW.LEEDUSER.COM

Cabinets & Tops ¹¹

61

Follow your nose—and keep nature in mind.

Many small cabinet makers have made great strides toward wise resource management, and reduced indoor pollutants in their products—and some of the big players are (finally) getting serious.

BACK IN THE MID-1990S, it was almost impossible to find off-the-shelf cabinetry that didn't contain particleboard saturated with formaldehyde, with the exception of one or two semi-custom high-end or European manufacturers. It's easier now, but primarily because of the efforts of small-scale cabinet shops. The U.S. cabinet industry at large, like the carpet industry, has been a follower—not a leader—in the arena of environmental responsibility and pollution control.

In 2006, the Kitchen Cabinet Manufacturers Association (KCMA) launched an in-house sustainability benchmark called the Environmental Stewardship Program (ESP). The program has some flaws, but at least it's a move toward the light. Many firms have used ESP guidelines as a baseline for how to improve sustainability. Keep in mind that not every green cabinet line will be KCMA certified, any more than every eco-friendly builder's work is LEED certified. But those that do get the ESP seal have at least taken some steps to clean up their practices and products.

Glossary of Terms

Know the Lingo

- **Particleboard:** Wood chips bonded together with resins that frequently contain air pollutants such as formaldehyde.
- **Medium Density Fiberboard (MDF):** An engineered wood often used in cabinet door construction. MDF may also contain volatile air pollutants.
- **Veneer:** Thin layer of wood typically glued to a less valuable substrate. Both the adhesive and the substrate can contribute to indoor air pollution, depending on the glues used.
- **Substrate:** A panel that's used underneath higher value finish materials. In cabinetry, substrates typically are made of plywood, particleboard or other engineered wood products.
- **Surface Seal Paint:** Some finishes, such as AFM Safecoat *Hard Seal*, have a low enough permeability that they can be used to prevent or slow the release of air pollutants from particle board and other resin-bonded materials.

ESP offers manufacturers 105 possible points. They have to get 80 to qualify for certification. It should be noted that they *self certify* by sending in documentation (often from other industry-friendly organizations such as the Composite Panel Association) to prove that they have met certain criteria.

A cabinet company looking for the ESP label must achieve a *continued on page 64*



VISION HOUSE® TUCSON PRODUCT Vetrazzo

Vetrazzo recycled glass countertops are in a matrix that resembles terrazzo. Vetrazzo is 85% recycled glass and other content (by volume). Countertops made in the Emerald Coast color the glass is from green float glass used in construction, plus oyster shells from the South Carolina coast and bits of marble from the historic Georgia Marble Quarry.

www.vetrazzo.com/eng



VISION HOUSE® TUCSON PRODUCT Gladiator Storage Solutions

No need to have a messy garage. Gladiator has bike storage, their GearBox system, shelving, hooks and other wall applications, stools and more. Gladiator helps homeowners actually have the room to park the car in the garage.

www.gladiatorgarageworks.com

What makes CABINETS and TOPS green?

Solid Wood Construction

Finding kitchen cabinets and shelves that are made with zero formaldehyde or other offgassing substances can be challenging. Most of the MDF used for shelves and doors (commonly known as particle board) used in cabinets tends to offgas for months—or even years. One workaround is to have a local woodworker make them.

Recycled Countertops

Many varieties of durable, partly recycled countertops are now available, such as the Paperstone product shown here. Other options include quartz-based products such as Vetrozoo (see previous page). These materials require far less environmental impact than imported stone such as granite.

Safe Finish

Try to use water-based final coatings for your cabinet and floors. Spend extra to buy the most durable finish you can find. Every time you have to re-coat surfaces, you introduce toxins back into your living space—and extract more resources from the natural world.

PRO TIP:

Remember the Range Hood.

If you go to all this trouble to keep the air clean in your kitchen, then fail to install a vent fan on your range, you will be disappointed in the overall air quality in your home.

PHOTO: TRUDEAU ARCHITECTS, RANDALL PERRY PHOTOGRAPHY

What Makes a Cabinet Green?

Engineered Wood Veneer

As a surfacing option, thin wood veneer is considered green because it can be made from younger growth trees or with leftover scraps from furniture factories.

KCMA Certification

The Kitchen Cabinet Manufacturers Association has its own green certification program called the Environmental Stewardship Program (ESP). As with any industry self assessment, ESP certification should be used as a baseline to identify green-minded companies, not a guarantee that a particular brand will meet all of your sustainability expectations. Keep in mind that many companies that make sustainable cabinetry and shelving do not pursue KCMA certification.

Low-Impact Paint or Stain

To limit VOCs from paints or stains, you have two options: If you're set on a hard, glossy enamel finish, the best bet is to have it baked on at the factory, where it can fully offgas. For cabinets finished onsite, low-VOC, water-based stains or paints should be specified.

Certified Wood Doors

The lumber used in doors and other parts of the cabinet box should come from companies certified by FSC, SFI or another credible certifying organization.

Moisture-Proof Feet

By putting metal or polymer feet on a cabinet, you keep it out of harm's way—more specifically, if a leak develops, moisture won't have a chance to saturate the bottom panel, inviting mold or mildew and shortening the life of the unit.

Clean Core Materials

The formaldehyde-bonded particleboard and plywood often used for shelving is bad for indoor air quality. New products include agrifiber panels (typically straw-based), that use low-VOC binders to replace formaldehyde glues.



Straw is replacing wood in some types of cabinet base shelves.

SOURCE: WWW.AZEXIS.COM

INSPIRATION FOR THIS IMAGE:
CRYSTALCABINETS.COM

minimum number of points in each of the following categories:

Air Quality.....30
Product Resource Management.....30
Process Resource Management.....20
Environmental Stewardship.....15
Community Relations.....10

Some points are sound—such as the 5 points awarded under ESP for “reviewing the environmental practices and policies of its key vendors and contractors,” although *reviewing* it should be noted, does not guarantee any changes. Unfortunately, other point criteria act as loopholes that weaken the program. For example, a company can earn 10 points in Air Quality if “75% of finished products are finished domestically, and finishes used emit no greater HAPs (hazardous air pollutants) than allowed by local plant operating permits.” We’d call that simply playing by the rules. They also can earn 5 Community Relations points for not getting any citations “from any federal, state or local environmental regulatory agency in the previous 12 months.” Again, they can rack up points

simply for staying on the right side of regulations. Our point is not to bash the KCMA, but to urge its many members to think much bigger about what it means to be green. We often write about ESP-certified cabinet brands that are being used in our demonstration homes and other projects. We know these companies, and they’ve indicated that they want to get real about sustainability. We believe they’re sincere, and we expect exciting new cabinet products soon.

Homeowners and builders have been frustrated too long by the lack of readily available green cabinetry and shelving. It’s time to give them more options. For people with asthma, chemical sensitivity, or infants in the house, the only alternative in the past has been to take matters into their own hands, to have their cabinets custom built and finished with low-VOC paints, or to seal in VOCs and formaldehyde with surface sealing paints. They shouldn’t have to work so hard.

A few brands are pointing the way by offering low-VOC water-borne finishes and safer adhesives, along with straw core shelves and wood for both door faces and veneers that is certified by the Forest Stewardship Council. Change is coming. **GB**

Countertops: What’s the Difference?

● Excellent ● Very good ● Good ● Fair ○ Poor

Material	Price per sq.ft.	Overall score	Test results			
			Stains	Heat	Abrasion	Impact
Quartz (engineered stone)	\$50-100	79	●	●	●	●
Granite	45-200	78	●	●	●	●
Laminate	10-30	78	●	●	●	●
Solid surfacing	35-100	62	●	●	●	●
Tile (ceramic and porcelain)	10-30	58	●	●	●	●
Concrete (topical sealer)	80-120	53	●	●	●	●
Stainless steel	100-150	52	●	●	●	●
Concrete (penetrating sealer)	80-120	38	●	●	●	●
Limestone	60-100	36	●	●	●	●
Marble	50-140	26	●	●	●	●

SOURCE: CONSUMER REPORTS

Consumer Reports analyzed various attributes of common countertop materials, including how it handles staining, heat, abrasions and impact. Quartz (engineered stone) got the highest marks, with marble coming in last, primarily because it doesn’t hold up well against abrasions and impact. While both quartz and granite garner high scores, it’s important to remember that large amounts of energy are required to transport these stones, so it’s best to look for a local fabricator. Stainless steel has become quite popular in contemporary kitchens, but it is susceptible to scratching. – *Editor*

Alternative Energy¹²

Today's replacement for yesterday's fuels.

Renewable and alternative energy sources make sense for many homeowners, especially if the home is well built and well designed, with efficient appliances.

PRODUCTION OF ELECTRICITY and hot water at home using natural energy from the sun is nothing new. But technologies have greatly improved over the past few years. Not only do they cost less to install, but they're more reliable, more efficient—and simply a better deal. In addition, the supporting hardware is vastly superior to the old stuff. The politics of alternative energy is changing too, albeit more slowly than many would like. In many states, utilities are now required to buy back any “extra” electricity you produce. And both wind turbines and solar installations are eligible for 30% tax credits with no upper limit from the federal government, plus certain state and utility incentives. If you're looking at alternative systems, here's some essential information.

WIND TURBINES

Lighter Wind Demands

Small-scale wind turbines that create electricity have always been a fairly specialized form of power generation—most valuable in

mountainous and coastal regions. The challenge has been to build a turbine that produces adequate electricity, even in low wind, to make it worth the cost. We're getting much closer. For example, both the Swift (www.swiftwindturbine.com) and the Skystream (www.skystreamenergy.com) turbines begin producing power in winds of just 8 miles per hour.

continued on page 67

VISION HOUSE® TUCSON PRODUCT

Rheem Solar Thermal Hot Water

The Rheem 80-gallon tank holds water heated by flat panels on the roof of the VISION House® Tucson, which features the company's *SolPak Series*. Excess heat from the Rheem heat pump will also help keep water hot. The Rheem net-zero energy system



includes the following components: the Rheem *Hydronic Air Handler*, indoor coil, *Prestige Series* high-efficiency heat pump and *400 Series* thermostat; Rheem *Solaraide* storage tank; *SolPak* solar collectors; *SolPak* pump station and tankless electric *RTE-27* water heater. www.rheem.com

Glossary of Terms

Know the Lingo

- **Inverter:** Device that converts direct current (DC) electricity into alternating current (AC), the type of power most commonly used by U.S. appliances and light fixtures.
- **Grid-Tied:** Electricity produced on site (from photovoltaic panels, wind turbines, etc.) is fed directly into local power lines, rather than being stored in batteries.
- **Cogeneration:** Production of electricity from heat that would otherwise be wasted, such as hot flue gases produced by a gas-powered furnace or boiler.
- **Wind Maps:** Useful for siting (and evaluating the viability of) wind turbines, wind maps show how much wind can be expected in a geographic region or specific site.
- **Building Integrated Photovoltaics (BIPV):** Electricity generating solar panels that have been designed to resemble various familiar types of roofing.
- **Standby Heat Loss:** Heat lost by hot water that is sitting passively in a storage tank or pipes. Super-insulated hot water tanks greatly reduce this loss.

VISION HOUSE® TUCSON PRODUCT

Schneider EVlink Indoor Charging Station

The *EVlink* charges vehicles quickly and features an integral ground-fault circuit interrupter (GFCI), automatic recovery and restart after a power loss and user-friendly LEDs to display status, such as charging and power. It works with a greater number of applications, including locations wired for either 208 or 240 voltage.

www.schneider-electric.com/us



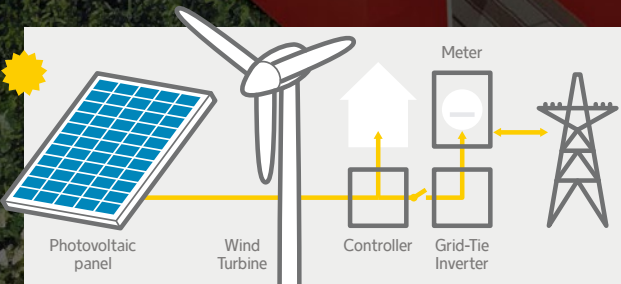
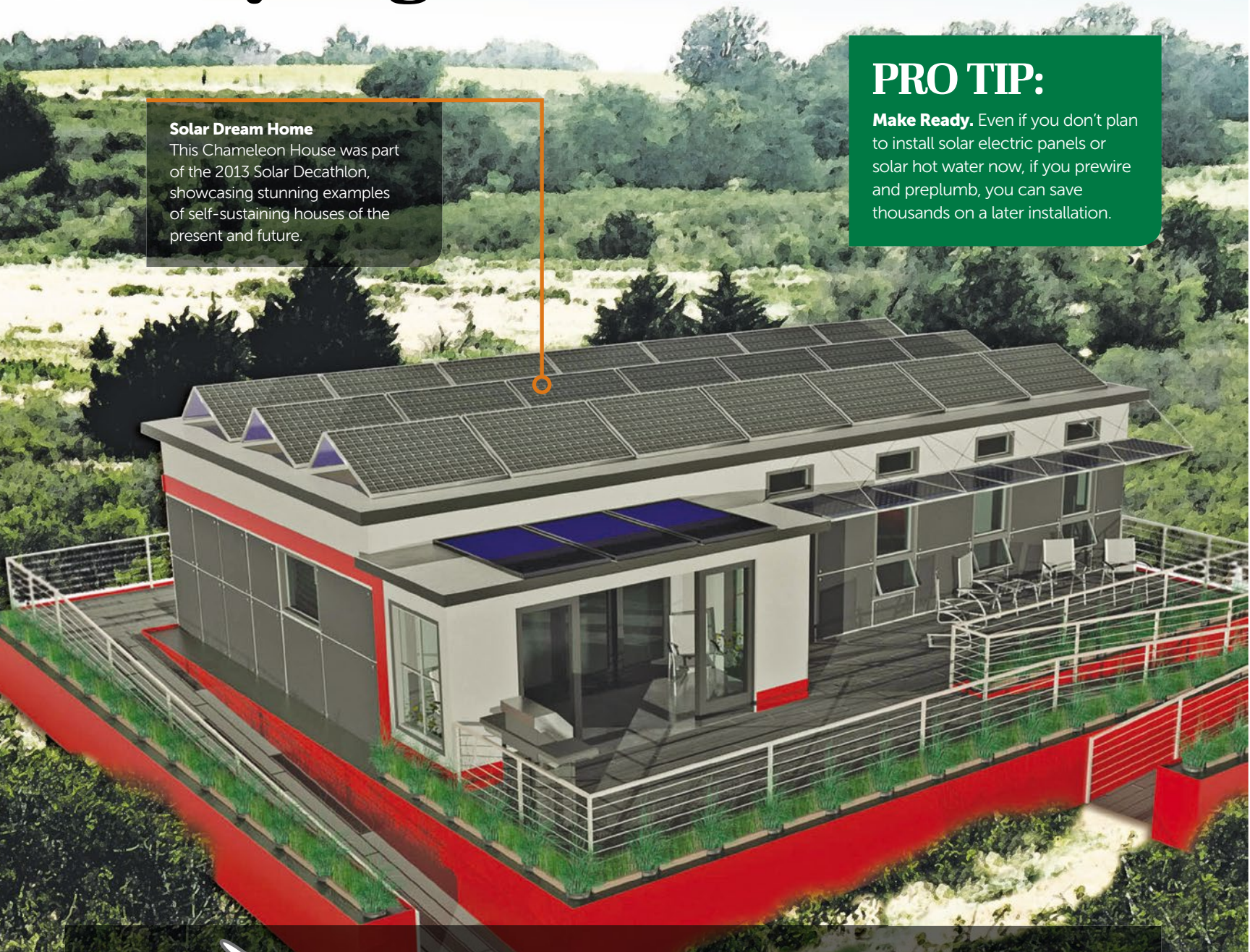
Will you go “OFF THE GRID?”

Solar Dream Home

This Chameleon House was part of the 2013 Solar Decathlon, showcasing stunning examples of self-sustaining houses of the present and future.

PRO TIP:

Make Ready. Even if you don't plan to install solar electric panels or solar hot water now, if you prewire and preplumb, you can save thousands on a later installation.



Different Approaches to Solar at Home

Creating electricity with either photovoltaic panels or wind turbines typically begins with production of direct current (DC) electricity. That current then passes through a transformer to become the typical alternating current (AC) used in almost all homes (aside from some RVs and boats). Most modern systems do not include battery storage, simply because battery technology has not matured enough to warrant the expense and environmental impacts. That may change in the next few years, but for now, the best bet is a grid-connected system that can later be reconfigured for advanced batteries.

The advantage of wind power over PV? The wind often blows when it's dark outside. But before you buy, take a look at the national wind map published by the National Renewable Energy Laboratory (NREL). You'll see that not every area of the United States is well suited for wind-powered living. In fact, if you live in any of the Southeast states—and you don't have a place right on the water—wind is a long shot. You will make a lot more power with a good solar PV setup.

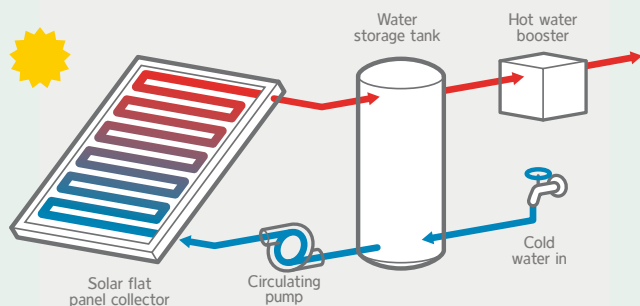
PHOTOVOLTAICS

Looking Sharp

The race is on to build better PV cells that convert sunlight to electricity. New solar films and panels are being tested that are more efficient, less expensive and lighter than ever. The current challenge is to find a more affordable alternative to the polycrystalline silicon based panels that dominate the market. But while that R&D is going on, existing solar products are becoming more practical. For example, Sanyo recently came out with double-sided solar panels that can simultaneously provide shade (in the form of an awning), and take in sunlight on both the top and bottom surfaces.

At the same time, the range of building integrated photovoltaics (BIPV) has exploded. That's good news for homeowners. It means you can now have a solar generating system built right into your roof that looks like asphalt shingles or architectural metal or even clay tiles. And, as we mentioned earlier, many states require utilities to buy any leftover electricity you generate. One of the key improvements in BIPV in recent years has been the way they connect to each other and your home's power system. The early products were co-dependent. In other words, when the connection broke on a solar shingle, the whole roof stopped producing. Newer systems have built-in redundancy in their wiring, and most are more modular, making replacement of a single faulty tile or panel less of a hassle.

SOLAR HOT WATER



Typical Solar Hot Water System

Using the sun to heat your home's hot water is a time-tested idea. Typically, the liquid circulating from these panels to your home's hot water tank is not water, it's something that won't freeze or boil easily, such as glycol. The heat is transferred to your fresh water inside the tank—and that's where some of the best new technology is found. The latest insulated hot water tanks don't rust, and the best ones lose less than half a degree per hour. That heat you collect from the sun can be stored for days.

Small-Scale Cogeneration



The freewatt Plus Warm Air System captures waste energy from a furnace component and converts it into electricity, producing 1.2 kW whenever the furnace is running. It also provides backup power during an outage. <http://tinyurl.com/lyh6fzm>

SOLAR HOT WATER

Smart Storage

The availability of extremely durable hot water storage tanks—which in some cases also serve as water heaters—has made solar hot water collection even more viable. Many tanks now include a separate closed loop of a freeze-resistant liquid. That extra loop is specifically for solar hot water—so that when the sun is shining, the solar panels on the roof heat the clean water in the tank. But when the sun is not sufficient (or you have teenagers using up the “free” hot water) an external boiler or heating system built into the tank kicks on to make up the difference.

One of the great advantages of a solar hot water system is the relatively rapid payback. In other words, if you install this year, it may pay for itself in less than three years, especially once you figure in the tax credits and rebates available.

COGENERATION

Waste Not

Cogeneration has been common at large factories for decades. It's basically a way of squeezing more work out of fossil fuels. Also known as combined heat and power (CHP) generation systems, these mechanical wonders put the waste heat generated by a home furnace or boiler to work making electricity. By some estimates, they achieve 90% efficiency, compared with 30%–40% from your local power station. If you're already replacing or installing a new boiler or furnace, why not take it to another level and try cogeneration? **GB**

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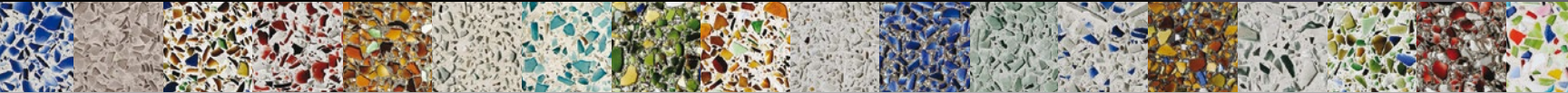
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Home: Where the *Hope* Is

EVERY TIME I TRAVEL ON BUSINESS, and that is far too often nowadays, I find myself remembering that old adage, “home is where the heart is.” When practically the first thing you do upon returning home is start booking flights and lodging for the next trip, it is impossible to ignore just how great it feels to be *home*—even if you know that the light at the end of the tunnel is your next encounter with the “FASTEN SEAT BELT” sign. But I digress...

Last month we were all witnesses to the ridiculous debacle inside the Beltway, as our elected officials disgraced themselves and our system of government while playing chicken with our economic future—as if it were all a schoolyard game. Both ends of the political spectrum displayed their selfish lack of responsibility, while the rest of us mostly watched in dismay and disgust.

At the time, I was struck by how frequently one spokesman or another would attempt to claim the imaginary high ground by declaring “what the American people want”—as though he or she spoke for the majority and not just some narrow slice of the electorate, essentially the special interest group from their district who got them elected, and who now holds them hostage to their ideology.

The same thing happens every day when it comes to what people want and expect in their homes. Economists, sociologists, politicians, marketers, manufacturers and trade associations spew endless propaganda in our direction, in their efforts to convince us that they know what homeowners and homebuyers want—all of which is designed to gain some advantage in reaching their goals.

I can’t speak for anybody else, but I know what I want: I want *home* to be the place where I feel the most comfortable, the most secure, the most at ease. I want to rest assured that it will shelter me and the ones I love from the storm, and from the chaos and confusion that unsettles so much of daily life in these turbulent times.

I want to have a certain level of confidence that I can be self-reliant—that if the power goes off or the highway bridge to town gets washed out, we will be just fine. I want to know that I can rely on my neighbors, and that they share that assurance. At the end of the day, we know we are in this together, and that no matter what a bunch of egomaniacs and zealots waste their time (and a lot of our money) on, we will be here long after they are gone and forgotten.

Home, I think, is the only place we really trust to keep our hope—the place where we can plan for the future, and let our hearts dream. **GB**





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