

Award-Winning Coverage of Sustainable Construction, Products and Lifestyles

# GREEN BUILDER<sup>®</sup>

The Homeowner's Handbook 2017 / [www.greenbuildermedia.com](http://www.greenbuildermedia.com)

## THE HOMEOWNER'S HANDBOOK

THE 8TH EDITION of our free guide for eco-minded homeowners goes "back to basics," offering hundreds of good ideas for building and outfitting a super-sustainable home.

**ADVICE** from  
green pros on the  
best systems and  
practices to fine  
tune your home.

**RECOMMENDATIONS**  
on the most durable  
and efficient  
building materials  
and products.

**TIPS** on planning  
and building the  
sustainable home  
of your dreams.





Green  
Builder®  
Media *presents*

# FLEX HOUSE

by Shelter Dynamics

## The Flex House: Right-Sized Living

Green Builder® Media and Shelter Dynamics proudly introduce The Flex House, a model for “Right-Sized” living in a small, flexible space that is completely connected, intelligent, resilient and sustainable.

To us, “Right-Sized” living doesn’t just refer to square footage. It also means having the flexibility to adapt your home to your evolving lifestyle and consuming only the natural resources that you need—no more, no less.

The Flex House boasts a fully integrated smart + solar system, using advanced, intelligent technology to streamline energy usage. The house serves as its own microgrid, producing all of its own energy. The Flex House features water conserving products and fixtures, and non-toxic, sustainable materials to ensure healthy indoor spaces.

**Visit The Flex House at CES (January, 2018 in Las Vegas).**

To learn more about The Flex House, visit  
<http://www.greenbuildermedia.com/vision-house-flex-house>  
or contact Cati O’Keefe at [cati.okeefe@greenbuildermedia.com](mailto:cati.okeefe@greenbuildermedia.com)

### PROJECT PARTNERS



### PROJECT SPONSORS



Movie stars. Heads of State. Your mother-in-law. With the ActiClean self-cleaning toilet, you’ll be ready.

In a world full of surprise visitors, it’s nice to know your clients can always count on a clean toilet. With a simple push of a button, the ActiClean self-cleaning toilet sends a powerful stream of cleaning solution to scrub the bowl deep-scour clean. Easy to install and beautiful with any bathroom design, ActiClean from American Standard is ready no matter who walks through the door. See how it works at [americanstandard.com](http://americanstandard.com)

*American  
Standard*

# EDITOR'S NOTE

The Inside Scoop

By **Matt Power**  
Editor-in-Chief

## Back to Basics

Don't let fear make you hasty. Address the fundamentals, and your home will feel like the safe haven it should be.

THERE'S A CRACKLING TENSION IN THE AIR? Can you feel it? Part of it, of course, is the the chaotic state the world's climate: from superstorms to uncontrollable wildfires. On top of these shudders from the planet is the often racist, childish and violent rhetoric from our political leaders. It's no wonder that more people are circling the wagons, "fortressing" their homes with security systems, surveillance cameras and generators.

We don't have to make choices about our homes from a place of fear. If we slow down a little, take a deep breath, and look at how we live from the ground up, creating a safe, low-energy, durable home seems far less daunting. We can't prevent the Yellowstone volcano from exploding and wiping out life on Earth, but we can create a home that you can practically heat with a candle, that will stand up to the next hurricane,

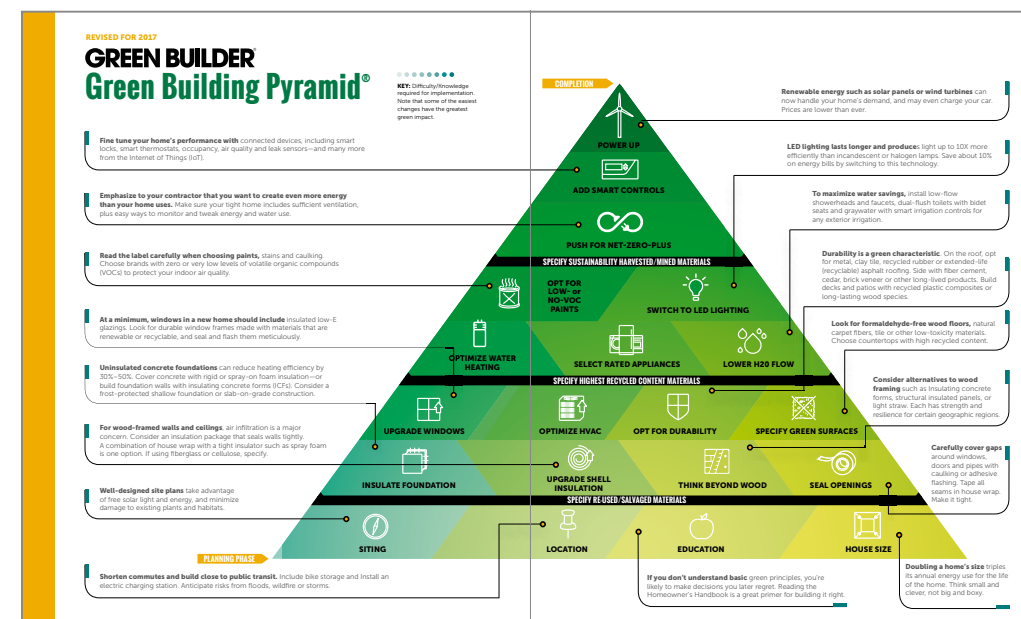


provide most of its own power, and not look like an alien spaceship.

What I'm talking about is good building science. The aspects of our homes that most affect our future selves happen in the planning and construction phase. That's why I created a diagram called "The Green Building Pyramid" about 8 years ago. Since then, the pyramid has been copied and changed slightly and republished by many different publications (usually without credit to the original author).

The premise of the Pyramid is simple. Focus on the lowest cost/big impact aspects of construction first. These include WHERE you build your home, SITING it in relation to the sun, and SIZE of the floorplan. Next, move up the pyramid, building a durable, super-efficient shell, one step at a time. Use the best wall system for your region, the right windows, the most durable siding, and so on.

When I first created the Pyramid, wifi smart home systems were still a luxury amenity. That's something that has changed rapidly. So I've added suggestions of when and where to introduce these bells and whistles into the building process. The premise is still the same. Electronics and other sensitive technology such as solar panels and inverters become vastly more effective if they rest on the sturdy base of other choices along the building path. Build it right, with performance and self-sufficiency in mind, then add smart thermostats, smart locks, and every security system you want. Build as small as you can manage, and spend less time managing, more time living, resilient in the face of anything the world throws at you over the coming years. **GB**



**Priorities.** By working from the ground up, you can arrive at the safe, durable home of your dreams.

# UNITED WE BUILD



**YOHE ROJAS**  
Team Leader  
Whirlpool plant in Clyde, Ohio

## It matters who makes it.

For consistent, proven quality, count on the number one major appliance manufacturer in the world – Whirlpool Corporation. We're dedicated to delivering consumer-focused technology like the Whirlpool® Ventless HybridCare™ Dryer. This compact, energy-efficient model installs virtually anywhere and uses a ventless heat pump design to recycle air. Of the appliances we make, more than 80% of those sold in the U.S. are assembled in the U.S. So, you know you're getting the highest performance possible from right here at home.



**WHIRLPOOL® VENTLESS HYBRIDCARE™ DRYER - WED9290FC**  
Designed, Engineered and Assembled in the U.S.A.

**Whirlpool**  
CORPORATION

DISCOVER THE ADVANTAGES OF AMERICAN MANUFACTURING. [VISIT INSIDEADVANTAGE.COM/GREENBUILDER.](https://www.insideadvantage.com/greenbuilder)

**A M A N A**

**Whirlpool**

**MAYTAG**

**KitchenAid**

**JENN-AIR**

# GREEN BUILDER®

Volume 12, Issue 7  
The Homeowner's Handbook 2017  
Published by Green Builder® Media

**GREEN BUILDER MAGAZINE EDITORIAL OFFICES**  
PO Box 97  
Lake City, CO 81235  
360-376-4702  
F: 360-376-4703  
[www.greenbuildermedia.com](http://www.greenbuildermedia.com)

**GREEN BUILDER MEDIA LEADERSHIP**  
**Sara Gutterman** CEO  
[sara.gutterman@greenbuildermedia.com](mailto:sara.gutterman@greenbuildermedia.com)  
360-376-4702 x101

**Ron Jones** President  
[ron.jones@greenbuildermedia.com](mailto:ron.jones@greenbuildermedia.com)  
360-376-4702 x102

**Cati O'Keefe**  
Chief Development Officer /  
Editorial Director  
[cati.okeefe@greenbuildermedia.com](mailto:cati.okeefe@greenbuildermedia.com)  
360-376-4702 x105

**ADVERTISING SALES**  
**Craig M. Coale** Publisher  
[craig.coale@greenbuildermedia.com](mailto:craig.coale@greenbuildermedia.com)  
360-376-4702 x103 or 512-344-9754

**Scott Cunningham** Southeast  
[scott.cunningham@greenbuildermedia.com](mailto:scott.cunningham@greenbuildermedia.com)  
678-576-1487  
AL, AR, FL, GA, NC and SC

**Dave Haggett** Midwest  
[dave.haggett@greenbuildermedia.com](mailto:dave.haggett@greenbuildermedia.com)  
847-934-9123  
IA, IL, MN and WI

**John Clemens** West Coast  
[john.clemens@greenbuildermedia.com](mailto:john.clemens@greenbuildermedia.com)  
951-404-7000  
AZ, CA, NV, OR and WA

**AUTOMOTIVE ADVERTISING SALES**  
**Dawn Rivard**  
[dawn@focusmm.net](mailto:dawn@focusmm.net)  
586-214-0635

## GREEN BUILDER® Digital Archive

Looking for a specific building science article about fly ash or wood-burning stoves? Trying to remember the details of a great green house featured in *Green Builder*?

Now you can find digital versions of those archived stories and issues online—free to our print subscribers. We've been steadily adding past issues to our content archive, and the collection is almost complete. **Just go to our website: [www.greenbuildermedia.com](http://www.greenbuildermedia.com)**, and click on "Magazine" to find the archived content you need.

**EDITORIAL**  
**Matt Power** Editor-in-Chief  
[matt.power@greenbuildermedia.com](mailto:matt.power@greenbuildermedia.com)  
207-619-2713

**Alan Naditz** Managing Editor  
[alan.naditz@greenbuildermedia.com](mailto:alan.naditz@greenbuildermedia.com)  
916-681-2057

**O'Brien Design** Art Direction  
[john.obrien@greenbuildermedia.com](mailto:john.obrien@greenbuildermedia.com)  
207-865-9908

**Therese Workman** Copy Editor  
[info@greenbuildermedia.com](mailto:info@greenbuildermedia.com)

**Melissa Smith** Web Editor  
[melissa.smith@greenbuildermedia.com](mailto:melissa.smith@greenbuildermedia.com)

**PRODUCTION**  
**Mary Kestner** Production Manager  
[mary.kestner@greenbuildermedia.com](mailto:mary.kestner@greenbuildermedia.com)  
360-376-4702 x107

**CIRCULATION**  
**Mary Kestner**  
[mary.kestner@greenbuildermedia.com](mailto:mary.kestner@greenbuildermedia.com)  
360-376-4702 x107

**GENERAL INFORMATION**  
[admin@greenbuildermedia.com](mailto:admin@greenbuildermedia.com)  
360-376-4702 x109

**FINANCE**  
**Dan DeGolier** Chief Financial Officer  
[dan.degolier@greenbuildermedia.com](mailto:dan.degolier@greenbuildermedia.com)  
303-503-1000

**Hannah Judson** Controller  
[hannah.judson@greenbuildermedia.com](mailto:hannah.judson@greenbuildermedia.com)  
970-397-5483

ISSN 1559-4971  
The trademark and service mark GREEN BUILDER is registered under the U.S. Trademark Act for a variety of goods and services.

[www.greenbuildermedia.com/subscribe-togreenbuilder](http://www.greenbuildermedia.com/subscribe-togreenbuilder)  
Click above to subscribe to *Green Builder* magazine today!

[www.greenbuildermedia.com/about-green-builder-media](http://www.greenbuildermedia.com/about-green-builder-media)  
Click above to learn more about Green Builder® Media.

**MISSION STATEMENT:** "Our mission is to effect meaningful, positive change for a better world. As advocates for sustainability, we provide mind-expanding information that catalyzes and inspires commitment to sustainable living."

**Problems with your subscription?**  
For assistance, please contact Mary Kestner, Project Coordinator  
[mary.kestner@greenbuildermedia.com](mailto:mary.kestner@greenbuildermedia.com)  
360-376-4702 x107

**Subscription Information**  
Subscribe to *Green Builder* magazine and receive valuable information about how to increase your bottom line, differentiate your business and change the world. At \$39.95, it's an easy return on your investment. Just go to [www.greenbuildermedia.com](http://www.greenbuildermedia.com) and click on "subscribe." To unsubscribe or change your address, e-mail your name, company, and address to: [mary.kestner@greenbuildermedia.com](mailto:mary.kestner@greenbuildermedia.com).

*Green Builder* has reduced its environmental impact through Zerofootprint Offsets [www.zerofootprintoffsets.com](http://www.zerofootprintoffsets.com). Almost all of the natural resources used to produce *Green Builder* will be returned to the environment by planting trees and restoring watersheds. Also, greenhouse emissions will be mitigated through carbon offsetting. (Printed on recycled paper.)



**NEW! SUBSCRIBE TO OUR NEWSLETTERS**  
[www.greenbuildermedia.com/enewsletter-subscribe](http://www.greenbuildermedia.com/enewsletter-subscribe)

**twitter** @greenbuildermag @visionhousegbm

  
[www.instagram.com/greenbuildermedia](http://www.instagram.com/greenbuildermedia)

**facebook**  
[facebook.com/GreenBuilderMedia](https://facebook.com/GreenBuilderMedia)

  
[pinterest.com/greenbuilder](https://pinterest.com/greenbuilder)

[www.greenbuildermedia.com](http://www.greenbuildermedia.com)

Panasonic

One Fan—  
Endless IAQ Solutions



WhisperGreen Select  
Pick-A-Flow Technology 50-80-110 CFM + Plug 'N Play modules = The ability to create your perfect fan



The customizable vent fan for virtually any application.

Thanks to an impressive array of advanced options, our new WhisperGreen Select is the ideal all-purpose IAQ Solution. The ingenious new Pick-A-Flow (50-80-110 CFM) technology gives you the ability to select your required air flow with just the flip of a switch. Then, a set of four unique Plug 'N Play modules allows you to further customize the fan by choosing Multi-Speed Operation, Motion Sensor, Condensation Sensor and Automatic LED Night Light. With Multi-Speed you can select the proper CFM settings to satisfy ASHRAE 62.2 continuous ventilation requirements. WhisperGreen Select also features our revolutionary DC Motor with SmartFlow™ optimum CFM technology and our unique LED replaceable lamps. Our new Flex-Z Fast™ bracket system provides quick and easy installation. WhisperGreen Select can also be used to comply with LEED for Homes, CALGreen and ENERGY STAR® for Homes 3.0.

Learn more about the fan that does it all at [us.panasonic.com/ventfans](http://us.panasonic.com/ventfans).



Multi-Speed



Condensation Sensor



NiteGlow™ LED Night Light



Motion Sensor

WhisperGreen Select™  
VENTILATION FAN





# TABLE OF CONTENTS

HERE'S A SAMPLE OF WHAT'S INSIDE:

“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.” (p.30)

ON THE COVER  
BACK TO BASICS

Visit us at [www.greenbuildermedia.com](http://www.greenbuildermedia.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.

EDITOR’S NOTE

Back to Basics

THE HOMEOWNER’S HANDBOOK, 8TH EDITION

Our latest edition of our popular green building guide revisits the essential building science of high performance homes.

THE GREEN BUILDING PYRAMID

The pyramid shows clearly how to get the most bang for your building buck. Start with key design elements and location, and leave the wifi gadgets and solar panels for the last phase.

01 EXTERIORS	12
02 ROOFING	16
03 STRUCTURE	20
04 INSULATION	24
05 INDOOR AIR QUALITY	28
06 WINDOWS & DOORS	32
07 HEATING & COOLING	36
08 LIGHTING	40
09 APPLIANCES	42
10 PLUMBING	48
11 FINISHES	50
12 CABINETS & TOPS	54
13 ALTERNATIVE ENERGY	58

FROM THE TAILGATE

New Offerings for the Sustainable Minded

02

09

10

12

16

20

24

28

32

36

40

42

48

50

54

58

64

Green Builder® Media presents

# SUSTAINABILITY Symposium 2018

*Champions of Change*

JANUARY 8, 2018

University of Central Florida Campus, Orlando

Co-hosted by: **GREEN BUILDER MEDIA** Building a Better World

Sponsored by: **IR Ingersoll Rand** Inspiring Progress™ **EMERSON** **Panasonic** **OUC** The Reliable One®

**Climate change is the challenge of our generation, and an opportunity of a lifetime.**

The Sustainability Symposium 2018: Champions of Change will offer ideas and inspiration for positive action, proactive activity, and implementable solutions that will facilitate the transition to a clean economy and sustainable future.

**Our world-class line up of speakers** includes today’s foremost experts on smart cities, sustainable development, renewable energy, and advanced technologies:

- Paul Hawken
- Jeremy Rifkin
- Governor Martin O’Malley
- Mayor Buddy Dyer



**Don’t miss this groundbreaking event! Register today at [www.greenbuildermedia.com/champions-of-change-2018](http://www.greenbuildermedia.com/champions-of-change-2018)**

# Stay on Top of Building Code News with CodeWatcher!

CodeWatcher is the only resource you need to stay on top the world of residential codes, regs, and rules. We pull back the curtain on the building code



process to make sure it helps builders put up the best-performing, safest homes in the world. And, as important, we spearhead the notion that home owners must be educated on the regulatory actions that profoundly impact the safety, durability, performance, and financial worth of their homes.

Check us out at [www.codewatcher.us](http://www.codewatcher.us) where you can sign up for our **FREE** newsletter and digital magazine.

## WHAT'S NEW IN THE 8TH EDITION...

### Flex House Products

Our guide features a number of new products. Don't miss new "smart" devices that improve your home's energy efficiency, insulation to significantly improve your home's R-value, counter tops made from recycled materials.



### Sustainable Appliances

Learn what's new in energy efficient appliances, including condensation clothes dryers that save homeowners a ton on energy bills. (p. 42)

### NEW Efficient Windows

Check out our side-by-side comparison of energy efficient windows to make the best choice for your home. (p. 34)

# The Homeowner's HANDBOOK

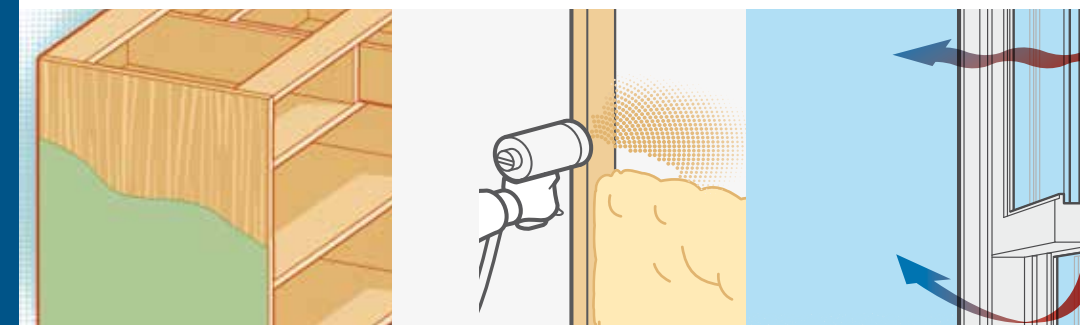


Remodeling? Building a new home? This comprehensive guide has you covered.

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.

## CONTENTS

Exteriors .....	12
Roofing .....	16
Structure .....	20
Insulation .....	24
Air Quality .....	28
Windows .....	32
Heating & Cooling .....	36
Lighting .....	40
Appliances .....	42
Plumbing .....	46
Finishes .....	50
Cabinets & Tops .....	54
Alternative Energy .....	58



## GREEN PROFESSIONALS: SHARE IT!

Green building professionals: Feel free to share chapters of *The Homeowner's Handbook* with clients, friends and prospective clients. Visit our website for a free download—or to purchase hard copies: [www.greenbuildermedia.com/the-homeowners-handbook](http://www.greenbuildermedia.com/the-homeowners-handbook)

REVISED FOR 2017

# GREEN BUILDER®

## Green Building Pyramid®

●●●●●●●●

**KEY:** Difficulty/Knowledge required for implementation. Note that some of the easiest changes have the greatest green impact.

**Fine tune your home's performance with** connected devices, including smart locks, smart thermostats, occupancy, air quality and leak sensors—and many more from the Internet of Things (IoT).

**Emphasize to your contractor that you want to create even more energy than your home uses.** Make sure your tight home includes sufficient ventilation, plus easy ways to monitor and tweak energy and water use.

**Read the label carefully when choosing paints,** stains and caulking. Choose brands with zero or very low levels of volatile organic compounds (VOCs) to protect your indoor air quality.

**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.

**Uninsulated concrete foundations** can reduce heating efficiency by 30%–50%. Cover concrete with rigid or spray-on foam insulation—or build foundation walls with insulating concrete forms (ICFs). Consider a frost-protected shallow foundation or slab-on-grade construction.

**For wood-framed walls and ceilings,** air infiltration is a major concern. Consider an insulation package that seals walls tightly. A combination of house wrap with a tight insulator such as spray foam is one option. If using fiberglass or cellulose, specify.

**Well-designed site plans** take advantage of free solar light and energy, and minimize damage to existing plants and habitats.

**Shorten commutes and build close to public transit.** Include bike storage and Install an electric charging station. Anticipate risks from floods, wildfire or storms.

COMPLETION

**Renewable energy such as solar panels or wind turbines** can now handle your home's demand, and may even charge your car. Prices are lower than ever.

**LED lighting lasts longer and produces** light up to 10X more efficiently than incandescent or halogen lamps. Save about 10% on energy bills by switching to this technology.

**To maximize water savings,** install low-flow showerheads and faucets, dual-flush toilets with bidet seats and graywater with smart irrigation controls for any exterior irrigation.

**Durability is a green characteristic.** On the roof, opt for metal, clay tile, recycled rubber or extended-life (recyclable) asphalt roofing. 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.

**Look for formaldehyde-free wood floors,** natural carpet fibers, tile or other low-toxicity materials. Choose countertops with high recycled content.

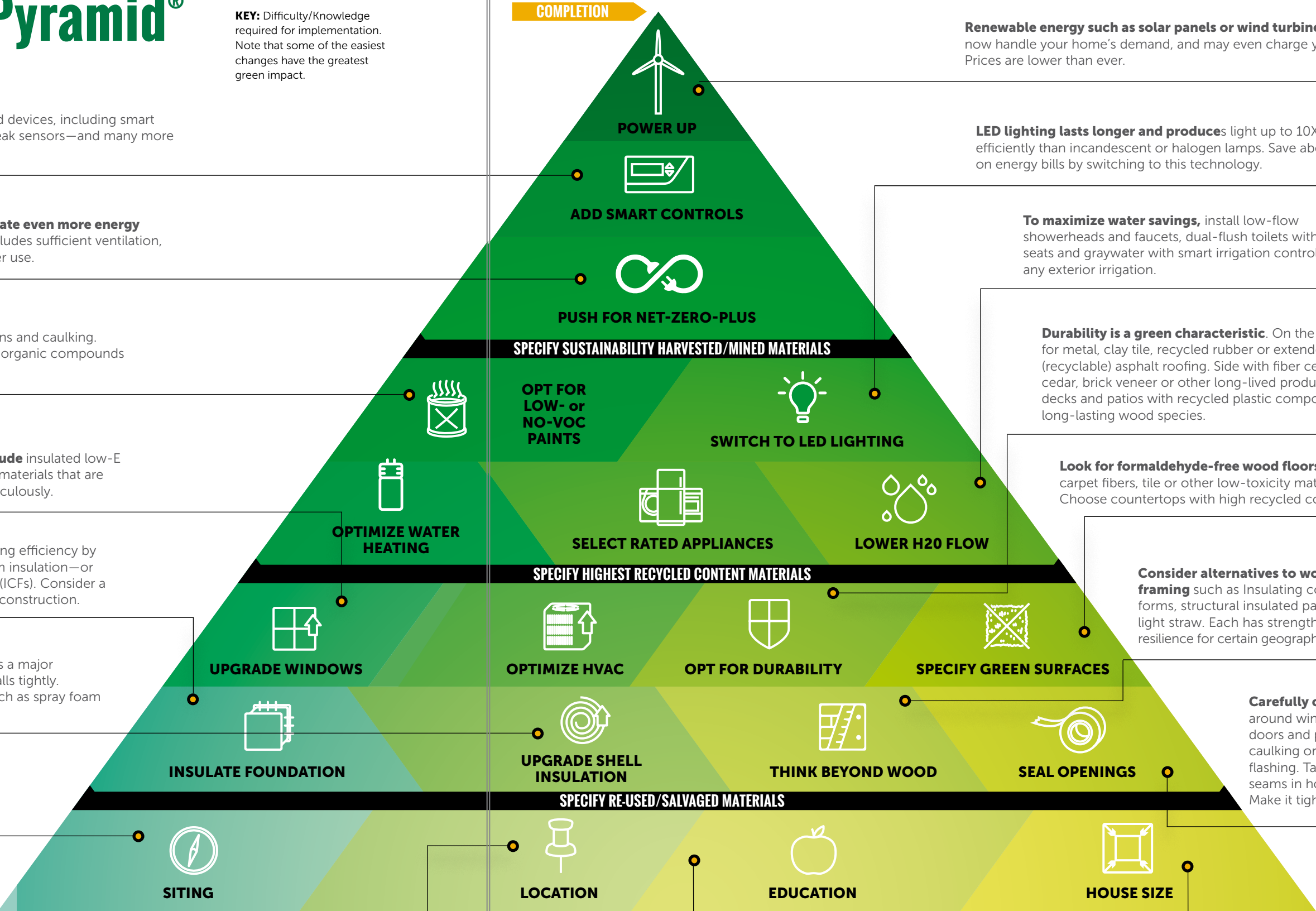
**Consider alternatives to wood framing** such as Insulating concrete forms, structural insulated panels, or light straw. Each has strength and resilience for certain geographic regions.

**Carefully cover gaps** around windows, doors and pipes with caulking or adhesive flashing. Tape all seams in house wrap. Make it tight.

**Doubling a home's size** triples its annual energy use for the life of the home. Think small and clever, not big and boxy.

**If you don't understand basic** green principles, you're likely to make decisions you later regret. Reading the Homeowner's Handbook is a great primer for building it right.

PLANNING PHASE



# Exteriors01

Think beyond initial cost. Maintenance matters.

When it comes to your home’s exterior, durability, maintenance and fire resistance are just as important as aesthetics.

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](http://www.freedoniagroup.com)), fiber cement, stucco and brick siding will see rapid advances through 2017. Demand for fiber cement is predicted to grow 8.5 percent annually. Vinyl siding will remain dominant, but will continue to lose its market share. 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



**Dupont Tyvek HomeWrap**

HomeWrap is a breathable material that allows moisture to pass through, promoting drying and preventing mold and water damage. It also can reduce home energy bills by controlling airflow and water intrusion, which helps insulation work better and allows the HVAC system to work more efficiently. [www.bit.ly/1o20Uqs](http://www.bit.ly/1o20Uqs)

**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.boralamerica.com/Bricks](http://www.boralamerica.com/Bricks)




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. Manufacturer CalStar utilizes fly ash as a binder, which eliminates the need for energy-intensive kiln firing.

**James Hardie HardiePanels with ColorPlus Technology**

James Hardie’s ColorPlus technology protects cladding products against peeling, cracking and chipping. Multiple coats of a proprietary finish are applied in the factory to every surface and edge, and the finish is cured between coats. A 15-year limited warranty covers both paint and labor. [www.jameshardie.com/Why-Hardie/ColorPlus-Technology](http://www.jameshardie.com/Why-Hardie/ColorPlus-Technology)



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 percent.

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**

- May not be perfectly straight, which can cause install problems
- Vulnerable to pests such as carpenter ants and termites
- Offers minimal insulative benefits (between R-0.7 and R-1.4 per inch)
- 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 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.

**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

**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.

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. Some manufacturers, including James Hardie and Allura, offer fiber cement that has been pre-finished (painted) in the factory.

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**

- 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

# What Makes a HOME Resilient?

## Renewable Energy

Onsite wind and solar PV systems save energy and turn your home into a "power house" that can potentially feed the grid. Solar shingles or a building integrated photovoltaic (BIPV) system can minimize the aesthetic impact of a solar array.

## Durable Materials

Long-lasting siding materials such as brick, stucco and fiber cement also tend to be fire resistant. Look for products with 50-year warranties. If you do use wood for trim or siding, choose a long-lasting, sustainably harvested species such as cedar.

## Smart Siting

Locating homes out of flood and wind zones and siting them to best take advantage of passive solar energy makes them inherently resilient. In the case of this home, its unique circular shape prevents pressure from building up on any one side.

## Solid Structure

Reinforced wood framing and alternative systems, such as structural insulated panels (SIPs) or insulated concrete forms (ICFs), are all good options for creating strong, durable buildings.

## Rainwater Harvesting

Harvesting and storing water onsite not only saves energy, but ensures your home has a reserve supply if centralized service is interrupted. Recycling graywater and using it to water landscaping or flush toilets will stretch your home's water budget.

## Right Roofing

Metal roofing is a good choice for both fire and storm resistance. It is also the ideal roofing material for supporting solar PV installations and harvesting rainwater.

## Redundant Systems

Back-up power sources ensure your home can ride out storms and other emergencies. Propane or gas-powered generators are a smart option, as are solar thermal systems that can operate independently of the grid.

## Stormwater Management

Directing stormwater to a rain garden, swale or a cistern reduces flooding erosion and water pollution and can recharge groundwater.

## Stormproof Windows

Reinforced windows with impact glass prevent wind and water from entering the home. A rolling shutter system can protect your windows during extreme conditions.

## Multiple Tiedowns

Make sure your home is connected from the roof to the foundation. Metal strapping and hangers help the structure resist seismic forces and high winds.

## Firewise Landscaping

Removing brush and kindling around structures minimizes your home's vulnerability to fire. Choose drought-tolerant, fire-resistant native plants for landscaping; visit [www.firewise.org](http://www.firewise.org) for tips on what plants are appropriate for your region.

## PRO TIP:

Check out the National Fire Protection Association (NFPA) website to learn about its Firewise Communities program, and for tips on protecting your home from wildfires.

[www.firewise.org](http://www.firewise.org)



# Roofing02

Select the best defense for your climate.

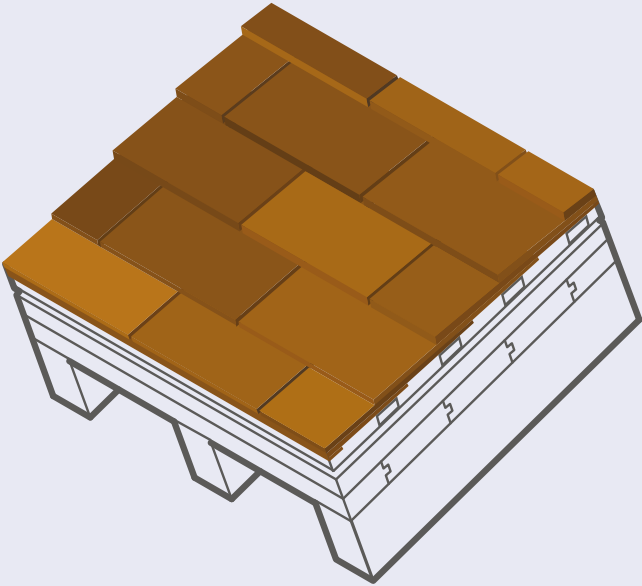
Your roof should protect your home from the elements for at least 50 years. Make sure your investment counts.

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 percent 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 lessening demand on the home's heating system—and therefore the energy it consumes. Recent "cool roof" asphalt composition shingle offerings, in fact, have achieved federal Energy Star status for their reflective values, helping reduce peak cooling demand by up to 15 percent.

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

At the same time, cooler shingles last longer, so they've increased their likely service life. Recycling programs, which convert asphalt shingles into roads, are also becoming more prevalent. You can help by choosing a roofing contractor who participates in such programs.



**Fabral Standing Seam Metal Roof Panels**

Durable, low-maintenance metal roofing sheds snow and protects the home from extreme weather. Standing seam panels are finished with the *Enduracote* paint system, which is guaranteed with a lifetime film integrity warranty and a 30-year warranty against color fading.

[www.fabral.com/residential](http://www.fabral.com/residential)



**GAF Timberline Cool Roof**

*Timberline* 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](http://www.gaf.com)

**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 percent) 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 percent 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 percent; 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 (p. 23) 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.

**RECYCLED POLYMER**  
**Reuse Rubber and Plastic**

Lightweight, affordable, easy to install and theoretically recyclable, recycled polymer roofing products are gaining attention in the marketplace. By preventing the extraction and transport of virgin raw materials, recycled roofing products are considered very sustainable. However, the product does require packaging and transportation to the manufacturer's facility for reuse. And some reclaimed rooftop

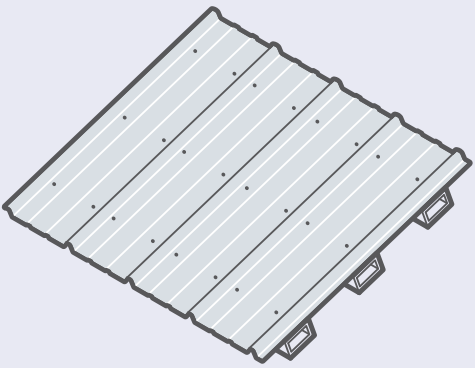
**Huber ZIP System**

The *ZIP System* is a structural roof and wall system that consists of sheathing and tape. It includes water resistance and an air barrier that streamlines the weatherization process. To install, put up the panels and tape the seams. *ZIP System* is 40 percent quicker to apply than housewrap. It comes in 6,000; 215,000; and 340,000 square feet.

[www.huberwood.com/zipsystem/home-zip-system](http://www.huberwood.com/zipsystem/home-zip-system)



Metal Roofing



**Virtues**

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

**Caveats**

- Higher initial cost
- Susceptible to impact or walking damage
- Colors may fade
- Recyclable does not always mean "recycled"

**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.

Life Expectancy of Roofing Materials	
Asphalt	20+ years
Fiber Cement	25 years
Wood	25 - 30 years
Slate	50+ years
Simulated Slate	10 - 50 years*
Metal	40 - 80 years
Clay/Cement	Lifetime
Copper	Lifetime

\*The two sources reported large differences on the longevity of this material.

**Mitigating Factors.** The actual lifespan of roofing materials depends on original quality, installation, maintenance, climate and other factors.

SOURCE: NAHB AND INTERNACHI

materials may contain components such as metal fasteners and adhesives, thereby rendering those portions unusable for new roofing products.

In addition, these plastic products have not been in the market long enough for homeowners to know how stable they are, how well they hold up to UV light degradation and what kind of expansion-contraction issues may occur over time.

**CEMENT COMPOSITES**  
**Lower Life-Cycle Costs**

Also scoring high in the recycled content category are cement composite roofing materials, such as fiber-cement shingles, which offer good durability. However, the sustainability of cement composites depends on the source of feedstocks used for production and, more importantly, the source of energy used to create the cement.

Fiber-cement products have high embodied energy as well. In response, some companies use fillers like wood fibers or fly ash to reduce the required amounts of cement, concrete and aggregate material. Another side benefit is these filler materials create tiles and shingles, which weigh significantly less than standard concrete roofing products and therefore require less energy to transport.

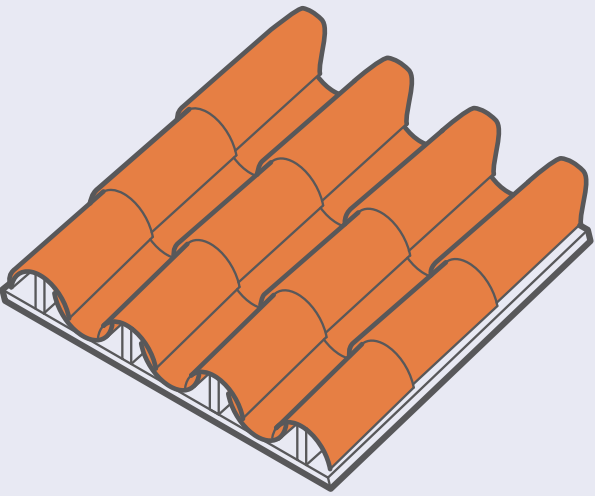
However some fiber-cement roofing shingle products were discontinued after beginning to fail from swelling, cracking, shrinking or discoloration within five years.

**CLAY/CONCRETE**  
**Almost Forever**

Clay or concrete roof tiles 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 shrunk in the U.S., but is growing steadily worldwide.

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 percent recyclable and biodegradable

**Caveats**

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

Consider a green roof for capturing stormwater and mitigating the “urban heat island” effect.

# Sustainable Spectrum: Low-Slope Roofing

**W**HAT IS THE MOST ECO-FRIENDLY OPTION FOR FLAT ROOFS? The durable synthetic rubber membrane known as EPDM (ethylene propylene diene monomer)—with its low installed cost—continues to be a popular choice. However, as a petroleum-based product with a fairly short service life, it is not all that sustainable.

Responding to the market demand for sustainable products, some manufacturers have begun offering “cool” EPDM in white, to decrease unwanted heat gain to the interior, extend the membrane’s life and help mitigate the heat island effect.

Otherwise, a protected membrane roofing assembly enhances durability for low-slope roofing and could therefore be considered sustainable, says Christopher Dixon senior associate/architect and specifier at NBBJ in Seattle.

“Thermoplastic polyolefin (TPO) membrane roofing materials are popular today and have recently replaced PVC as the most common thermoplastic membrane material,” adds Mark Yanowitz, principal and licensed construction designer at Verdeco Designs in Andover, Mass. “They are generally preferred over PVC, as they are considered a ‘cleaner’ polymer, containing less problematic additives than their PVC equivalent. All thermoplastic membranes are recyclable, but to date, the local and national secondary markets are not well established.” TPO is white (and therefore, cool), but longevity depends on



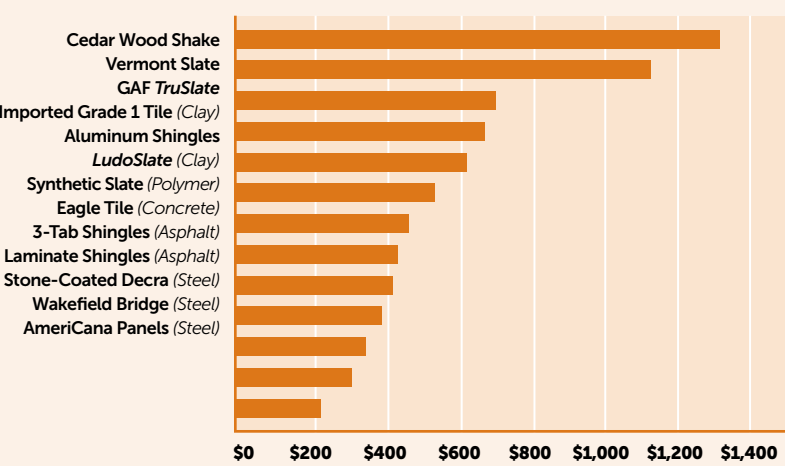
PHOTO COURTESY: INTERCONGREEN.COM

**A Growing Trend.** The green roof topping Armstrong Atlantic State University’s Learning Commons absorbs rainfall and reduces stormwater runoff.

the product quality and proper installation, so do your research.

At the same time, Yanowitz suggests that the leading sustainable strategy for flat roofs is integrating a green planted roof. “Along with protecting the roofing membrane below, these systems can greatly assist in the building insulation and in the reduction of stormwater runoff.”

## Cost per Year of 100 sq. ft. (Over 35 years)



Roofing Material	Cost per Year of 100 sq. ft. (Over 35 years)
Cedar Wood Shake	\$1,300
Vermont Slate	\$1,100
GAF TruSlate	\$1,050
Imported Grade 1 Tile (Clay)	\$700
Aluminum Shingles	\$650
LudoSlate (Clay)	\$600
Synthetic Slate (Polymer)	\$550
Eagle Tile (Concrete)	\$500
3-Tab Shingles (Asphalt)	\$450
Laminate Shingles (Asphalt)	\$400
Stone-Coated Decra (Steel)	\$350
Wakefield Bridge (Steel)	\$300
AmeriCana Panels (Steel)	\$250

## Roofing Durability

While numbers vary somewhat by brand and installation quality, the chart at left offers a broad overview of the long-term cost of different roofing types, based on expected lifespan and maintenance. Created by a roofing reseller, the chart shows only a few brands, but as a general rule, you get what you pay for. An early initial investment in metal or high-end laminate shingles pays back nicely over time.

– Editor

GRAPHIC: WWW.ABSROOF.COM

# Structure03

Think in terms of systems, not just sticks and bricks.

Wood framing, concrete blocks and SIPs each have pros and cons. Make sure you understand your options before you start building.

**W**HILE 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.

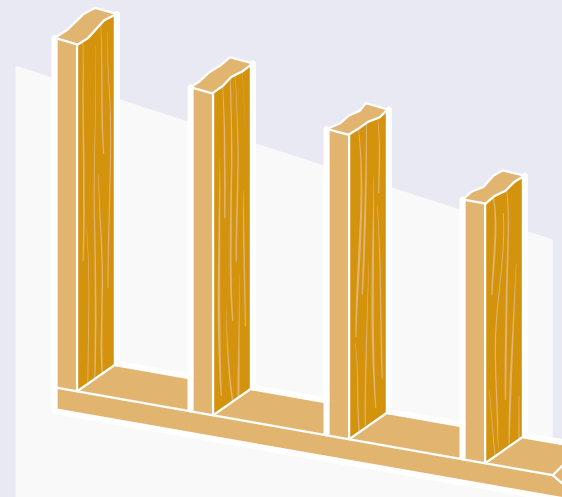
## WOOD FRAMING

### 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](http://www.fsc.org)) or the Sustainable Forestry Initiative ([www.sfiprogram.org](http://www.sfiprogram.org)). Typically, energy-efficient builders prefer 2" x 6" 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.

## Dimensional Lumber



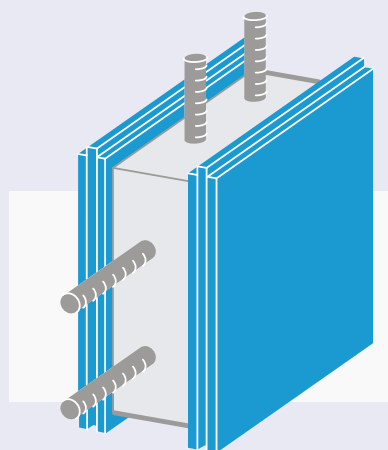
### Virtues

- 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

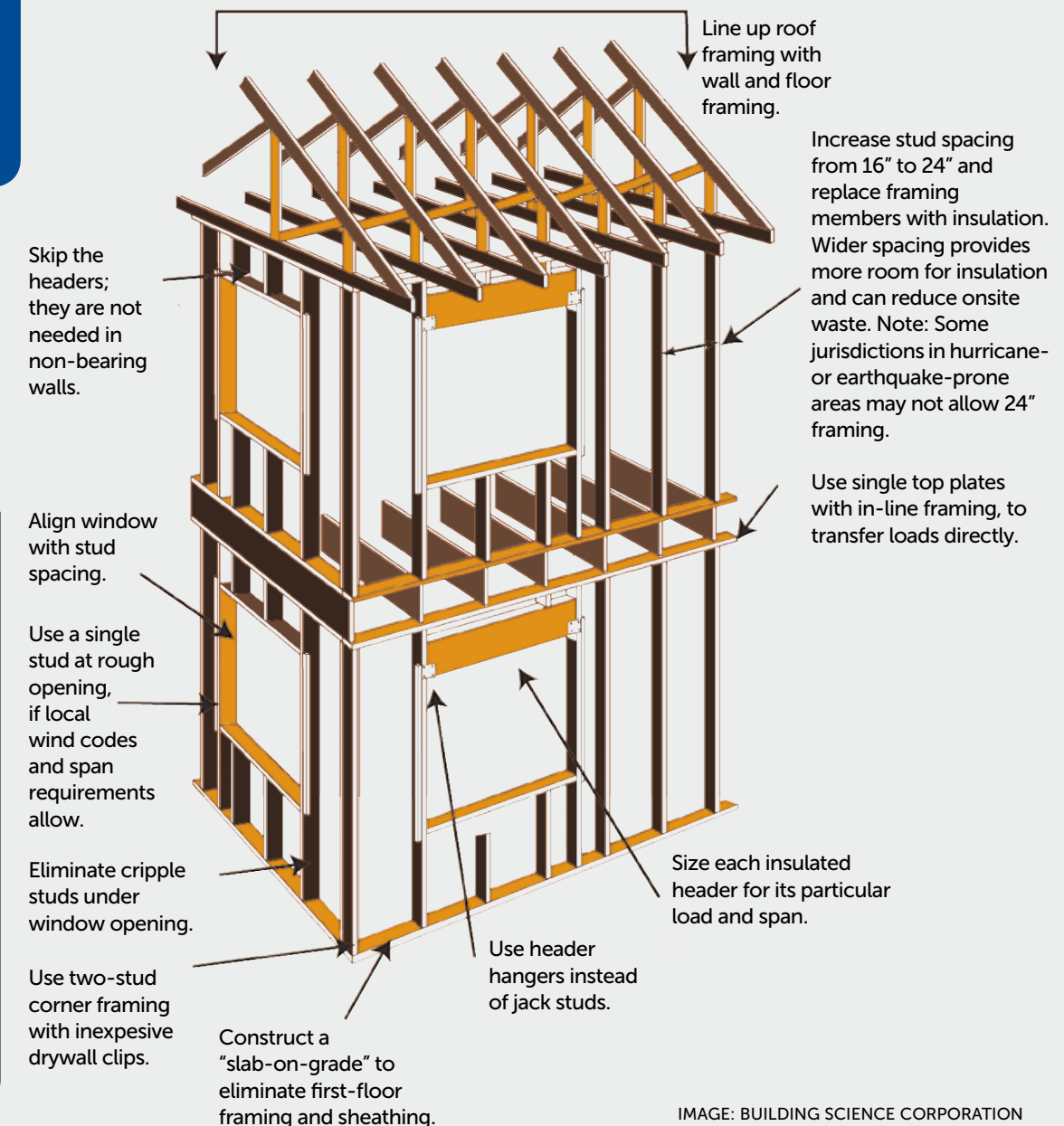
# What makes FRAMING green?

## 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.

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.



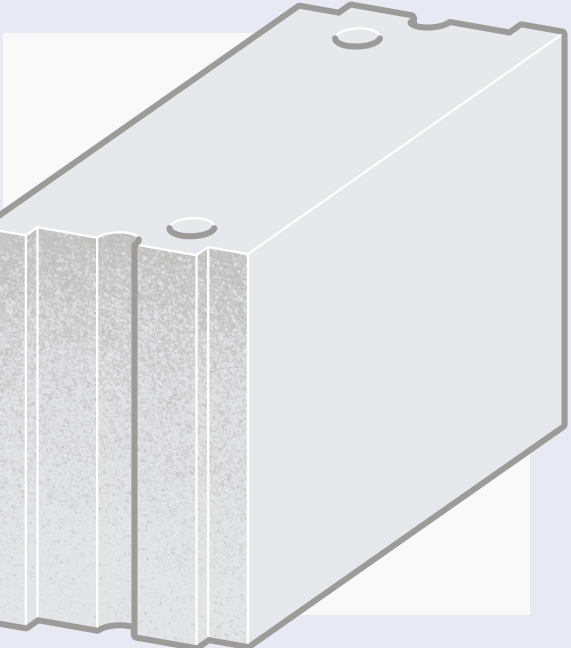
### LP TechShield Radiant Barrier Sheathing

LP TechShield radiant barrier sheathing is designed to lower a home's attic temperature. The sheathing blocks up to 97 percent of radiant heat in the roof panel from emitting into a home's attic, reducing an attic's temperature by up to 30° F. The product includes VaporVents technology with post-lamination incising and is installed like conventional roof sheathing. All wood is sourced through programs certified under the Sustainable Forestry Initiative.

<http://lpcorp.com>

IMAGE: BUILDING SCIENCE CORPORATION AND YOUTHBUILDUSA.ORG

### 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.



### CICFI

Comprised of leading ICF companies, the Council for ICF Industries (CICFI) is a non-profit dedicated to promoting and enhancing the social, environmental and economic value of ICFs in North America. Advantages of ICF construction include versatility, strength, energy efficiency and speed of construction.  
[www.cicfi.org](http://www.cicfi.org)

### 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](http://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.

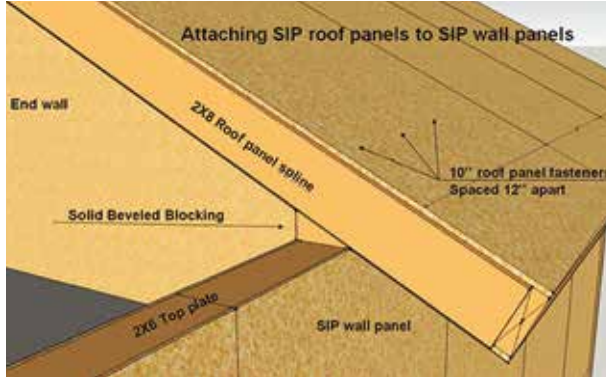
**STRUCTURAL INSULATED PANELS**  
**Many Strengths**  
The concept here is simple. Two sturdy panels—typically oriented strand board (OSB)—are glued under pressure to a super-insulating layer of plastic-based rigid foam (either polystyrene



### Norbord Inc. SteadiTred Stair Treads

These sturdy stair treads are available square-edged or bullnosed, and come pre-sized in popular lengths and widths for faster construction. Moisture and wear resistant, *SteadiTred* stair treads are made from OSB from rapidly renewable aspen trees.  
[www.norbord.com](http://www.norbord.com)

## SIPs on the Roof?

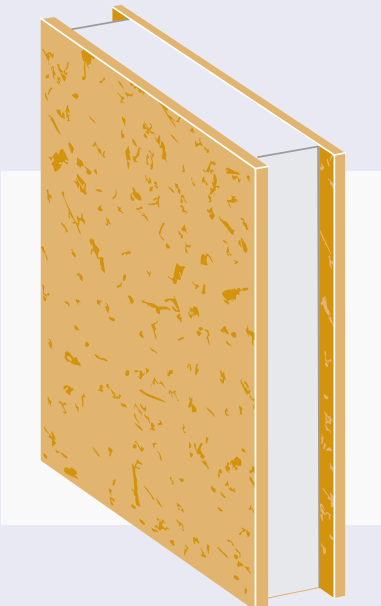


The point where wall panels connect to an SIP roof is one of the trickier details when building a complete home shell with these pre-made panels. Get it right, and you’ll have a super-strong, super-insulated structure.

IMAGE: [WWW.THERMALSHHELLHOMES.COM](http://WWW.THERMALSHHELLHOMES.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 percent 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**

## Structural Insulated Panels



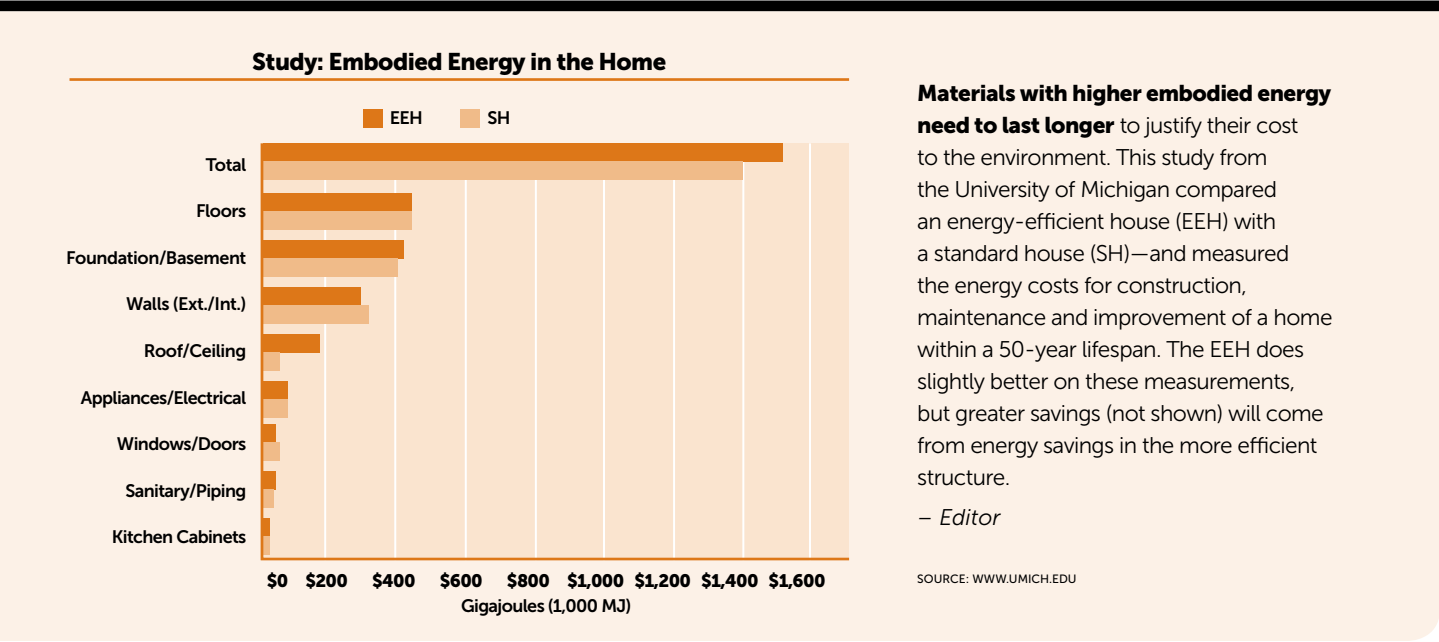
#### Virtues

- Reduces labor time/cost up to 60 percent
- 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)

**Structural Insulated Panel Association (SIPA)**  
Since 1990, SIPA has worked to advance energy-efficient construction through the use of structural insulated panels (SIPs). A replacement for wood-frame construction, SIPs are made of foam core sandwiched between two structural facings. SIPs provide builders shorter construction time and less jobsite waste. Homeowners benefit because smaller heating and cooling systems are required with SIP construction. [www.sips.org](http://www.sips.org)



# Insulation04

Proper installation has a major impact on performance.

Insulating your roof, walls and foundation will also insulate your wallet from the high energy cost of heating and cooling your home. This one-time investment will save you money for decades.

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.

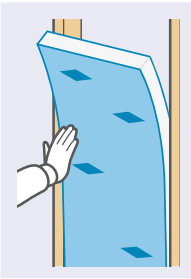
Building scientists (a new breed of experts) now have a deep understanding of how insulation works. They've learned that factors such as air infiltration, dampness and age can dramatically affect performance.

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 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



### 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](http://www.coloradoenergy.org).
- **Batt:** A length of insulation that is pre-cut to fit certain wall cavity dimensions. Typically sold in a pre-cut 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).

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 percent).

## SPRAY FOAM

Filling Every Void

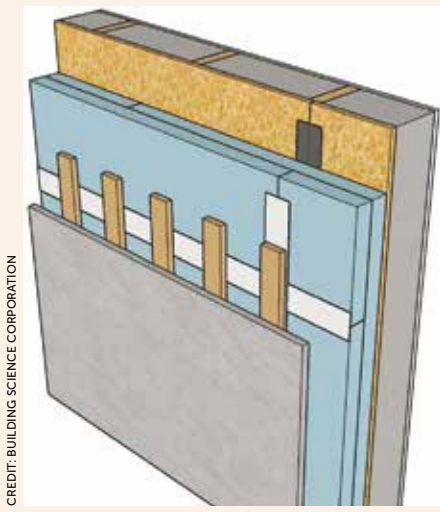
Insulating walls and ceilings with spray foam is relatively expensive, typically more than twice the cost of fiberglass batts, and most often it's a job best handled by pros. Why is foam green? Not because of what's in it. Even the most eco-friendly brands replace only a small percentage of their petroleum-based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

## Cladding Considerations

EXTRA-THICK LAYERS of exterior insulation can greatly improve the energy performance of homes, but installation requires some special techniques.

For thinner insulation, the cladding can often be attached directly through the rigid insulation back to the structure. The practical limit of this approach is around 1-1/2" of rigid insulation, due to the limited fastener lengths for many pneumatic nail guns.

For thicker insulation, vertical wood furring strips can provide a cladding attachment location. This approach also provides a drainage and ventilation gap behind the cladding, which helps manage water. To adequately support the cladding, the furring strips should be attached back to the structure using #10 or larger wood screws that are sized to maintain a 1-1/4" minimum embedment into the structural framing.



Some claddings, such as stucco and adhered stone veneer, may require additional support between the structural furring strips to facilitate the installation. Wood shingles require a continuous nail base, which is best provided by installing another layer of structural sheathing directly over the insulation in place of wood furring strips.

## 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



### Bayseal Insulation

Covestro's Bayseal insulation provides a high R-value and reduces air intrusion, accumulation, radiative heat transfer and air movement. A spray polyurethane foam expands, filling cracks, crevices and voids to create a seamless air barrier system that provides high building envelope performance. <http://bit.ly/2dM2Rty>

## Fixing a Hole with Attic Caps



**Easy-to-Use Options.** Using a reflective material to cover stair openings, the *Attic Stairways Insulator* by Owens Corning helps to reduce seasonal heat loss and gain.

While no one seems to have exact figures, third-party testing suggests that some brands cut attic air infiltration by 70 percent.

The ready-made systems, such as Owens Corning's foil-covered *Attic Stairway Insulator* (R-10; \$54), are almost effortless to install. Systems like those offered by Owens Corning work well in attics, where traffic is infrequent. In homes where the homeowner trucks in and out of the attic every day, however, other products offer more flexibility. For example, a rigid foam system such as the *Energy Guardian* (R-38; \$185) has a removable foam top. The lightweight *Attic Tent* (R-3.2; \$200) seals tightly with zippers.

So, how much energy do attic caps really save? *Attic Tent* estimates about a 20 percent annual heating/cooling reduction. The products also reduce unwanted air infiltration, offering other "green" benefits, such as keeping dust and pollutants out of living areas and reducing drafts.

# 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](http://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 percent 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

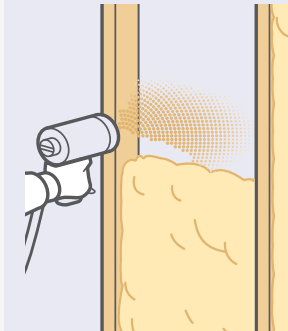
Many new homes include interior wall insulation—in part because it makes walls more soundproof. But it also has energy advantages. It allows you to "zone" different parts of the home, so that only the areas of the home being used are fully heated or cooled.

## 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](http://WWW.OWENSCORNING.COM)). THE COLOR PINK IS A REGISTERED TRADEMARK OF OWENS CORNING; TEXT BY GREEN BUILDER STAFF

## Spray Foam Insulation



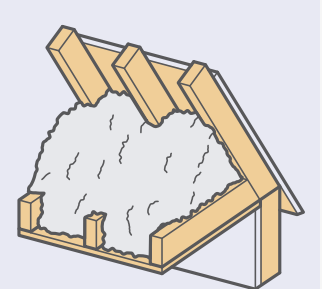
### Virtues

- 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

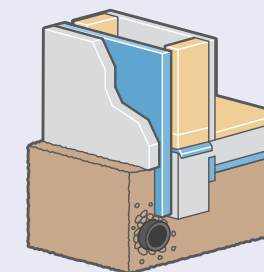
fill, is non-flammable, requiring no chemical flame retardants. As a result, offgassing emissions tend to be low. Mineral wool includes high levels of post-industrial recycled content waste (up to 90 percent), reducing the environmental impact of its production. Rigid exterior insulation made from mineral wool is now becoming available, as well.

## 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**

## 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



## DuPont Tyvek ThermoWrap R5.0

DuPont Tyvek ThermoWrap R5.0 offers the air and water management benefits of DuPont Tyvek HomeWrap and also adds R-5 to the wall assembly. Unlike other exterior insulation products, ThermoWrap is breathable, allowing any moisture that finds its way into the wall cavity to escape. <http://bit.ly/1XQDW7W>

# Indoor Air Quality05

Remove particles, don't just send them airborne.

Controlling the flow of air in and out of the home has a huge impact on indoor air quality, but monitoring potential toxins in materials and products is equally important.

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—has suddenly become 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.

<b>Virtues</b>	<b>Caveats</b>
<ul style="list-style-type: none"><li>Reduces air infiltration</li><li>Repels windborne rain</li><li>Long service life</li></ul>	<ul style="list-style-type: none"><li>Can't be left exposed indefinitely</li><li>Requires careful installation</li></ul>

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 percent 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.

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, Interface and Shaw Industries ([www.shawfloors.com](http://www.shawfloors.com)) have begun to approach carpets from a more eco-friendly perspective—not only recycling old carpets, but offering less toxic installation systems and products that have lower levels of offgassing.

PRODUCTS AND FURNISHINGS  
Bringing It Home

Carpeting is not the only source of VOCs and other harmful chemicals. After your new home or remodel project is complete, make sure you don't compromise indoor air quality with the products and furnishings you bring into the space. This goes from everything from furniture, which can contain flame retardants and formaldehyde, to cleaning products.

It may take a little research to ensure items are completely non-toxic. Some manufactures have made it easier by revealing their products' "ingredients" with either in-house labels or by seeking third-party certifications. Several organizations have developed standards that make it easier to specify and use low-emission products. These include UL Environment, which developed the GREENGUARD standard and which maintains a database of thousands of certified products in 28 categories.

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 percent 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.

### Stove Sense

Smoke from residential wood heaters contains fine particle pollution (PM) and other pollutants such as carbon monoxide, volatile organic compounds (VOCs) and benzene. Fortunately, newer, EPA-certified units burn much cleaner and are far more efficient.

The EPA first set emissions standards for wood heaters in 1988. In 2015, the EPA strengthened these standards. The new limit for particulates emissions for catalytic and non-catalytic wood heaters is 4.5 grams per hour (g/h). In five years, the limit will drop to 2.5 g/h. The rule does not affect existing woodstoves.

If you are thinking about replacing your old stove, here are a few points to consider:

- You can expect to use up to one-third less firewood with a new EPA-certified wood stove compared to an older, less efficient stove.
- Newer, more efficient stoves burn cleaner, reducing creosote buildup and the risk of chimney fires.
- Some regions host change-out programs and offer incentives for swapping out your old stove for a certified unit.
- Some new certified stoves exceed EPA standards and produce emissions in the 1 to 4 g/h range.
- Pellet stoves, which utilize compressed pellets made from wood or biomass for fuel, are among the cleanest-burning stoves on the market.
- Gas and gas fireplace inserts, which do not require EPA certification, burn cleanly and produce few emissions.

Learn more at <http://www2.epa.gov/burnwise>

### Panasonic WhisperFit EZ Ventilation Fan

This ceiling-mount ventilation fan is ideal for residential remodeling. Built-in Pick-A-Flow speed selector allows a user to select required airflow (80 or 110 CFM). Installation for this Energy Star-certified fan is made easy with the Flex-Z Fast installation bracket and detachable installation adapter.


<http://bit.ly/1U48PEQ>



### BEAM Alliance Central Vacuum

The BEAM Alliance power unit and cleaning set by Electrolux boasts advanced technology. A high-efficiency motor uses 30 percent less energy than other central vacuums. The system comes with the BEAM Alliance HEPA filter and a collection receptacle that snaps into place to assure a perfect seal, preventing dirt and allergens from re-entering your home.

[www.beamvac.com](http://www.beamvac.com)



### FLEX HOUSE SPONSOR Viking Freedom Recessed Fire Sprinkler

The VK494 pendant fire sprinkler is the first concealed residential sprinkler to have the same flow rates for both of its temperature settings: ordinary (155° F) and intermediate (200° F). This makes it capable of functioning effectively at close or further ranges from a heat source.

[www.vikinggroupinc.com](http://www.vikinggroupinc.com)



# Why Homeowners Don’t Use Range Hoods—and Why They Should



Home occupants are not using range hoods to control moisture, but “smart” range hoods will do this task automatically.

CONTROLLING MOISTURE BUILD-UP in the home is one of the most important strategies for ensuring healthy indoor air. A continually moist environment harbors biological pollutants such as mold and dust mites, which can trigger asthma and other respiratory illnesses. Regular use of kitchen exhaust ventilation systems can help control moisture. Yet, according to a study published by the Forum for Family and Consumer Issues (FFCI), most people don’t use range hoods for moisture control, but for other issues, such as smoke and odors. The study, *Use of Kitchen Ventilation: Impact on Indoor Air Quality*, found that noise is a major factor, as is homeowner ignorance about the importance of ventilating a modern home. Most of the participants (92 percent) reported having mechanical kitchen ventilation systems. Here’s the really interesting part:

Only 8 percent of the participants used their ventilation system whenever they cooked, while 8 percent used ventilation “almost never,” and 15 percent used ventilation only “once in a while.” The most common reasons cited for using a kitchen ventilation system were to control odors and smoke. Noise was the most common reason for avoiding the kitchen ventilation system.

### OUR RECOMMENDATIONS

Since people are more likely to use a fan if it isn’t noisy, always spec an Energy Star-rated unit. Range hoods that have earned the Energy Star label are not only 70 percent more efficient, they must also meet standards for noise and efficacy. The Energy Star website also includes a searchable database: <http://bit.ly/2dxlYX4> One of the best innovations in range hood technology in recent years has been particle- and heat-sensing devices. In our view, these devices should become the de facto standard across the industry. Further, it’s time for range hoods to be integrated with the Internet of Things. For homeowners, reluctant or not, there would be clear health benefits to regular use of range hoods. And for those who choose not to use the hoods, devices that are “smart” can automatically kick on anyway, clearing the air for everyone else who lives in the building. Visit <http://bit.ly/1PReChg> to read the full study.

### SPOT VENTILATION Local Management

Chronic moisture can lead to mold growth. Exhaust fans excel at removing excess moisture that tends to build up in specific locations, such as bathrooms and kitchens. Kitchen range hoods also remove cooking contaminants. These fans have become quite sophisticated and quiet; some manufacturers such as Panasonic offer “smart” models that adjust to changing moisture conditions, or that can sense when a room is occupied. Whole-house exhaust-only ventilation systems exist, but be aware that these rely on cracks and penetrations in the building envelope to supply the makeup air that replaces the exhausted air. In tighter homes, this can create “negative pressure.” In general, we recommend using exhaust fans to supplement balanced whole-house ventilation systems.

### 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” x 36” tile carpet and low-VOC adhesives to test these principles.

### EcoMotor Ceiling Fans

Ceiling fans from Emerson can help distribute air during the heating and cooling seasons for more efficient use of conditioned air. The fans also help create better airflow when using natural ventilation. EcoMotor ceiling fans are extremely energy efficient, requiring a maximum of 33 watts to operate. The quiet and durable DC motor is capable of six speeds. The fans range in size from 42 to 72 inches and come in a variety of styles, from traditional to contemporary. Many are compatible with Emerson’s *IkGLO* LED light fixtures. [www.ceilingfans.emerson.com](http://www.ceilingfans.emerson.com)



### AirCycler g2-k Whole-House Ventilation System

The g2-k system integrates with an existing HVAC system and combines the advantages of central fan integrated supply and whole-house exhaust fan ventilation systems. It includes the AirCycler g2 furnace fan timer, FanConnect bath/fan light switch with remote fan control and a motorized fresh air damper, available in four sizes. [www.aircycler.com/pages/g2k](http://www.aircycler.com/pages/g2k)



### 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 with which they’re sealed. These mechanical wonders take hot, unconditioned fresh air from outside, pass it over a heat collecting medium, where it gets a partial cool-down before entering the home. A study by John Bower (visit [www.healthyhouseinstitute.com](http://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 (ft²)	Bedrooms				
	0-1	2-3	4-5	6-7	>7
Less than 1,500	30	45	60	75	90
1,501-3,000	45	60	75	90	105
3,001-4,500	60	75	90	105	120
4,501-6,000	75	90	105	120	135
6,001-7,500	90	105	120	135	150
Greater than 7,500	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.

-Editor  
SOURCE: ASHRAE 62-2-2003

# Windows & Doors06

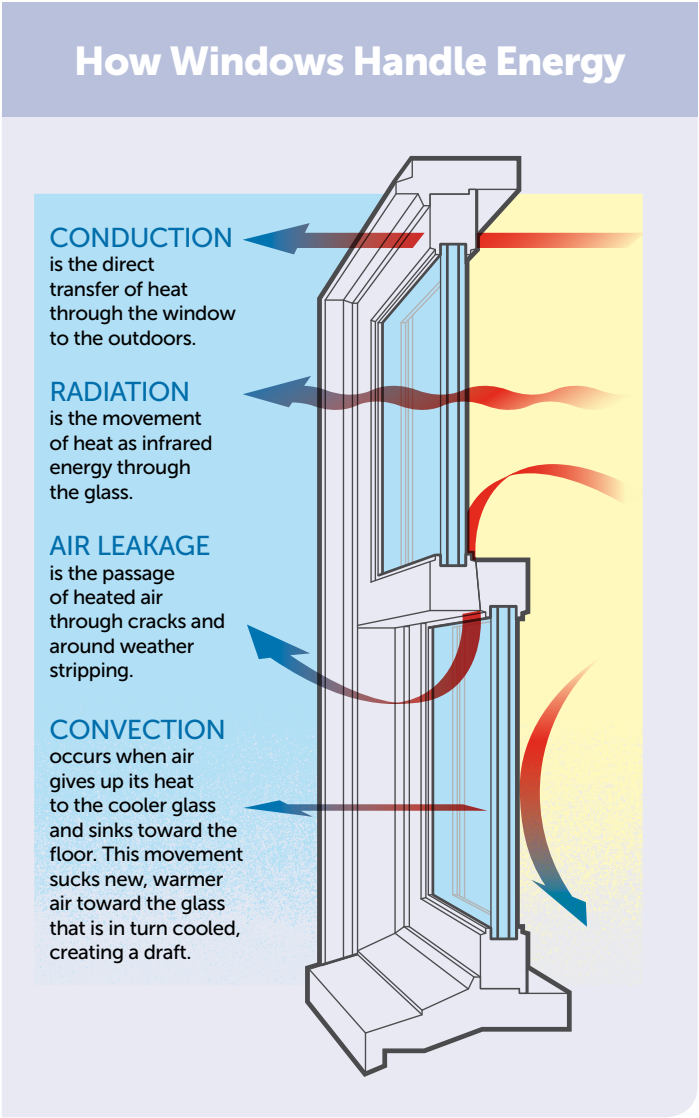
Look for performance, warranty and durability.

Window and door manufacturers are not only creating more durable and energy-efficient products, they're tailoring glazing options for specific climates.

**G**LAZING TECHNOLOGY HAS improved by leaps and bounds over the past few years. Today, you can get a high-performance window or door that looks good and performs well at any price point. The windows and doors you select for your house—retrofit or new—must meet your local energy code requirements, 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. As an example, a study by the Efficient Windows Collaborative ([www.efficientwindows.org](http://www.efficientwindows.org)) shows that the annual heating cost of a typical house in Boston drops from about \$750 a year to \$550 (24 percent) by switching from double-pane windows to triple-pane



GRAPHIC INSPIRED BY FINE HOMEBUILDING

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 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

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 website at [www.efficientwindows.org](http://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.

INSULATED GARAGE DOORS

**I**N MOST MODERN HOMES, garage doors are the single largest opening; in homes with an attached garage and/or a heated garage space, this large opening is a significant source of energy loss, translating into higher utility bills and a larger carbon footprint.

Although you may not be able to tell the difference from appearances alone, eco-friendly or green garage doors differ from traditional garage doors in that they generally contain enough insulation to provide an R-value of 12 or greater and contain recycled and/or recyclable materials to minimize their impact on the planet. Recycled wood fibers as well as partially recycled steel are common materials used to produce green garage doors; these products have a long lifespan and are designed to require little or no annual maintenance such as the painting or staining which is needed with some older garage door models. Since one environmental aspect of a green garage door is energy savings, most models are filled with an insulating foam which



PHOTO: PRESTIGE PRODUCTS, DENVER, CO

**Hidden Beauty.** Insulated garage doors can also have a traditional look. provides a high R-value without excessive thickness. When combined with quality weather striping, green garage doors can significantly reduce the loss of heated or cooled air which may have passed through the shared wall of your home (in the case of an attached garage) or heat that is generated by a separate heater or furnace if your garage space is also conditioned during a portion of each year.




**EuroLine Windows Inc. 4700-Series ThermoPlus Tilt and Turn Windows**

These European-style windows combine a six-chamber vinyl-fiberglass hybrid frame with optional foam inserts and triple-pane insulating glazing to achieve the thermal performance needed for passive solar house design—at a considerably lower cost. One easy-to-operate handle moves the multi-point locking hardware into place, locking the window on all sides for higher security and a tighter seal. [www.euroline-windows.com](http://www.euroline-windows.com)

**Schlage Sense Deadbolt**

With keyless entry, built-in alarms and durable design, this multi-function lock offers control via simple access codes, so homeowners never have to worry about losing, hiding, carrying or forgetting their house keys again. The touchscreen deadbolt connects with Nexia Home Intelligence, enabling homeowners to manage their home security from anywhere. At ANSI Grade 1, the touchscreen deadbolt boasts the highest level of security and durability for residential door locks. [www.schlage.com](http://www.schlage.com)



# A Breakdown on High-Performance Windows

WINDOWS ARE AN IMPORTANT FACTOR in improving the performance of the building envelope. But with so many options available, selecting the right window can be challenging. To increase insulation, homeowners should choose a double- or triple-pane window. Between each pane is an insulating air pocket, so more panes means more insulation. These windows can be filled with gases such as argon or krypton to provide better insulation than air. In addition, insulated windows can include low-emissivity (low-E) coatings, which can reduce energy loss by 30 percent to 50 percent, according to the U.S. Department of Energy (DOE). Some windows are tinted or coated with heat-absorbing glazing, which absorbs solar radiation and reduces the solar heat gain coefficient, visible transmittance and glare. Storm windows are another option for efficient windows. Though they don't add more insulation, but they can help reduce the amount of air flow through windows, which can help with heating and cooling costs. The table below demonstrates the performance of common high-performance windows compared to standard single-pane windows.

	Glass Thickness (Inches)	Visible Transmittance (% Daylight)	U-Factor (Winter)	Solar Heat Gain Coefficient
Single Pane	0.25	89	1.09	0.81
Double Pane Insulated Glass	0.25	79	0.48	0.70
Triple Pane Insulated Glass	0.125	74	0.36	0.67
High Efficiency Low-E	0.25	70	0.29	0.37
Suspended Coated Film	0.125	55	0.25	0.35
Suspended Coated Film w/ Argon Gas Fill	0.125	53	0.19	0.27

CREDIT: WHOLE BUILDING DESIGN GUIDE

## Energy-Efficient Window Frames

Efficient windows don’t stop at just the pane. It’s also important to consider the type of window frame. **Composite Frames.** These frames are made from composite wood products, such as particle board. They resist moisture and decay better than conventional wood, and typically have the same or better structural and thermal properties. **Vinyl Frames.** These frames have a hollow cavity that can be filled with insulation to increase their energy efficiency. To prevent sunlight from breaking down the material, they usually are made from polyvinyl chloride with ultraviolet light stabilizers. **Wood Frames.** Wood is a natural insulator, so these frames provider higher insulation values. However, wood naturally expands and contracts in response to hot or cold weather conditions, which may affect their performance.

CREDIT: U.S. DEPARTMENT OF ENERGY

## Glossary of Terms Know the Lingo

- **Visible Transmittance:** The percentage of light transmitted through the window.
- **U-Factor:** The rate of heat loss. (The lower the number, the higher the heat loss resistance.)
- **Solar Heat Gain Coefficient (SHGC):** The amount of solar energy transmitted, measured on a scale of 0 to 1. (The lower the number, the less solar heat transmitted.)

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 percent. UV absorbers can be incorporated into thin plastic films in multilayer windows or as an interlayer in laminated glass. In both cases, the UV transmission can be reduced to less than 1 percent. 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](http://www.hvaccomputer.com)). You enter in some information about

## Replace, Restore or Enhance?

REPLACING OLD SINGLE-PANE WINDOWS can greatly increase the energy efficiency of your home. But in some cases, replacing windows is not possible, either because of the expense or because you want to retain the historical integrity of your house. In this case, you have two options:



CREDIT: LORRI SIFES

**Wood Window Restoration.** Typically, damage occurs to wood windows when paint isn’t maintained and water enters the wood, and compromised weatherstripping can cause drafts. Careful restoration can bring your vintage wood windows back (see photo above). Depending on the state of neglect, steps may include: 1) stripping and sanding, 2) repairing any rot, 3) reglazing (setting the glass), 4) replacing damaged sash cords, 5) painting and caulking, and 6) weatherstripping. Once repaired, the most important thing you can do is maintain your wood windows by keeping them painted. **Low-E Storm Windows.** You can enhance your existing windows’ performance by adding low-E storm windows on either the interior or exterior. If your windows are standard sizes, you can find matching storms at your local Big Box store. A study conducted by the Pacific Northwest National Laboratory shows that low-E storm windows can result in whole-house energy savings of 10 percent. And because they cost significantly less than replacement windows, you’ll see the payback in five to seven years.

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**

## Exterior Doors: The Sum of Their Parts

For best performance, a door should fit precisely in its opening, which is carefully gasketed and engineered for modern locks and handles. The elements around a good exterior door opening have been designed and tested together—as one door opening solution. This not only helps prevent cold (or warm) drafts, it ensures that the door can be fitted with wifi locks and security features. New electronic locks and wifi-security systems depend on a precision fit to work properly. When combined with well engineered doors, they can result in cost



**Case In Point.** The Mercury Door from Assa Abloy is made from sustainably sourced materials, and engineered to fit precisely in its opening. [www.assaabloy.com](http://www.assaabloy.com)

savings. Why? Because doors that close tightly, or alert users if left ajar, or allow for remote monitoring can be managed to minimize energy loss, the same way commercial properties do. But you’re also looking for a product that offers clear description of how it was made. What is the supply chain? Is it made with wood from carefully managed forests? Look for documents such as Environmental Product Declarations, Health Product Declarations, and Declare labels to help you research and make the best decisions for products.

# Heating & Cooling07

Critical to a home's overall energy performance.

The energy savings and increased comfort far outweigh the upfront cost of an energy-efficient HVAC system.

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 percent (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.

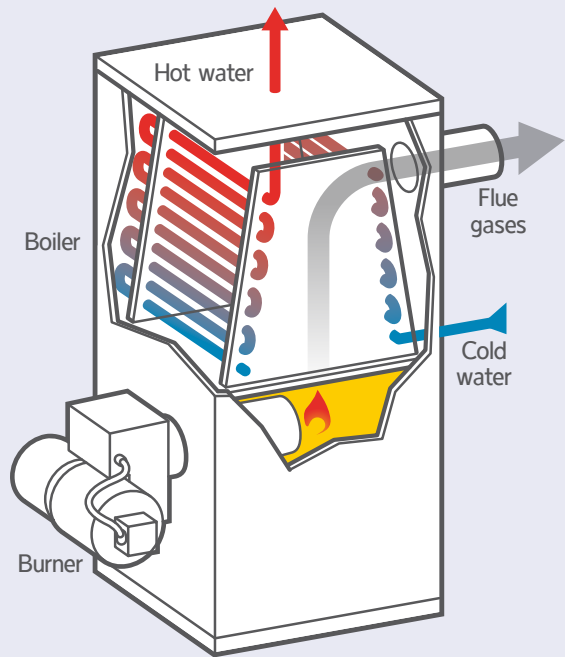
One way that new technology squeezes more heating power from gas is with an exhaust heat exchanger. This exchanger steals back heat from the furnace's waste byproducts. Another feature, flame modulation, adjusts the flame size, based on demand. These furnaces include variable-speed blower fans with high-efficiency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



### Uponor Ecoflex Pre-insulated Pipe System

This versatile pipe provides proven, reliable performance for underground distribution of hydronic heating, cooling and potable-water systems. Ecoflex features flexible, durable cross-linked polyethylene (PEX) or high-density polyethylene (HDPE) carrier pipe surrounded by multiple layers of PEX-foam insulation, which is then covered by a watertight HDPE jacket. <http://bit.ly/1OZy4aN>

## High-Efficiency Boiler



### 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 percent more expensive than a conventional boiler
- There are fewer high-efficiency boilers to choose from than there are high-efficiency furnaces

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

## Sensi Wi-Fi Programmable Thermostat

Sensi Wi-Fi programmable thermostat is a smart thermostat from Emerson that helps lower energy use. It can be programmed with custom schedules for each day of the week, and users can adjust the temperature with a smartphone, using the free Sensi mobile app. Flexible programming and the ability to control the thermostat remotely ensure that heating and cooling only occur when needed. The thermostat offers precise temperature control (it is accurate to within one degree Fahrenheit) and is one of the only Wi-Fi thermostats to be Energy Aware certified. <https://sensicomfort.com>



## Mini-Split Heat Pumps



DUCTLESS MINI-SPLIT HEAT PUMPS, or MSHPs, are a good heating and cooling option for homes without duct systems. Mini-splits can supplement an existing wood stove or condition a new addition, and they are also ideal for super-efficient new homes. Mini-splits have two main components: an outdoor compressor/condenser and an indoor air-handling unit. A conduit, which houses the power cable, refrigerant tubing, suction tubing and a condensate drain, links the outdoor and indoor units. MSHPs are quiet, efficient and flexible, and because there are no ducts, they are easy to install. Here are a few points to consider if you are in the market for a mini-split:

- **Choose the Right Mode.** MSHPs work best when allowed to modulate. Using them in "on/off" mode not only compromises their efficiency, but will likely result in wide temperature swings and discomfort.
- **Know Yourself.** Because MSHPs don't rely on ducting to distribute air, be aware that your habits may affect temperatures in different rooms. For example, if you tend to leave your bedroom door closed all the time, it may be warmer or cooler than the rest of the house.
- **Build Efficiently.** The number of MSHPs required to heat your home depends on its square footage, but also on your home's layout. A small, very efficient two-story house might be served by just one MSHP, but be aware that there may be temperature differences between the two floors, even if you use distribution fans.
- **Bigger May Be Better.** Oversizing MSHPs—choosing units rated for a larger house—is okay. Oversizing can even be beneficial, since MSHPs modulate their capacity and reach their highest efficiency when running at the lower end of their capacity range.

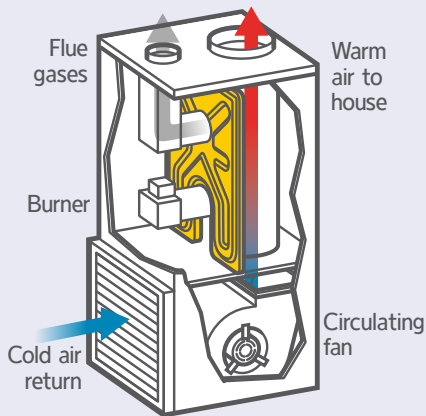
## Air-Source Heat Pump

### 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



## 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 percent 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 to 12 percent 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 to 300 percent, 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.

# Everything You Need to Know About Radiant Heat

Consider the four big benefits of radiant heat, and you’ll understand why it is poised to grow as the heating system of choice in today’s high-performance homes.

**R**ADIANT FLOOR HEATING—A concept that’s been around since ancient Roman times—isn’t a tough system to understand, install, operate or maintain. In fact, it’s one of those systems people hear about and think, “Wow. I’d like to have heated water circulating underneath my floor, warming everything it touches.”

Here are the four key benefits of in-floor radiant heat systems:

#1: COMFORT

“Comfort” is a key reason people consider installing a radiant heat system in their house. With radiant, heat slowly rises from the floor as opposed to blowing down at different temperatures with a forced-air system. Radiant floor heating produces room temperatures at 75 °F at floor level, declining to 68 °F at eye level, and then to 61 °F at the ceiling.

According to the Radiant Panel Association, a radiant heat floor normally feels “neutral” with a surface temperature lower than normal body temperature, although the overall sensation is one of comfort.

# 2: EFFICIENCY

The water in a hydronic radiant floor system has the capacity to transport energy 3,500 times greater than air, so it can heat (and even cool) using less energy than a forced-air system. This amounts to greater comfort at a lower thermostat setting, which provides reduced energy use and lower energy bills.

In fact, more people are comfortable with radiant floor heating set at a lower thermostat setting than with forced-air heating at a higher setting. In addition, a radiant heating system works in zones, allowing different areas of a home to be at varying temperatures.

# 3: HEALTH

A radiant floor heating system provides very high indoor air quality because it does not use fans or blowers, which can circulate dirt, dust and other allergens throughout a home. Plus, warm radiant floors can eliminate the need for carpeting, which is a breeding ground for dust mites, a very common cause of allergy-related respiratory diseases.



CREDIT: UPONOR

# 4: COST

Before looking at cost, consider durability: A radiant system lasts two to three times longer than a typical furnace, primarily because it doesn’t have as many moving parts. The boiler system can last 20 to 30 years; the piping in the floor—radiant heat system manufacturer Uponor offers a durable crosslinked polyethylene (PEX)—will last for the life of the home.

The actual costs for installation and equipment vary greatly, depending on the manufacturer, type of system, the size of area to be heated, type of zoning and controls required, flooring type and labor cost. There are other factors as well, such as whether you are ripping out an existing floor or installing the system in a new concrete floor.

While radiant is more expensive up front than a forced-air system, by rolling it into your mortgage you can enjoy the benefits of the system immediately; if you choose forced air, you pay less up front but will have higher utility bills, lower indoor air quality and reduced comfort.

To learn how radiant heat systems work, visit Uponor at [www.uponor-usa.com](http://www.uponor-usa.com).

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.

DOMESTIC WATER HEATING  
Multiple Options

Most homes have reservoir-type water heaters, which use gas, propane or electricity to heat water that is stored in a 50- or 80-gallon tank until the water is needed. Other homes have tankless water heaters, which heat water on demand. Another option, condensing heaters, capture the heat that would otherwise be lost in the exhaust gases and use it to heat water via a heat exchanger. Recirculating pumps move water from the source and back again, creating a continuous loop that results in no water wasted. **GB**

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 percent for gas boilers, 83 percent for oil boilers, 80 percent for gas furnaces and 82 percent 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:** The 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.

## GE Aros Smart Window Air Conditioner Could Be a Game Changer

Typical window air conditioners, the kind you pick up at Walmart for \$150, are about as “smart” as a toaster and far more polluting. They’re noisy, inefficient, include minimal controls and, if you’re lucky, contain an on-board thermostat.

Over time, we need to phase out this technology completely, in favor of more efficient ways of cooling, such as heat pumps, mini-split systems, evaporative coolers and geothermal loops. In the meantime, GE came up with a solution.

The Aros, co-designed by Quirky and GE, is the first AC unit to include Wi-Fi compatibility. That means you can program and control it from your smartphone or laptop. Just as importantly, the Wink app that controls it provides feedback on performance, telling you which settings will operate it most efficiently, based on the weather. Chances are, Aros can save you big on energy bills.

Just how much depends on your lifestyle. Simply setting the temperature schedule for your work week and sleeping periods should save you 20 percent or more. If you’re a frequent traveler or rent out your home on Airbnb, your savings could be much higher, as the wireless app allows you to minimize cooling when the home isn’t in use.



CREDIT: GE

To figure out your “payback” on the unit, a simple formula is: **8,000 BTUs / SEER 10 = 800 W = .8 kWh**  
**.8 kWh x \$0.15 (average U.S. utility cost) = \$0.12 per hour to run your window air conditioner.**

In a hot climate where the unit is run 24 hours a day for 125 days of summer, your window air conditioner will have an annual running cost of \$360 per year.

Let’s say you now have a programmable AC and can save even a modest 20 percent over a comparable conventional unit. You will pay off the “extra” cost of the wireless unit in about three years, because you’re saving \$72 a year in energy costs. After that, you’ll save a flat 20 percent on your energy bills every year the unit remains in service. Not a bad deal.

# Lighting08

Affordable LEDs are rapidly phasing out the competition.

Retrofitting your home with LEDs is one of the simplest ways to reduce overall energy demand.

LIGHTING MAKES UP about 11 percent of the typical home’s energy use. But as homes become more efficient and demand for space heating and cooling drops, the lighting piece of the “pie” becomes more significant. The emergence of LED lighting has transformed the lighting industry over the past several years. The EPA estimates that widespread use of LEDs could save 348 terawatt-hours (TWh) by 2027—the equivalent annual output of 44 large electrical plants. LEDs, or light emitting diodes, produce differently than old-fashioned incandescent bulbs or compact fluorescent bulbs. LEDs utilize a semi-conductor as the diode; when electricity passes through it, the material lights up. The heat generated is captured in a heat sink. LEDs are much cooler than “conventional” bulbs; they are also much more energy efficient and last much longer. Until recently, applications were limited and LEDs were prohibitively expensive. That has changed, as a quick tour of any big box store will show you. LED lamps (bulbs), can lights and fixtures have become cost competitive, making it easy to retrofit existing fixtures with energy-efficient LEDs. At the same time, “smart” technology is changing how we think about lighting, and holds the potential for making already efficient lights even more so. Here are some points to consider as you plan your next lighting purchases.

LEDSDisruptive Technology

For a long time, LEDs were unknown in residential lighting, but were used in electronics and in the marine and aviation industries. More recently, LEDs have been used in traffic signals, vehicle lights and entertainment lighting, including “holiday” lights. Part of the problem was that there is actually no such thing as a “white” LED.



**FLEX HOUSE SPONSOR**  
**Sylvania LED Lighting**

In addition to tradition white lighting, RGB LEDs—as in red, green and blue—can blend all three colors to create thousands that establish mood within a home. They’re dimmable and “smart,” and can be controlled via a smartphone through a hub or gateway.  
<http://bit.ly/2j4Dtnb>

**The Cost of Lighting, Bulb by Bulb**




	LED	CFL	Incandescent
Lifespan	50,000 Hours	10,000 Hours	1,000 Hours
Watts	8-12	13-15	60
*Annual Energy Use	18.3 kWh	25.5 kWh	109.5 kWh
**Annual Energy Cost	\$2.19	\$3.06	\$13.14
Energy Cost, 50,000 Hours	\$60.00	\$84.00	\$360.00
Toxic Materials	None	Contains Mercury	None
Cost per Bulb	\$3.00	\$3.00	\$1.00
# of Bulbs Needed, 50,000 hours	1	5	50
*Assuming average of 10 W for LED, 14 W for CFL, and assuming bulb is on an average of five hours per day			
**Assuming \$0.12/kWh			

Common LED colors include amber, red, green and blue. In order to “make” white light, different color LEDs are mixed or covered with a phosphor material that converts the color of the light. The phosphor is the yellow material you see on some LED products.

**Eaton HALO Series LPM9**

Eaton’s *LPM9* is a line-voltage LED module with shatter-resistant glass. It’s styled to look like an *A19* lamp and is dimmable to 5 percent with select dimmers. The module is part of Eaton’s *HALO* line, which is an ultra-low profile LED surface-mounting luminaire with the performance and appearance of a traditional downlight. *HALO* LED lighting products reduce energy consumption and maintenance requirements compared to traditional incandescent bulbs. <http://bit.ly/2cGpfTd>



Not only were the first residential LED products expensive, the quality of the light was disappointing. LEDs are directional light sources, which means they emit light in a specific direction, unlike incandescent and compact fluorescent bulbs, which emit light and heat in all directions. For this reason, LED fixtures use light and energy more efficiently in many applications; however, they are also prone to casting a harsh “spotlight,” rather than a diffuse, even light. Another issue was light quality, which was much cooler than the warm incandescent bulbs we grew up with. LED products include a Kelvin rating, which measures the light’s color temperature. In general, lighting in the 2,700 to 3,000 K range is pleasing to most people; the higher the number, the “whiter” the light. For comparison, incandescent bulbs range between 2,700 and 2,800 K. LED choices have expanded rapidly, from can light and bulb retrofits to dedicated LED fixtures that include internal drivers that transform their higher voltage to household voltage. Although LED light quality issues have largely been solved, you still need to be selective. LED bulbs that have earned Energy Star certification are subject to specific requirements designed to replicate the experience you are used to with a standard A-type bulb, so they can be used for a wide variety of applications. A general-purpose LED bulb that is not certified may not distribute light in all directions and could prove to be a disappointment if used in a table lamp.

**CFLS**  
**Not Without Issues**

Compact fluorescent lights, or CFLs, also produce light differently than incandescent bulbs. In an incandescent, electric current runs through a wire filament and heats the filament until it starts to glow. With a CFL, an electric current is driven through a tube containing argon and a small amount of mercury vapor. This generates invisible ultraviolet light, which excites the fluorescent phosphor coating on the inside of the tube, which then emits visible light. CFLs need a little more energy when they are first turned on, but once the electricity starts moving, CFLs use about 70 percent less energy than incandescent bulbs. Older CFLs used large and heavy magnetic ballasts that caused a buzzing noise in some bulbs. Most CFLs today (and all Energy Star-certified CFLs) use electronic ballasts, which do not buzz or hum. CFLs used to have cost and light quality advantages over LEDs, but both of those gaps are closing quickly. Without question, LEDs are the lights of the future.

**CONNECTED LIGHTING**  
**Maximizing Efficiencies**

Smart lighting can adjust itself to changing light conditions or occupancy; it can also be programmed to turn on an off at certain times. Some smart lights even “learn” occupant behavior and adjust accordingly. Increasingly, connected lights are part of comprehensive energy management systems. In many cases, these lights can be synced to other features or devices—so long as they all speak the same wireless “language.” One example of this is the *Caséta Wireless System*, offered by Pennsylvania-based Lutron Electronics. Through their mobile app, you can control not only your home’s lighting, but also the position of shades and thermostat settings,

## 3 Lighting Control Devices Every Home Needs

It should come as no surprise that lights can use a lot of energy, especially if they are left on when not in use. Energy-efficient bulbs are the most obvious solution to saving energy and money when it comes to lighting in the home. Lighting control devices can help to reduce energy usage and energy costs even further. These allow homeowners to customize the amount of light used, and can ensure that lighting is only used when needed. Here are three solutions to consider:



**Universal Dimmers**

**What They Do:** Dimmer light switches (see above photo) can help to reduce energy usage by decreasing lighting levels, and thus decreasing the amount of energy used to keep lights on.

**Where to Install:** Universal dimmers are ideal lighting control devices for most areas within a home, giving you the ability to control lighting levels for any task at hand.

**Occupancy Sensors**

**What They Do:** Occupancy sensors ensure lights aren’t left on when they’re not needed. They automatically turn the lights on when motion is detected and turn the lights off when the room has been vacated.

**Where to Install:** Occupancy sensors are perfect for entry ways in the home, such as near a door or garage door leading to the house, a laundry room, utility closet or anywhere where “hands-free” lighting control is desired.

**Lighting Automation Solutions**

**What They Do:** For homeowners looking to take their lighting control to the next level, lighting automation devices are the ideal solution. Devices with Z-Wave radio frequency technology, such as Leviton’s line of *Vizia RF +* devices, offer one-touch control of lights; they also allow you to set lighting “scenes” for certain times of day or events.

**Where to Install:** Lighting automation solutions are ideal for living rooms, TV rooms or rooms with lots of windows. Lighting levels can be adjusted according to time of day and the availability of natural light.

Source: Leviton

creating “scenes”—coordinated actions among various wireless devices—for specific events. Wireless lighting saves the hassle of having to break through drywall to wire new outlets and switches. If you’re converting to LED lamps or fixtures anyway, this might be a good time to add wireless sensors and controls. **GB**

# Appliances09

## Technology you can trust.

Proper sizing and use can make these labor-saving machines more energy efficient.

**H**OME 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.

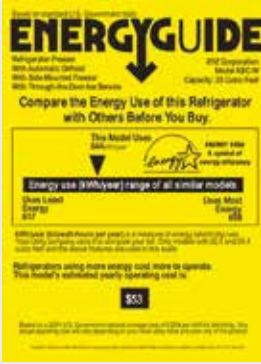
### REFRIGERATORS

#### 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 percent 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](http://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



**Don't overlook the familiar yellow EnergyGuide sticker.**

It holds a host of information that can help you find the most efficient appliances available.

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 drier, 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).

### 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



**FLEX HOUSE SPONSOR**  
**Bosch Home Appliances**

Bosch's compact appliances, such as its line of 24-inch refrigerators, offer the same Energy Star-rated performance of their larger counterparts—but in a smaller package. They also feature a clean and intuitive user interface, with special attention to touch and feel.

[www.bosch-home.com/us/](http://www.bosch-home.com/us/)

**Whirlpool Compact Tall Tub Dishwasher**

At 18" wide, this compact and sleek stainless steel dishwasher fits into tight spaces where other dishwashers cannot. Sound-reducing insulation keeps this Energy Star-qualified unit quiet during operation.

<http://bit.ly/1NBrW5A>



# What makes a DISHWASHER green?



**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.

**Tough Interiors**

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

**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.

**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.

PHOTO: BOSCH  
800 SERIES  
DISHWASHER

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.

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 60 dB, so choosing a unit that is quieter than that is important. Because of advances in

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 percent 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):** CEE, a consortium of efficiency program administrators from across the United States and Canada, periodically compiles lists of products that meet the organization’s tiers of efficiency, based on manufacturer data. [www.cee1.org](http://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.

What are Smart Appliances?

GET READY FOR A whole new wave of intelligent appliances. These “smart” refrigerators, washers, dryers and water heaters can track how much energy they are using; those that are smart grid ready have the ability to shift usage to periods of lower electricity demand, thereby easing pressure on the electrical grid. For example, a smart washer can delay the start of a load to off-peak times, or a refrigerator can turn its compressor off for a couple of hours.

Some smart features are geared toward convenience; for example, you can select cycles and start or start washer or dryer loads remotely, download new cycles or even troubleshoot problems with technicians. LG Electronics offers a smart refrigerator that will send you a photo of its contents to your smartphone, if you’re having trouble remembering what you need to buy at the grocery store. Smart ovens can download and store recipes (with photos), and smart dishwashers will make suggestions on the most efficient cycle for the particular load.

Though many of the major manufacturers, including Whirlpool, GE, Bosch and LG Electronics, are starting to offer smart appliances, expect a greater range of offerings over the next few years. The expansion of choices should start driving the price of intelligence down.



IMAGE CREDIT: LG ELECTRONICS

insulation and sound proofing, some dishwashers can be “whisper quiet,” creating as little as 41 dB 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 percent 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.

Save Big with Condensation Clothes Dryers

CLOTHES DRYERS ARE RESPONSIBLE for 6 percent of a home’s total energy usage, according to the Consumer Energy Center. This is partly because they use temperature-controlled air from inside a home, and then pump it out. In the winter, a home furnace must make up for the warm air lost. In the summer, air cooled by an air conditioner is used and re-heated in the dryer.

On the other hand, condensation clothes dryers work on a loop system. Air is drawn into the loop, goes through the dryer system and then is reused, instead of being pumped outside.

Though these units still carry a higher price tag, they do result in significant energy and cost savings. Reviewed.com estimated LG’s model, Whirlpool *Duet WED99HEDW*, can save homeowners 50 percent on the cost of drying clothes. Bosch makes a few condensation clothes dryers, such as the 24” *Compact Condensation Dryer 800 Series*. That unit consumes 311 kW per year, far less than the nearly 1,000 kW per year used by traditional clothes dryers, according to the Department of Energy.

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 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 specifications for clothes dryers took effect on January 1st of this year. [GB](#)

How do condensation dryers work?

1. Ambient (cool) air enters the dryer.
  2. Ambient air enters heat exchanger and is heated.
  3. Ambient air (warm and dry) exits heat exchanger.
  4. Process (heated) air enters drum to absorb moisture and dry load.
  5. Process air (wet) enters heat exchangers, is cooled releasing moisture.
  6. Process air (dry) exits heat exchanger.
  7. Process air enters heater and is heated up.
- Drain.** Water is collected and pumped into the drain.



CREDIT: BOSCH

# Plumbing<sup>10</sup>

Technology plus behavior change saves water.

Faucets and fixtures are more miserly than ever before, but your behavior plays an important role, too.

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 percent. But as a nation, we're still slipping—using about the same volume of fresh water every year.

But it's not just our water use indoors that needs belt tightening. Lawn irrigation accounts for up to 35 percent of water use in many homes. A combination of native landscaping, rainwater harvesting, graywater systems and smart irrigation controls can greatly reduce water waste.

Indoors, 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 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



**FLEX HOUSE SPONSOR**  
**American Standard FloWise Showerhead**  
The FloWise three-function showerhead uses a turbine to rotate the head. This provides the user with a full, satisfying spray, while only using 1.5 gallons of water per minute, well below the limits set by the EPA's WaterSense program.  
[www.americanstandard-us.com](http://www.americanstandard-us.com)

Durable Faucet Features

- Faucet Body and Finish**  
Solid stainless steel is durable, hygienic and resists chipping and scratching. Physical Vapor Deposition (PVD) finishes, which are molecularly bonded to the surface, are durable.
- Inside the Faucet**  
Stainless steel components will last much longer than plastic. Ceramic disc cartridges are far superior to compressed rubber seals and are standard on most faucets.
- Spray Hoses**  
If your faucet has an extender, make sure the hose is made from braided stainless steel rather than plastic.

IMAGE: MGS SPIN D FAUCET



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



**FLEX HOUSE SPONSOR**  
**Rachio Wi-Fi Smart Sprinkler Controller**  
This sprinkler controller offers "set it and forget it" intelligence that can compensate for weather, season and the unique characteristics of irrigation zones. It can also track water use over time.  
[www.rachio.com](http://www.rachio.com)



**FLEX HOUSE SPONSOR**  
**Nexus eWater Recycle Ready Assembly**  
The easy-to-install Recycle Ready Assembly, a pre-assembled graywater collection system, captures two out of every three gallons of indoor water for reuse in landscaping and for toilet flushing.  
[www.nexusewater.com](http://www.nexusewater.com)

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.

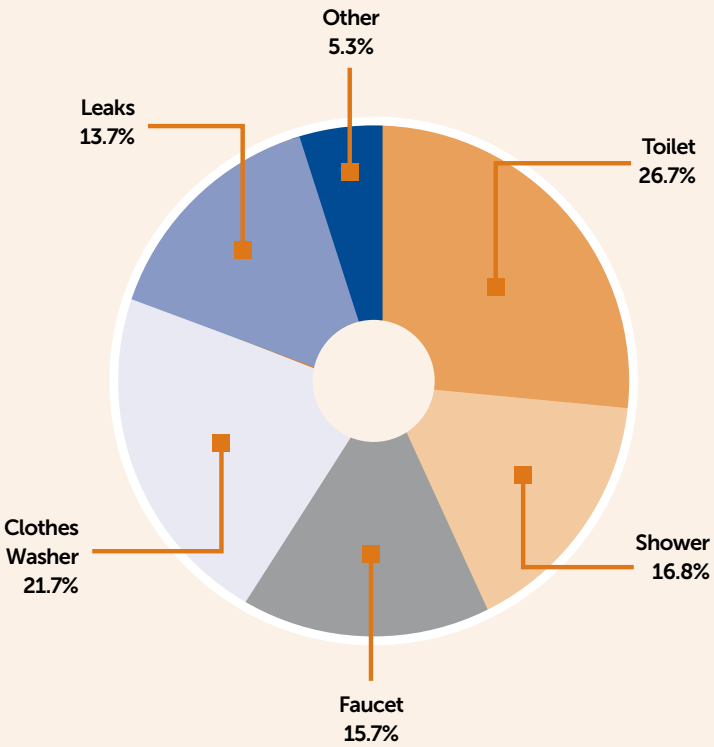
PLUMBING  
Think Flexible

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

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 percent. 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.

The next step would be to install a bidet, which would cut overall residential water use by hundreds of gallons a day (what it takes to make toilet paper).

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

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.

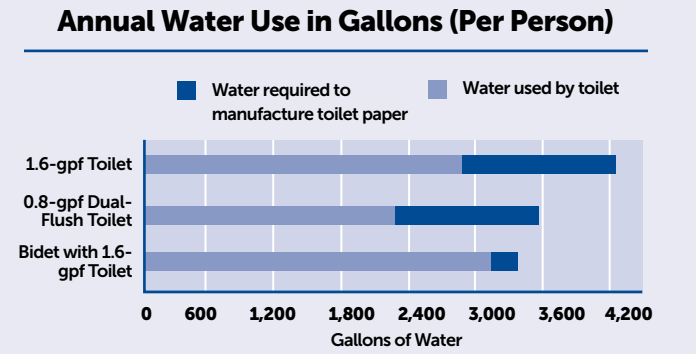
Manufacturers will continue to tweak toilet efficiency, no doubt, but the biggest gains could probably be made by simply adjusting our behavior: "If it's yellow, let it mellow." **GB**

The Benefits of Bidets

Bidet toilets work by using water, rather than toilet paper, to clean the nether regions. Bidets save more water indirectly by eliminating the need for toilet paper, the manufacture of which is a water-intensive process. But is a bidet really a better choice than, say, a water-efficient dual-flush toilet?

Annual toilet paper use in the U.S. tops out at 36.5 billion rolls. This equals 473,587,500,000 gallons of water and 15 million trees—and that doesn't account for the additional water required to treat and dispose of toilet paper waste. As the chart shows, a bidet attachment in combination with an efficient toilet saves about 200 gallons of water annually, compared to a dual-flush toilet. Other advantages? Water cleans better and is less abrasive than toilet paper, and bidets keep hands free—and clean.

If you're ready for a hands-free toilet, you don't have to purchase a new one; instead, you can opt for a bidet seat attachment. Depending on the model you choose, the money saved by crossing toilet paper off the grocery list will potentially pay for the bidet seat in a matter of months.



**Water Savings?** For this analysis, we assumed bidet users would still require 20 percent of the toilet paper used by "conventional" toilet users, and would require 0.125 gallons of water per use, in addition to the water required for flushing.

**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.

IMAGE: VISION HOUSE® TUSCON (LATHAMARCHITECTURAL.COM)

**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](http://www.schluter.com)) can add many years of leak-proof performance to a shower and/or floor.



**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.



**Leak Detection**

Wireless sensors such as *Wally* detect the presence of water or increased humidity and will send you an alert—even if you are far away from home. Place these sensors under sinks and other vulnerable locations.



**Low-Flow Toilets**

The best new low-flow toilets, such as the *Archer* toilet from KOHLER pictured here, use as little as 1.28 gallons per flush. Some dual-flush toilets require even less.

# What makes a BATHROOM green?

**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.

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.



# Finishes11

Balance durability with low toxicity.

Make sourcing paints and adhesives with no VOCs top priority, but don't forget about proper application and maintenance of these products.

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 10 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. On the other hand, several manufacturers have developed zero-VOC colorants—a common source of added VOCs in paint—and can claim that their products are truly "zero VOC."

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



**Sherwin-Williams Harmony Interior Acrylic Paint**  
GREENGUARD Gold-certified *Harmony* is a zero-VOC formula tinted with ColorCast Ecotoner colorants, which do not add VOCs. The paint also includes technology that can potentially reduce odors and harmful VOCs such as formaldehyde from carpets, furniture and finishes.  
<http://bit.ly/1NBstVC>

## 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://bit.ly/2dZPjdP>
- **Alkyd:** Commonly referred to as "oil based," this type of coating is typically higher in VOCs than waterborne 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 offgas 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.
- **Colorants:** These add color to paints, and are a potential source of added VOCs in paint products.

## 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, especially for people with asthma. Household cleaners

**FLEX HOUSE SPONSOR**  
**Mohawk Silver Ivory Laminate Flooring**  
Resembling real saw-cut planks with a cerused or limed finish, Mohawk Flooring's laminates are low-maintenance, scratchproof and will not contribute Volatile Organic Compounds or other harmful chemicals to the home.  
[www.mohawkflooring.com](http://www.mohawkflooring.com)



# What makes FINISHES green?

**Clean-Air Paints**  
Use only no-VOC or extremely 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.

**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 AFM Safecoat *Hard Seal* or some similar product to contain the offgassing.

**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. The Lauzon *Pure Genius* flooring pictured here uses a titanium finish that reacts with sunlight to break down VOCs and other chemicals.



**Lauzon Pure Genius Flooring**  
Forget smartphones, Lauzon's *Pure Genius* flooring is a smart floor, cleaning the air in your home by breaking down airborne toxins, such as VOCs. The filtering power of *Pure Genius* flooring is the equivalent of having three mature trees in your home, purifying the air up to 85 percent and reducing potential carcinogens that may lead to allergies and asthma.  
[www.lauzonflooring.com](http://www.lauzonflooring.com)

**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 percent 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.

Exterior Paint: Making It Last

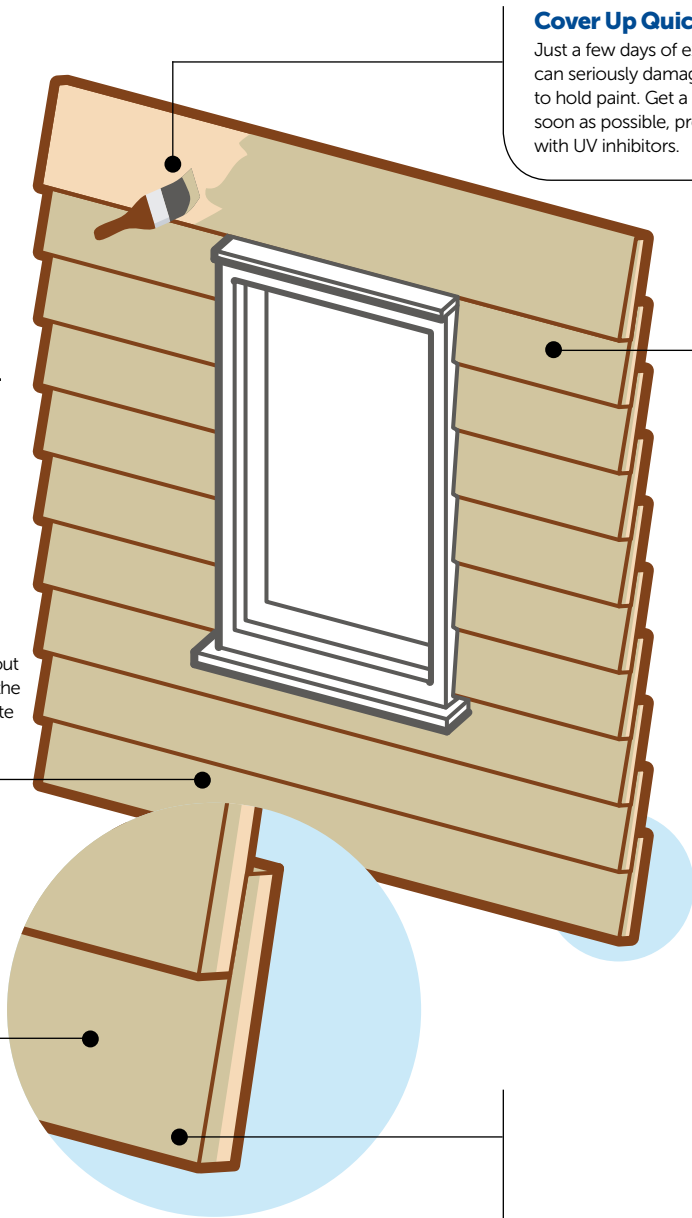
UNFORTUNATELY, PAINTING YOUR home is not a green activity. Why? Because products such as acrylic latex have a very high embodied energy—producing them takes a toll on the environment. It’s key, therefore, to maximize paint durability. You might think that switching to vinyl siding is a more “permanent” solution, but vinyl products come with a different set of environmental drawbacks. There’s no perfect fix. 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 percent. 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.

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 recently 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 caulks 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 caulks, never to use exterior products indoors. They tend to contain more volatiles.

There’s also the question of durability. While 100 percent 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**

Mohawk Bertolino Porcelain Floor Tile & Ceramic Wall Tile

Mohawk’s *Reveal* imaging technology helps create authentic definition, detailing and veining of natural marble in this porcelain tile collection. *Bertolino* comes in several large-format sizes, including 12” x 12”, 12” x 24” and 18” x 18”.

[www.mohawkflooring.com/flooring/tile](http://www.mohawkflooring.com/flooring/tile)



Standards for Low-Emitting Materials

Green Seal VOC Content Standards: Paints and Finishes

Low-Emitting Materials: Paints and Finishes Requirements

The Standard sets emission limits (measured as predicted concentration in air) for particulate matter, formaldehyde and other chemicals; GREENGUARD Gold certification also sets emission limits for specific VOCs.

Flat finishes .....	50g/L
Non-flat finishes .....	150 g/L
For anti-corrosive and anti-rust paints applied to interior ferrous metal substrates, the limit is somewhat higher.....	250 g/L
Clear wood finishes .....	350 g/L for varnish
.....	550 g/L for lacquer
Floor finishes .....	100 g/L
Sealers .....	250 g/L for waterproofing sealers
.....	275 g/L for sanding sealers
.....	200 g/L for all other sealers
Shellac .....	730 g/L for clear
.....	550 g/L for pigmented
Stains .....	250 g/L

GREENGUARD Total VOCs Emission Thresholds: Building Products and Interior Finishes

The Standard sets emission limits (measured as predicted concentration in air) for particulate matter, formaldehyde and other chemicals; the GREENGUARD Gold certification standard also sets limits for specific VOCs.

GREENGUARD .....	500 µg/m³
GREENGUARD Gold .....	220 µg/m³

SOURCES: WWW.LEEDUSER.COM AND INDUSTRIES.UL.COM

# Cabinets & Tops<sup>12</sup>

Choose products that won't pollute your indoor air.

From the incorporation of recycled materials to the use of non-toxic finishes, many makers of cabinets and countertops are finally offering truly green options.

**B**ACK 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

## 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 particleboard and other resin-bonded materials.

seal have at least taken some steps to clean up their practices and products.

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.

### FLEX HOUSE SPONSOR TheSize Neolith Countertop



Made from clays, feldspar, silica and natural mineral oxides, and treated with extreme heat and pressure, the *Neolith Fusion* collection of countertops looks and acts like real stone: durable, stainproof and scratch resistant.  
[www.neolith.com](http://www.neolith.com)

### Curava Recycled Glass Surfaces



Curava products are made from 100 percent recycled glass fragments within a resin binder. They are stain resistant with no waxes or sealers, contain no heavy chemicals, are nonporous and easy to clean, and are heat and scratch resistant. Curava surfaces are manufactured during daytime hours while using no artificial lighting in the factory, and the process results in no water waste.  
[www.curava.com](http://www.curava.com)

## What makes CABINETS and TOPS green?

### Durable Countertops

Nonporous solid surface material, such as the Wilsonart *Gibraltar* countertops pictured here, are naturally resistant to heat, stains and mold. Many varieties of durable, partly recycled countertops such as PaperStone are also now available. Other options include quartz-based products such as Vetrizzo or Cambria.

### 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 particleboard) used in cabinets tends to offgas for months—or even years. One workaround is to have a local woodworker make them. The Neil Kelly cabinets pictured here are free of added formaldehyde.

### 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.

### 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.

PHOTO: AARON ZILTNER / NEIL KELLY  
PORTLAND, OREGON KITCHEN  
DESIGNED BY THERESE DUBRAVAC  
[WWW.NEILKELLY.COM](http://WWW.NEILKELLY.COM)

What Makes a Cabinet Green?

INSPIRATION FOR THIS IMAGE: CRYSTALCABINETS.COM

**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 offgass. For cabinets finished onsite, low- or no-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.

**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.

**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.

The Importance of Certified Wood

Wood is a renewable resource, but in many places it has been harvested faster than it can regenerate, with little concern for the natural ecosystems or human communities impacted by the logging. However, you’ve probably heard of “certified wood.” This refers to lumber or products that contain wood fiber from sustainably managed forests. Globally, the area of certified forests has been rising steadily.

Wood products with certification labels have been vetted by third-party organizations. The two certification programs you’re likely to encounter are those managed by the Forest Stewardship Council (FSC) and the Sustainable Forestry Initiative (SFI).

The FSC certifies forests all over the world—380 million acres, to date. The standard includes provisions for protecting water quality, prohibiting pesticide use and protect old-growth habitat, among others. Read more here: <https://us.fsc.org>



As of this year, 250 million acres in the U.S. and Canada are certified to the SFI standard. The SFI manages standards for Forest Management, Fiber Sourcing and Chain-of-Custody certification; these standards were updated this year. Read more about the changes here: <http://bit.ly/1Mt2Hio>

Cabinetry is just one category where certified wood is available, so be sure to ask for certified wood for all aspects of your project, from framing lumber and plywood to trim. Certified wood may cost 10 to 15 percent more—although the cost depends on availability and varies from region to region—but choosing it over lumber that isn’t certified will help ensure forests, which are a key tool for fighting climate change, stay intact and healthy.

A cabinet company looking for the ESP label must achieve a 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 five 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 percent 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 five 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 Energy<sup>13</sup>

Transitioning to a future free of fossil fuels.

Renewable energy systems can take a well-designed, energy-efficient home to net-zero-energy status.

**P**RODUCTION 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 percent 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](http://www.swiftwindturbine.com)) and the Skystream ([www.skystreamenergy.com](http://www.skystreamenergy.com)) turbines begin producing power in

**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.

winds of just 8 miles per hour.

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.

## KOHLER Home Generators

You won't worry about power outages with a KOHLER home generator. Offering standby power, each unit runs on liquid propane or natural gas and requires a smaller installation footprint, because it's roughly half the size of larger-kW counterparts. KOHLER generators can be controlled remotely from a smartphone, tablet or computer.  
[www.kohlergenerators.com](http://www.kohlergenerators.com)



## Grundfos SQE Residential Groundwater Pump

Unlike conventional well pumps, the Grundfos SQE residential groundwater pump provides constant pressure, no matter how many faucets are being used. At three inches in diameter, the lightweight, easy-to-install unit has an intelligent built-in variable speed motor that automatically increases or decreases its speed, depending upon the amount of water consumed. [us.grundfos.com](http://us.grundfos.com)

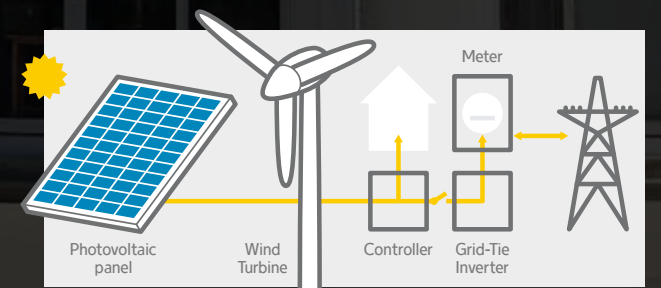


# Ways to go SOLAR

**Lease or Own?** The rise of solar leasing programs is putting solar arrays on more rooftops. A leased system must be grid-tied; if you own your system, you will have to weigh the pros and cons of being tied to the grid or not.

## PRO TIP:

**Make Ready.** Even if you don't plan to install solar electric panels or solar hot water now, if you pre-wire and pre-plumb, 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.

## SMA Sunny Boy Storage Battery Inverter

The Sunny Boy Storage transformerless battery inverter converts electricity from high-voltage battery to the grid, and vice versa. The inverter, which was first introduced in Europe, is lightweight, affordable and efficient, and it is compatible with high-voltage batteries from several manufacturers. The SMA Sunny Boy Storage battery inverter can be used in both retrofits and new PV installations. It will be available in 3.8- and 6.0-kW models.  
[www.sma-america.com](http://www.sma-america.com)



RESIDENTIAL SOLAR ARRAY BY NRG HOME SOLAR  
[WWW.NRGHOMESOLAR.COM](http://WWW.NRGHOMESOLAR.COM)

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 Leasing

Third-party-owned solar PV systems have made solar technology affordable to more people. Typically, a solar leasing company provides the array at a low (sometimes no) upfront cost. The leaser is guaranteed a fixed monthly rate for the term of the lease (often 20 years); in addition, the leasing company provides all maintenance of the array and often enables web-based monitoring of the system. Some companies offer a power purchase agreement instead of or in

### SOLAR SAVINGS

**What You Could Save Over Time**

What would you do with an extra \$20K? That’s how much the average solar system will save you over 20 years. Residents in states with high electricity rates, such as Hawaii, can expect to save even more.

SOURCE: ONE BLOCK OFF THE GRID

Small-Scale Cogeneration



**Heat and Power.** Innovative new co-generation equipment such as this unit from Australia-based Cogen Microsystems could dramatically change how homes are heated and cooled, but retail versions seem to come and go from the marketplace.

addition to a straight lease. In this arrangement, the customer pays for the energy produced by the panels, at a fixed and predetermined rate. Is it better to lease or purchase a solar system? This often depends on your tax bracket. If you are unable to take advantage of the 30 percent federal tax credit, a third-party-owned system might be the way to go, as the solar provider can utilize the tax credit and pass

### Bosch Power Max 2 EV Charger

Bosch’s *Power Max* level 2 electric vehicle charging stations included 16 and 30 amp models. Just launched, the new *Bosch Power Max 2* includes a 40-amp variant, which means faster charging for EVs that can accommodate 40 amps.

**www.pluginnow.com**

on the savings. Solar leasing programs are not available in every state (or in every region of a given state); however, the largest providers are continually expanding their territories. Companies that offer solar leases are SolarCity, SunPower, Sunrun, Sungevity, Real Goods Solar and NRG Home Solar ([www.nrghomesolar.com](http://www.nrghomesolar.com)).

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 percent efficiency, compared with 30 to 40 percent 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?

RESILIENCE

Back-Up Plan

A renewable energy system can be part of a strategy for keeping your home powered up during storms and power outages. Grid-tied solar PV systems aren’t available when the grid powers down, so it’s necessary to have a back-up plan. While gas- or propane-fired generators are a good conventional source of back-up power, other options are becoming available. Some inverter manufacturers are starting to build in a limited amount of storage into their products. Stand-alone solar panels can be used to power specific appliances.

### FLEX HOUSE SPONSOR

#### JinkoSolar Steel Roof Mount

A simple, fast and cost effective system allows you to mount PV modules on tin and other color corrugated steel roofs. It has excellent adaptability, suitable for almost all roofs of this kind. Mostly pre-assembly components and intelligent design reduce installation time and cost.

**www.jinkosolar.com**

Solar Roof Area

**There are a number of different things you need to know before calculating the roof area required for your solar panel installation:**

1. The size of the system.
2. The type and dimensions of the solar panels.  
(You can get these from the solar panel datasheet.)
3. The spacing between solar panels.
4. The orientation of the panels.

**Once you’ve gathered this information, here’s how to calculate the area required:**

**Size of the system (watts) ÷ size of the solar panel (watts) = number of panels required.**

Example: 5-kW system ÷ 250 W = 20 panels

Each panel measures 1,680 mm x 996 mm,  
or 1.68 m x 0.996 m = 1.67 m²

Total Area = 20 panels x 1.67 m² = 33.40 m²

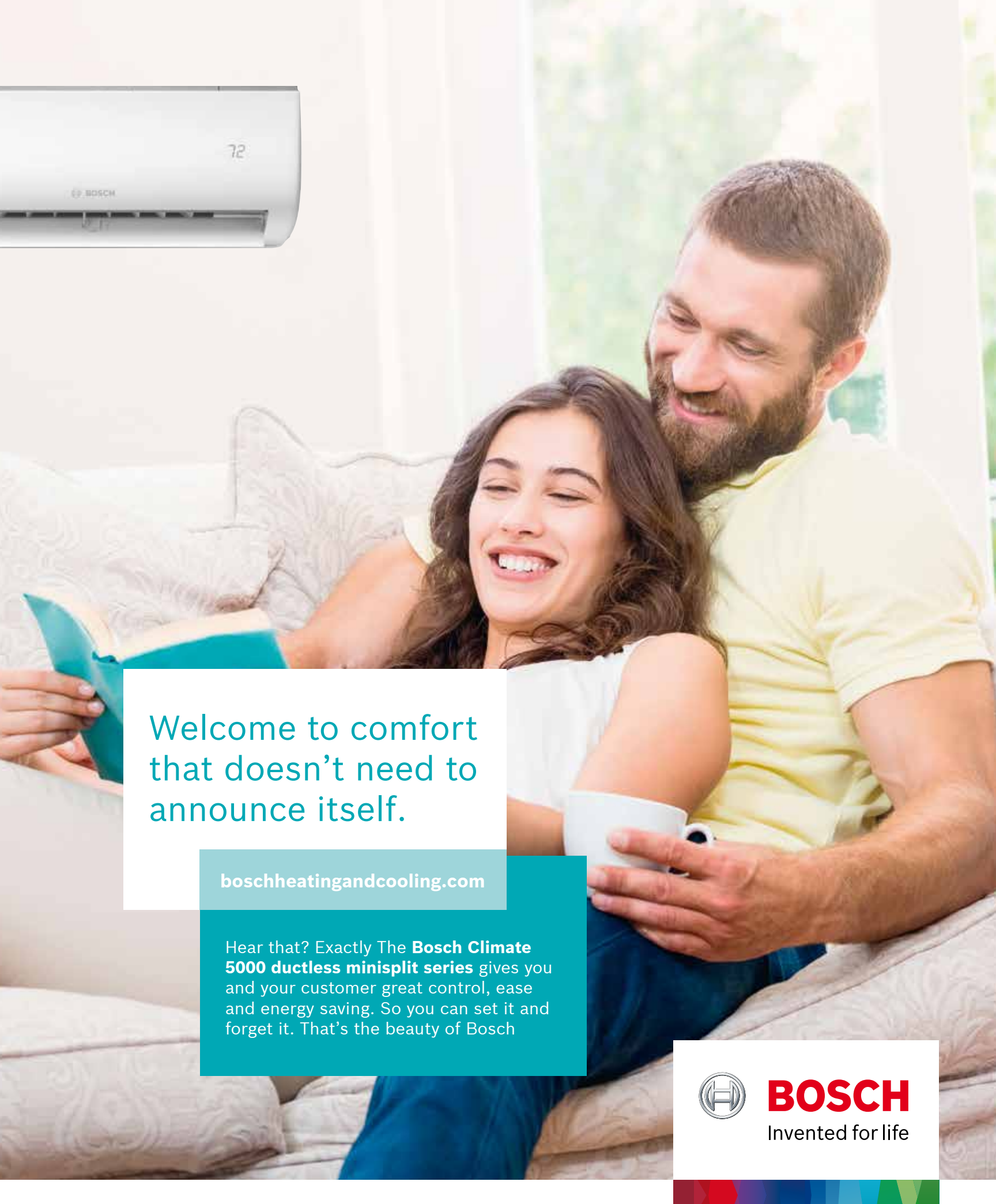
A little bit of space will also be needed between each panel for fixing the panels to the racks—this will depend on what type of racking system is used.

**Orientation.** If you don’t have enough roof space on a single roof face, consider splitting your system into two different orientations. The best orientation for panels (in the Northern Hemisphere) is south. East and west are slightly less efficient (around 9 percent less). If you split your panels between your south and west roofs evenly, you would only lose around 4.5 percent of your overall system capacity.

Battery banks have long been a staple of off-grid systems, but home batteries for grid-tied systems are just around the corner. Electric vehicle batteries paired with the right EV charger are another up-and-coming back-up power source. In this way, different power sources become part of a dynamic system that not only makes your home more resilient, but turns it into a dynamic participant in the grid rather than just an end user. **GB**

### Bosch eBike Systems

Available for the North American market in 2016, Bosch’s *eBike* system consists of an electrified drive unit, battery pack, computerized control panel and charger. An *eBike* can be part of an overall strategy for reducing emissions and building resilience, especially if you charge with solar power.” <http://bit.ly/1FMbBpa>



Welcome to comfort  
that doesn't need to  
announce itself.

[boschheatingandcooling.com](http://boschheatingandcooling.com)

Hear that? Exactly The **Bosch Climate 5000 ductless minisplit series** gives you and your customer great control, ease and energy saving. So you can set it and forget it. That's the beauty of Bosch



**BOSCH**  
Invented for life

## AD INDEX

### American Standard

Movie Stars. Heads of State. Your mother-in-law. With the ActiClean self-cleaning toilet, you'll be ready.  
[www.americanstandard.com](http://www.americanstandard.com)

PAGE 1

### Bosch Appliances

Timeless design on a smaller scale.  
[www.bosch-home.com/us](http://www.bosch-home.com/us)

COVER 3

### Bosch Heating and Cooling

Welcome to comfort that doesn't announce itself.

[www.boschheatingandcooling.com](http://www.boschheatingandcooling.com)

PAGE 62

### CodeWatcher

Stay on Top of Building Code News with CodeWatcher!

[www.codewatcher.us](http://www.codewatcher.us)

PAGE 8

### Flex House

Manifesting the concept of right-sized living.

[www.greenbuildermedia.com/vision-house-flex-house](http://www.greenbuildermedia.com/vision-house-flex-house)

COVER 2

### Panasonic

One Fan – Endless IAQ Solutions  
[us.panasonic.com/ventfans](http://us.panasonic.com/ventfans)

PAGE 5

### Schlage

The brand you know and trust can now deliver so much more.

[us.allegion.com/multifamily](http://us.allegion.com/multifamily)

COVER 4

### Sustainability Symposium 2018: Champions of Change

Climate change is the challenge of our generation, but an opportunity of a lifetime.

[www.greenbuildermedia.com/champions-of-change-2018](http://www.greenbuildermedia.com/champions-of-change-2018)

PAGE 7

### Whirlpool

It matters who makes it.

[www.insideadvantage.com/greenbuilder](http://www.insideadvantage.com/greenbuilder)

PAGE 3

## COMING NEXT ISSUE

## GREEN BUILDER®

### Champions of Change

Some of the nation's leading thinkers offer up ideas not only for housing, but for our survival and advancement as a species. It's time for some big ideas, in the face of big challenges.



Jeremy Rifkin

# FROM THE TAILGATE

New Offerings for the Sustainable Minded

By Ron Jones

## Get It in Writing

THERE IS AN OLD ADAGE of cowboy wisdom that says, “trust everybody in the game, but always cut the cards.” It’s another way of saying that while trust and communication are essential to a fair game and a successful outcome, in the final analysis, you have to watch out for your own interests, rather than leaving them in the hands of others.

It’s a principle that surely applies when attempting to achieve positive results in a construction project, no matter how large or small it may be. Whether you’re a building professional acting on behalf of a client, or a consumer trying to manage a project of your own, you always need to start with a basic level of trust, and then do everything you can to reduce the chances of miscommunication and potential conflict—but, most importantly—you have to stick to your guns when push comes to shove.

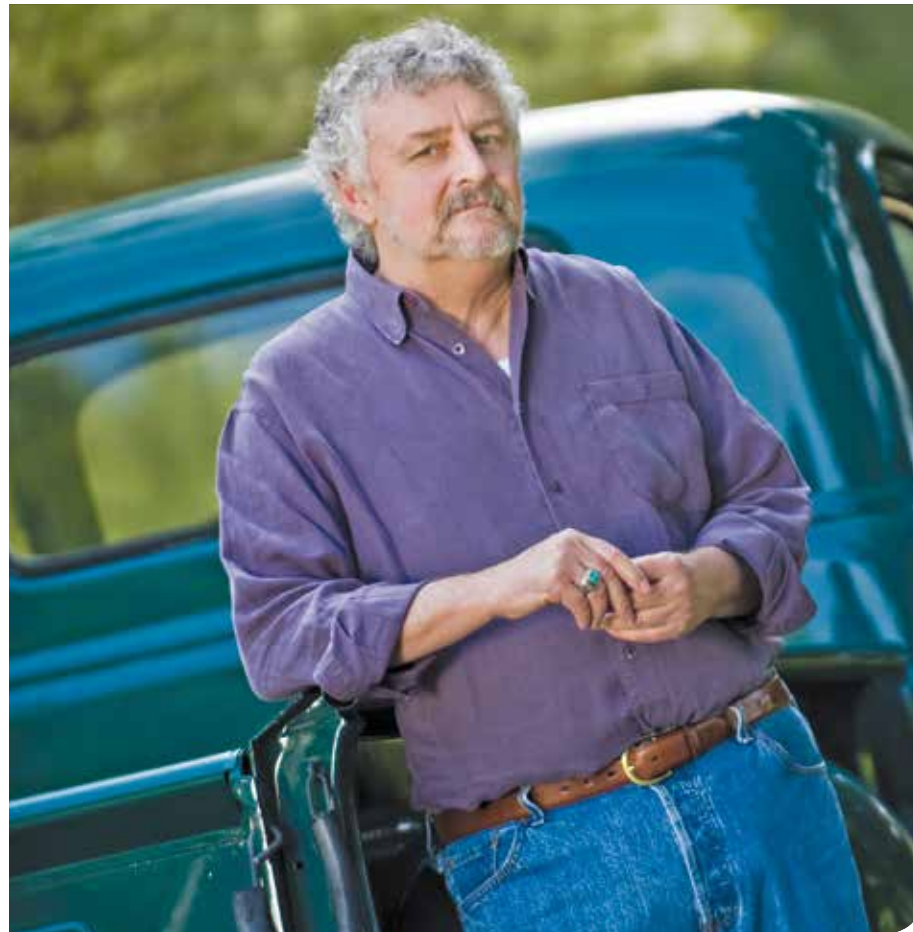
Years ago, I was asked by a favorite client to oversee a paving project on the property where I had built their custom home. They had taken their time deciding what kind of driveway material they wanted, and for a number of reasons, they selected asphalt as their best option. They were not familiar with the process, so they recruited me to arrange for the contractor and oversee the job.

I knew from past experience that there were a number of potential pitfalls waiting for the unsuspecting or inattentive, so I had my regular excavation contractor do all the prep work, and then helped to select the paving contractor from a couple of bidders.

When I signed the work order on behalf of the homeowners, I added a clause that no cold joints would be acceptable, and that the work had to be completed in one day. I made sure to point this out to the contractor, and got his signature on the agreement. I also made sure I would be available to be onsite for the duration of the work.

Things went smoothly enough until late in the day. With about 90 percent of the paving completed, the contractor started making it obvious that he was going to wrap up for the day. He matter-of-factly informed me that he would bring his crew back the following day to complete the job.

I reminded him that our contract contained a prohibition on cold joints, but he shrugged off the concern, saying it was no big deal and that, “a year from now nobody will be able to tell the difference.”



I said, “fine, come back a year from now and if our customer can’t find the cold joint you can pick up your check”.

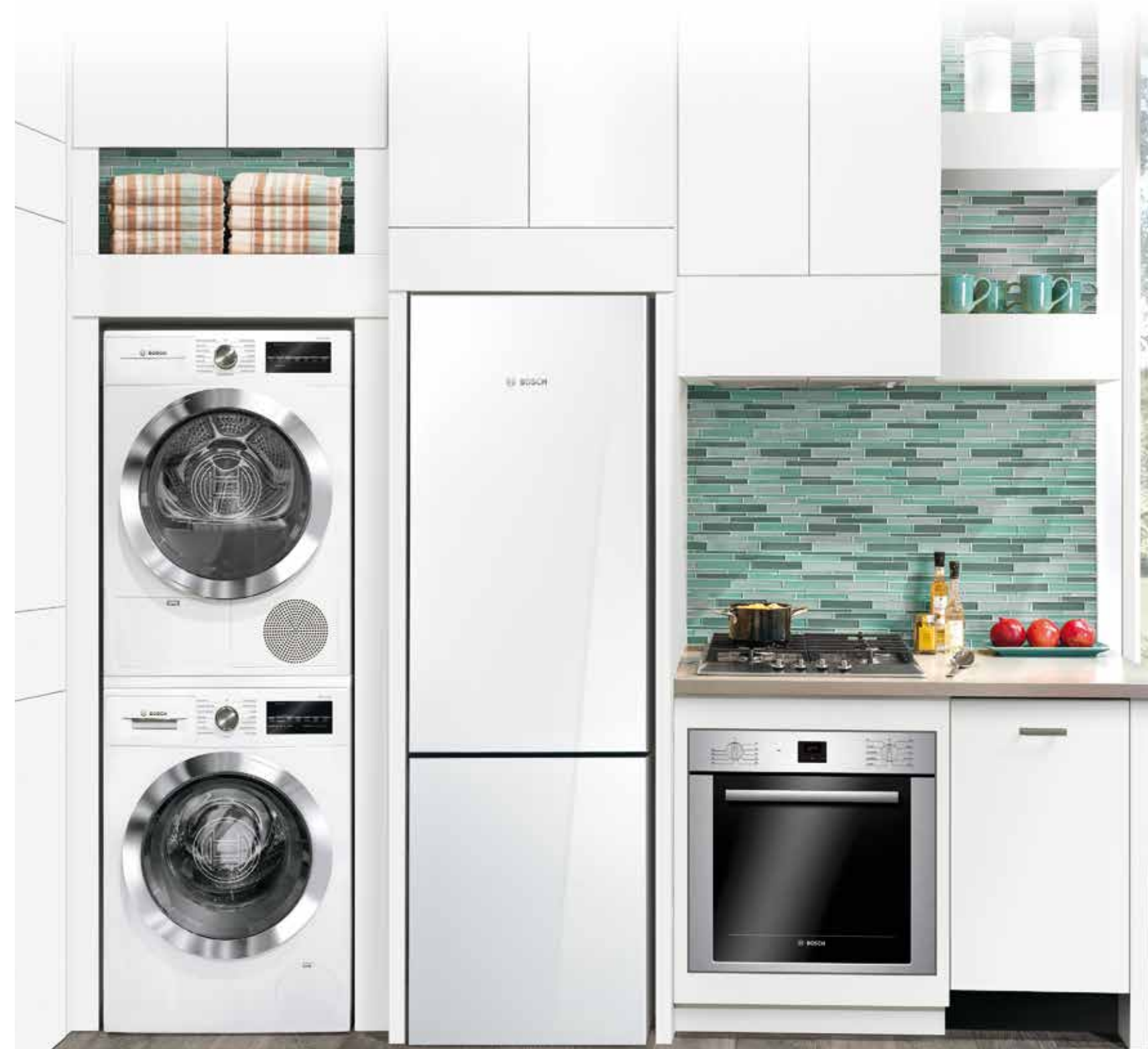
He immediately got on his phone, called the dispatcher at the batching plant and ordered the material needed to finish the job. It was well toward nightfall when all was wrapped up but the job was complete and the homeowner was delighted with the new driveway.

The easy thing would have been to go along with the contractor and avoid conflict but that is not what my customer trusted me to do. Would the homeowner have known what to say or do if he had been confronted by that uncomfortable situation? Would he have been willing to enforce the clause in the contract? Maybe, maybe not. Professionals and consumers alike are often faced with people who are willing to ignore what they have agreed to.

That’s why you should always cut the cards. By the way, that contractor was not asked to bid any more of my projects. **GB**

## Timeless design on a smaller scale.

Discover modern compact Bosch kitchen appliances, designed to enhance small spaces and maximize functionality.



Allegion creates peace of mind by pioneering safety and security.

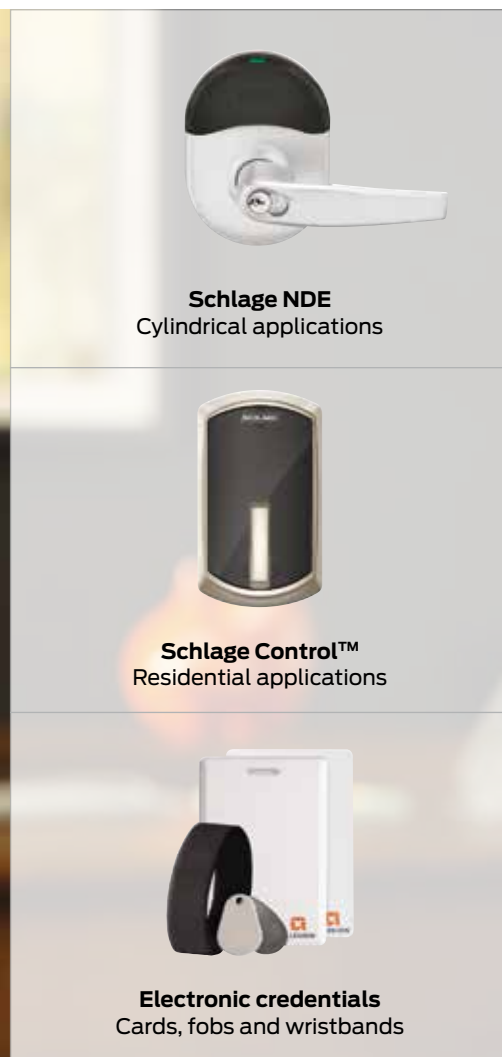
Call or visit us today to speak with an Allegion Architectural Consultant about Allegion products and specification writing services.

888-670-4329 [us.allegion.com/multifamily](http://us.allegion.com/multifamily)

2017 Editors' Choice  
**GREEN BUILDER**  
**HOT50**  
**PRODUCTS**



Schlage LE



**Schlage NDE**  
Cylindrical applications

**Schlage Control™**  
Residential applications

**Electronic credentials**  
Cards, fobs and wristbands

011530 © 2017 Allegion

# The brand you know and trust can now deliver so much more

Today, Schlage has added the latest technology to its world-class mechanical locks. Introducing the Schlage® LE wireless lock for mortise door applications. LE wireless locks are ideal for commercial spaces with resident entries, common area doors and sensitive storage areas. Like Schlage Control™ and NDE, LE wireless locks can be managed with ENGAGE™ web and mobile apps—now with enhanced capabilities.

Allegion offers an array of products and solutions for a multitude of applications. Visit our website to find out more at [us.allegion.com](http://us.allegion.com).

*aptiQ* ■ LCN ■ **SCHLAGE** ■ STEELCRAFT ■ VON DUPRIN

  
**ALLEGION™**  
PIONEERING SAFETY™