2007 Edition

HOME REMODELING GREEN BUILDING GUIDELINES

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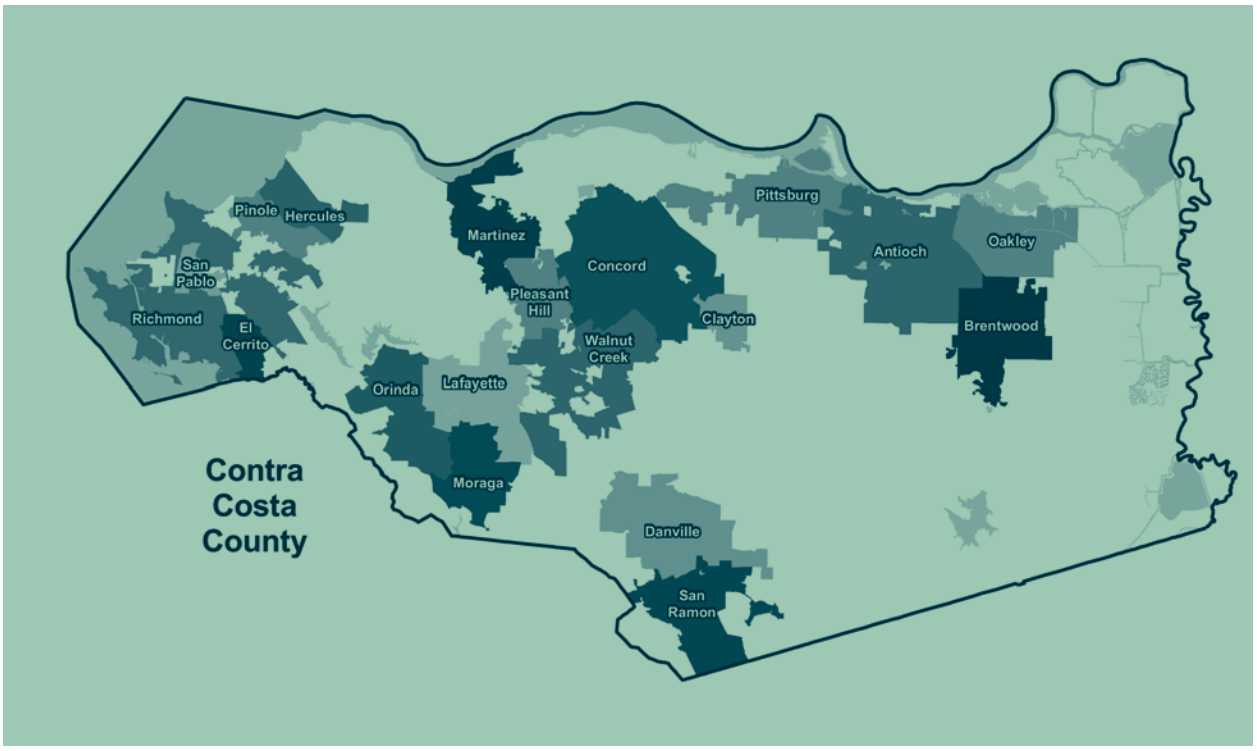

Recycling Agencies In Contra Costa

The local recycling agency phone numbers below will put you in contact with a representative for one of the nineteen cities or the unincorporated areas of Contra Costa County. These agencies offer a wide range of programs in the areas of waste reduction, recycling, composting, market development and other related technical assistance.

CITY/COUNTY	PHONE NUMBERS
Antioch	925-779-6137
Brentwood	925-516-6090
Clayton	925-673-7300
Concord	925-671-3394
Danville	925-906-1801
El Cerrito	510-215-4350
Hercules	510-215-3125
Lafayette	925-906-1801
Martinez	925-372-3531
Moraga	925-906-1801
Oakley	925-335-1231
Orinda	925-906-1801
Pinole	510-215-3125
Pittsburg	925-252-4110
Pleasant Hill	925-671-5203
Richmond	510-215-3125
San Pablo	510-215-3125
SanIRamonI	925-973-2800
Walnut Creek	925-906-1801
Unincorporated County (all other areas)	925-335-1231

Construction & Demolition Waste

Construction and demolition (C & D) debris comprise up to 30% of materials disposed in California landfills. Through job site recycling, efficient use of materials, use of recycled content building materials and similar practices, you can effectively decrease the amount of materials needed for home construction.

All cities and counties in California are required to implement programs that divert waste from landfills. The County and many cities have passed C & D ordinances that require certain construction projects to reuse and recycle jobsite debris. For additional details regarding these ordinances, go to http://www.cccrecycle.org/debris or call the Contra Costa County Community Development Department at 925-335-1231. Free copies of the "Contra Costa Builder's Guide to Reuse and Recycling", which identifies resources to reuse and recycle C & D debris are available on-line at http://www.cccrecycle.org or by calling the Recycling Hotline at 1-800-750-4096.

Household Hazardous Waste Facilities

Serving West County:
West County Household Hazardous Waste Collection Facility 888-412-9277

Serving Central County:
Central Contra Costa Sanitary District Household Hazardous Waste Collection Facility 800-646-1431

Serving East County:
Delta Diablo Sanitary District Household Hazardous Waste Collection Facility 925-756-1990

Local Water Utilities

The following cities/communities are served by their own local water utility:

CITY/COUNTY	PHONE NUMBERS
Antioch	925-779-7060
Brentwood	925-516-5416
Bay Point	925-458-3112
Martinez	925-372-3575
Oakley	925-625-3798
Pittsburg	925-252-4940

The remaining cities and unincorporated communities are served by one of the below water utilities.

Serving West County and portion of Central County:
East Bay Municipal Utilities District 510-287-1380 or www.ebmud.com

Serving majority of Central County: Contra Costa Water District 925-688-8000 or www.ccwater.com

Energy Utility

PG&E's Smarter Energy Line 800-933-9555 or www.pge.com

Design: Celery Design Collaborative, Berkeley, CA Printing: 100% post-consumer recycled paper using soy-based inks. March 2007

About Build It Green

Build It Green is a professional non-profit membership organization whose mission is to promote healthy, durable, energy- and resource-efficient buildings in California. Supported by a solid foundation of outreach and education, Build It Green connects consumers and building professionals with the tools and technical expertise they need to build quality green homes. Build It Green fosters collaboration with key stakeholder groups to accelerate the adoption of green building standards, policies, and programs.

In addition to providing these Guidelines for educational purposes, Build It Green offers the following companion resources at www.BuildItGreen.org:

- Green Points calculator
- List of references for all Guidelines measures
- Innovation checklist for approaches beyond the measures described in the Guidelines
- Cross-referencing with other residential initiatives (e.g. ENERGY STAR® Indoor Air Package, LEED-H, CA Green Builder and the NAHB Guidelines)
- Addendums that explain how to use the Guidelines in conjunction with other programs
- Information about new practices and materials or corrections that are identified after publication

RESOURCES

AccessGreen Directory

Locate green building products, local suppliers and service providers that correspond with the measures listed in the green building guidelines. The database is continuously updated based on the local availability of products and development of new materials. It is searchable by product categories, product names, and green building measures. Available at www.BuildItGreen.org

Ask an Expert

Have a green building question? The Ask an Expert hotline is a FREE service that provides homeowners and building professionals with unbiased, technical information for their green project.

Call today!
888-40-GREEN (888-404-7336) or
www.BuildItGreen.org

LOCAL SUSTAINABLE CONSTRUCTION RESOURCES

Green Building Program Information
925-335-1230 or www.cccrecycle.org/greenbuilding

Construction & Demolition Debris Recovery
925-335-1231 -or- www.cccrecycle.org/debris

Recycling Hotline
800-750-4096 -or- www.cccrecycle.org

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Foreword

These *Home Remodeling Green Building Guidelines* were developed:

- To present a range of voluntary green measures for building professionals and homeowners to choose from when remodeling a home in California
- To provide local governments with an educational tool for city staff, building professionals and homeowners interested in green residential remodeling
- To offer cost-effective suggestions to minimize construction-related waste, create healthier and more durable homes, reduce operating costs for homeowners and support local manufacturers and suppliers of resource-efficient building materials
- To create a policy foundation for local governments interested in implementing a green building program
- To establish regional consistency in green building guidelines to increase predictability for building professionals
- To integrate varying residential initiatives in order to achieve greater simplicity and local applicability
- To offer methods to reduce the impacts of building in California communities, including solid waste management, water conservation, energy efficiency and resource conservation
- To offer a set of guidelines developed by an independent, third-party source in collaboration with a wide range of expert stakeholders

Guidelines Development Process

The *Home Remodeling Green Building Guidelines* were first developed in 2001 through a collaborative process and public-private partnership among building professionals, green building experts and local government staff in Alameda County. Representatives from the local professional building industry—including Master Builders, McCutcheon Construction, Inc., Odin's Hammer, Canyon Construction and Jarvis Architects—provided input and direction on the development of the original Guidelines.

These Guidelines were updated in 2007, again using a collaborative process. The purpose of this update was to expand the Guidelines' applicability throughout California, address changes in Title 24, and incorporate measures from other regional and national residential green building initiatives.

Build It Green (see page 3) expanded and facilitated the stakeholder process to include input from its various councils, including the Green Professionals Guild, Public Agency Council, Builders Council and Suppliers Council.

Publicly available information, scientific data and third-party standards were referenced in the development of these Guidelines. The Guidelines are intended to be a living document, and will be updated as the green building marketplace changes, additional technical and quantitative information becomes available, measurement tools such as Life Cycle Assessment become more accessible, and new green measures are developed.

Acknowledgments

Special thanks to the following individuals and organizations for contributing to the development of these Guidelines:

BUILDING PROFESSIONALS

- Dennis Allen, Allen Associates
- Bruce Hammond, Hammond Fine Homes
- Geoffrey Holton, Geoffrey Holton and Associates
- Beth Leibbrandt, Harrell Remodeling, Inc.
- Maurice Levitch, Levitch Associates, Inc.
- Connie and Dennis McCullah, Odin's Hammer
- David Seth Melchert, Master Builders
- John Shurtz, Green Builders of Marin
- Lee Tollefsrud, Lawrence Construction

PUBLIC AGENCIES

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- Wes Sullens, Green Building in Alameda County
- Karen Kho, Green Building in Alameda County
- Wendy Sommer, Green Building in Alameda County
- Teresa Eade, Bay-Friendly Landscaping
- Cynthia Havstad, Bay-Friendly Landscaping
- Carlos Michelon, Metropolitan Water District
- Gary Klein, California Energy Commission
- John Koeller, California Urban Water Conservation Council
- Southern California Public Agency Council Technical Advisory Committee

NONPROFIT GROUPS

- Katy Hollbacher, Build It Green
- Jennifer Love, Build It Green
- Bruce Mast, Build It Green

OTHERS

- Marc Richmond, Practica Consulting
- Jennifer Roberts, Editor
- David Springer, Davis Energy Group
- David Blanke, Southern California Gas Co.
- David Johnston, What's Working
- Tom Larson, DUDEK
- Celery Design Collaborative, Graphic Design

This update of the Home Remodeling Guidelines also benefited from the technical input provided by numerous individuals and organizations during the development of the 2005 New Home Construction Guidelines.

"We love to build green not only because it is the right thing to do, but also because our clients and employees love it! Now that we have established a reputation as a green builder, we are getting lots of opportunities to build interesting, green projects. Green has been great for business."

—Michael McCutcheon, McCutcheon Construction, Berkeley, CA

Salvaged eucalyptus flooring

Design for daylighting

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Chapter One:

Overview of Green Building

"I build green for my clients to give them healthy, energy-efficient homes. I build green for myself to leave a light footprint legacy in this heavy footprint industry."

—Mark Nelson, Renaissance Remodelers, San Anselmo, CA

Overarching Principles of Green Building

1 **Build for the long-term**
Build durable, efficient homes and livable communities.

2 **Build for our children**
Make their homes, communities and environment safe.

3 **Build for the planet**
Use natural resources wisely.

Introduction

In response to growing concerns about the quality of our lives and the quality of our environment, an increasing number of Californians are embracing green building. This holistic approach to home building and remodeling emphasizes quality construction, energy efficiency, good indoor air quality, environmentally sound landscaping, and livable neighborhoods. As you'll discover in these Guidelines, green building provides countless benefits to California's building professionals, residents and communities.

Does green building really matter?

Green building means improving our design, construction and landscaping practices so that the homes we build or remodel today will last longer, cost less to live in, and won't harm our health. It also means protecting natural resources and improving the built environment so that people, communities and ecosystems can thrive and prosper.

With the budget and time pressures we're all under today, is it really worth the extra effort? Increasingly, homeowners and building professionals agree that it is worth the effort. Better homes, it turns out, are also better for business. Remodeling contractors and other building professionals who follow "building as usual" practices may find themselves at a competitive disadvantage as regulatory and market forces shift the industry toward built environments that are healthier, more resource efficient and less polluting.

By remodeling homes so that they are more durable, healthier, and less wasteful of energy, water and other resources, today's green remodelers are helping to safeguard the well-being and prosperity of Californians now and for decades to come.

Fundamental Objectives of Green Remodeling

There's nothing mysterious about green remodeling—it's really just applied common sense. To move forward with greening your remodeling project, it is helpful to think of green remodeling as quality design and construction achieved through the convergence of four fundamental objectives:

1. Conserve natural resources
2. Use energy wisely
3. Improve indoor air quality
4. Make communities more livable

Conserve natural resources

Residential remodeling activities consume large quantities of wood, water, metals, fossil fuels and other resources. Even though the majority of the materials used to remodel a home are put to good use, vast quantities of resources are wasted. In fact, each year close to nine million tons of construction and demolition debris is disposed of in California landfills, accounting for 22% of the entire state's waste stream.

Much of this waste is avoidable. Careful management of the construction process makes a big difference. There are also many well-established remodeling practices that help protect natural resources. If you are building an addition to an existing home, for example, advanced framing techniques can substantially reduce lumber requirements without compromising structural integrity. Using engineered lumber and wood products certified by the Forest Stewardship Council can help ensure the long-term health of forests.

Many effective remodeling strategies not only conserve natural resources, but also provide additional benefits such as saving money. These include using durable products such as roofing materials with 40- or 50-year warranties, and specifying recycled-content products that divert waste from landfills. Recycled-content decking, reclaimed lumber and other products put waste to good use, while providing quality and durability that often exceed conventional materials. For example, decking materials made of recycled plastic mixed with wood waste fibers can last up to five times longer than wood decking, and never needs to be treated or painted.

Water is another critical resource. California residences use 5.6 million acre-feet of applied water annually. Our prosperity and ability to meet the needs of our growing population hinge on having adequate supplies of clean, fresh water. Homes remodeled and landscaped to use water wisely make a tremendous contribution to protecting our shared resources and reducing the pressure on municipal water systems and supplies. An added benefit is lower water and sewer bills for the homeowner. Today's building professionals and homeowners can take advantage of a new generation of cost-effective, high efficiency appliances and landscape water management systems, as well as a variety of proven landscaping strategies that reduce water use.

Use energy wisely

Using fossil fuel–based energy is a major contributor to air pollution and global climate change. With homes accounting for roughly 31% of the electricity consumed in the state, it is clear that homeowners and remodeling professionals have a significant role to play in helping our society address energy-related concerns now and in the coming decades.

Energy efficiency is the cornerstone of every green home. Whether you are remodeling a 30-year-old suburban ranch house or a 120-year-old inner-city Victorian, you can improve its energy performance. Improving energy efficiency and using renewable energy sources are effective ways to reduce the potential of energy supply interruptions, improve air quality, moderate the impacts of global warming, and slow the rate at which we need to build new power plants.

Energy efficiency also makes good sense for homeowners: an energy-efficient house saves money by reducing utility bills year after year, and provides other valuable benefits. Better insulation, for example, reduces uncomfortable drafts, and double-pane windows make for a quieter home. Homeowners who have already made their homes as energy efficient as possible may choose to go a step further and install renewable energy systems such as solar water heating and photovoltaic panels.

Improve indoor air quality

On average, Americans spend 90% of their time indoors, yet the air inside our homes can be ten times more polluted than outdoor air, according to the U.S. Environmental Protection Agency. Children are particularly vulnerable when it comes to air pollution. A report in the New England Journal of Medicine states that 40% of children will develop respiratory disease, in part due to the chemicals in their homes.

A common source of indoor air pollution is volatile organic compounds (VOCs), a large class of chemicals that offgas from many building materials. Exposure to VOCs may cause a range of symptoms, from eye irritation and headaches to more severe effects. Many paints, floor finishes, adhesives and sealants emit unhealthy VOCs. Kitchen cabinets, countertops, shelving and furniture may be made from particleboard or medium density fiberboard. These pressed-wood products are typically made with adhesives that release urea formaldehyde—a known human carcinogen—into the home for years after installation.

Photovoltaic panels

Salvaged building materials

Fortunately, the building products industry is responding to these indoor pollution problems by developing safer products, including low-VOC paints, cleaners and adhesives. These products are now commonly available from most major suppliers at costs comparable to conventional products.

Poor indoor air quality is also often caused by biological contaminants, such as mold that grows as a result of moisture infiltration due to inadequate ventilation, poor design and maintenance, and other factors. Dust, another major source of air pollution inside homes, can be reduced by making sure the entryways have easy-to-clean flooring materials such as natural linoleum, bamboo or wood, and by offering a bench and shoe storage to encourage people to removes shoes before entering the home.

Make communities more livable

Whether you are updating the kitchen or adding a bedroom, it's natural to think of a remodeling project as a private affair. But it is important to remember that the remodeling decisions we make don't just affect our own lives. Our choices can also have an impact on other people's lives for decades to come. A home that is remodeled without taking energy efficiency into account will waste energy year after year, resulting in air pollution and global warming that affects all of us. A home remodeled using poor quality materials may put an unnecessary burden on landfills a few years down the line, if those materials have to be torn out and replaced. Landscaping that sends rainwater directly to the sewer rather than allowing it to sink in the soil strains our aging wastewater treatment systems.

Green remodeling offers remodeling professionals, community leaders and California residents sensible solutions that both improve an individual home's performance and provide broad-based community benefits. These benefits range from cleaner air to reduced global warming impacts, from healthier landscapes to longer-lasting buildings.

Clearly, green building cannot solve all the social, economic or environmental challenges facing California's communities. Still, green remodeling offers a valuable set of strategies for meeting our expectations for livable, healthy, sustainable communities.

Recycled plastic composite decking

Sustainably renovated home

Costs and Benefits of Green Remodeling

There are many reasons to embrace green remodeling. These include health considerations for residents and construction workers, utility and maintenance costs, concern about environmental issues such as global warming and destruction of old-growth forests, and a desire to create higher quality homes.

By applying a sustainable perspective to the remodeling process, green building brings the benefits of resource conservation, durability, energy savings and healthy living. Although all of these benefits are compelling, on any given project you or your client may decide that one type of benefit—such as energy savings or better indoor air quality—is most important.

If you are a building professional, green remodeling skills may help you expand your market and develop an environmentally friendly image for your business. And if you are a homeowner, green remodeling strategies that focus on energy and water conservation can reduce your utility bills year after year. While it's true that some individual green remodeling strategies may cost more, the benefits and value of adopting a green approach to remodeling are vastly higher than any small increase in cost.

Balancing costs and benefits

These Guidelines describe methods and materials that range in cost—some of them cost no more or even less than conventional options. In fact, when a remodeling project is designed from the outset to be green, it need not cost more than a conventional remodeling project. While not all measures described in these Guidelines will be applicable to your project, the measures included are relevant and reasonable for most existing homes in California.

Some of the measures do cost more initially, but this additional cost needs to be evaluated in the context of the longer-term benefits provided: utility and maintenance cost savings, better indoor air quality for residents, healthier jobsites for workers, and longer building life. When considering green building measures, it is very important to balance upfront design, product and construction costs with these other significant benefits.

While most green remodeling practices are just common sense, sometimes the greenest approach requires that the remodeling professional or homeowner become familiar with a new product or practice, such as incorporating a rain screen wall system when building new exterior walls. Learning new practices sometimes involves an initial outlay of time and money. But green buildings are more than just buildings. They are the manifestation of the homeowner's and building professional's desire to do their part in contributing to a healthier, more sustainable world.

Getting started with green remodeling

These Guidelines are for building professionals and homeowners planning to remodel single-family homes in California.

The methods and materials in these Guidelines range from basic, common-sense practices such as venting bathroom fans to the outside, to more sophisticated strategies such as installing renewable energy systems.

No matter where you are on the green remodeling spectrum—from novice to expert—you can count on these Guidelines for resources, design ideas and real-world advice that you can put to use today.

If you are new to green remodeling, you can start taking steps right away toward creating healthier and more energy- and resource-efficient homes. Inside these Guidelines, you'll find many strategies that are easy to implement and add virtually no cost.

As your experience with green remodeling grows, you'll likely find yourself scaling up to even healthier and more effective design and construction practices. The Green Remodeling Checklist in Chapter Two provides a very convenient way for you to track green features in a particular project. And for remodeling professionals, the Green Remodeling Checklist is also a handy way to benchmark your progress over time as you and your company gain experience with green building.

If you are experienced with green remodeling, some of the approaches and practices described here may already be part of your daily practice. In that case, these Guidelines will help you employ more advanced green-building strategies that will reinforce your organization's leadership position.

Chapter Two:

Green Remodeling Checklist

The Green Remodeling Checklist was developed to offer building professionals, homeowners and municipalities a tool to assess how green a particular remodeling project is. It is based on the green building methods and materials described in Chapter Three. The Green Remodeling Checklist was developed in coordination with local builders, city planners and building officials.

Because remodeling projects vary so widely in scope—from a bathroom re-do to a whole-house rebuild—it is not feasible to use the checklist to assign a "final score" for projects. Every effort should be made, however, to incorporate as many of the measures as possible into your remodeling projects. These measures were chosen based on their ability to improve the home and the environment, as well as on their ease of implementation and relative low cost. Consider these measures as a starting point for the greening of your project. To download an electronic version of the Green Remodeling Checklist, go to **www.BuildGreenNow.org**.

The Green Remodeling Checklist is also the basis of GreenPoint Rated, a third-party home rating program offered by Build It Green. For more information about GreenPoint Rated, visit **www.GreenPointRated.org** or call **510-845-0472**.

"As architects, we incorporate green building practices and the green building checklists from initial meetings with clients through design and into construction. The checklist and principles help us increase our understanding of our clients' needs and aid us in raising the awareness of both the client and contractor to the wide array of green options and benefits."

—**J. Bradford Hubbell, Hubbell Daily Architecture + Design, Mill Valley, CA**

Green Remodeling Checklist

▶ A. Site	Community	Energy	IAQ/Health	Resources	Water
1. Protect Existing Soil and Minimize Disruption of Existing Plants & Trees	▬				▬
2. Deconstruct Instead of Demolish				▬	
3. Recycle Construction and Demolition Waste				▬	
▶ B. Foundation					
1. Replace Portland Cement in Concrete with Recycled Flyash or Slag				▬	
2. Retrofit Crawl Space to Control Moisture			▬		
3. Design and Build Structural Pest Controls				▬	
▶ C. Landscape					
1. Construct Resource-Efficient Landscapes				▬	▬
2. Use Fire-Safe Landscaping Techniques	▬				
3. Minimize Turf Areas					▬
4. Plant Shade Trees	▬	▬			
5. Group Plants by Water Needs (Hydrozoning)					▬
6. Install High-Efficiency Irrigation Systems					▬
7. Add Compost to Promote Healthy Topsoil					▬
8. Mulch All Planting Beds					▬
9. Use Salvaged or Recycled-Content Materials for Landscape Elements				▬	
10. Reduce Light Pollution	▬				
11. Collect and Retain Rainwater for Irrigation					▬
▶ D. Structural Frame and Building Envelope					
1. Apply Optimal Value Engineering				▬	
2. Use Engineered Lumber: a) Beams and Header b) Insulated Engineered Headers c) Wood I-Joists or Web Trusses for Floors d) Wood I-Joists for Roof Rafters e) Engineered or Finger-Jointed Studs for Vertical Applications f) OSB Subfloor g) OSB Sheathing		▬		▬	
3. Use FSC-Certified Wood				▬	
4. Use Solid Wall Systems (includes SIPs, ICFs, & Any Non-Stick Frame Assembly)		▬		▬	
5. Reduce Pollution Entering the Home from the Garage			▬		
6. Design Energy Heels on Roof Trusses		▬			
7. Install Overhangs and Gutters		▬		▬	
8. Install Reflective Roof and Radiant Barrier		▬			
9. Replace Single-Pane Windows with High Performance Windows		▬			
10. Retrofit with Storm Windows		▬			
11. Install Low Solar Heat Gain Coefficient (SHGC) Window Film on Single-Glazing		▬			
12. Retrofit Structure for Earthquakes				▬	
▶ E. Exterior Finish					
1. Use Recycled-Content or FSC-Certified Decking				▬	
2. Install Rain Screen Wall System				▬	
3. Use Durable and Noncombustible Siding Materials				▬	
4. Use Durable and Noncombustible Roofing Materials				▬	
▶ F. Insulation					
1. Install Insulation with 75% Recycled Content				▬	
2. Install Insulation That Is Low-Emitting			▬		
3. Upgrade Insulation to Exceed Current Title 24 Requirements		▬			
4. Inspect Quality of Insulation Installation before Applying Drywall		▬			
5. Apply Caulking and Weatherstripping		▬			

▶ G. Plumbing	Community	Energy	IAQ/Health	Resources	Water
1. Distribute Domestic Hot Water Efficiently		▬		▬	▬
2. Replace Toilets with High Efficiency Toilets					▬
3. Upgrade to High Efficiency Water Heater		▬			
4. Install Water-Efficient Faucets and Showerheads					▬
▶ H. Heating, Ventilation & Air Conditioning					
1. Design and Install HVAC System to ACCA Recommendations		▬			
2. Install High Efficiency, Sealed Combustion Heating Systems		▬	▬		
3. Install Zoned, Hydronic Radiant Heating with Slab Insulation		▬	▬		
4. Install High Efficiency Air Conditioning with Environmentally Responsible Refrigerants	▬	▬			
5. Install Effective Ductwork: a) Install New Ductwork within Conditioned Space b) Use Duct Mastic on All Ducts & Joints Seams c) Install Ductwork under Attic Insulation (Buried Ducts) d) Pressure Balance the Ductwork System e) Protect Ducts during Remodeling and Clean All Ducts before Occupancy f) Insulate Existing Ductwork		▬	▬		
6. Install High Efficiency HVAC Filter			▬		
7. No Fireplace or Retrofit Wood Burning Fireplaces		▬	▬		
8. Install Effective Exhaust Systems in Bathrooms and Kitchen		▬	▬		
9. Install Mechanical Ventilation System for Cooling		▬			
10. Install Mechanical Ventilation for Fresh Air			▬		
11. Install Carbon Monoxide Alarms			▬		
▶ I. Renewable Energy					
1. Install Solar Water Heating System		▬			
2. Install Photovoltaic (PV) System		▬			
▶ J. Building Performance					
1. Whole House Inspection/Diagnostic Testing and Make Improvements		▬	▬		
▶ K. Finishes					
1. Design Entryways to Reduce Tracked-In Contaminants			▬		
2. Use Low-VOC or Zero-VOC Interior Paint			▬		
3. Use Low-VOC, Water-Based Wood Finishes			▬		
4. Use Low-VOC Caulk and Construction Adhesives			▬		
5. Use Recycled-Content Paint				▬	
6. Use Environmentally Preferable Materials for Interior Finishes: a) FSC-Certified Wood b) Reclaimed/Refinished c) Rapidly Renewable d) Recycled-Content e) Finger-Jointed				▬	
7. Reduce Formaldehyde in Interior Finishes			▬		
8. Test Indoor Air for Formaldehyde after Installation of Finishes			▬		
▶ L. Flooring					
1. Use Environmentally Preferable Flooring: a) FSC-Certified Wood b) Reclaimed or Refinished c) Rapidly Renewable d) Recycled-Content e) Exposed Concrete				▬	
2. Use Thermal Mass Floors		▬			
3. Use Flooring That Is Low Emitting			▬		
▶ M. Appliances and Lighting					
1. Install Water- and Energy-Efficient Dishwasher		▬			▬
2. Install ENERGY STAR® Clothes Washing Machine		▬			▬
3. Install ENERGY STAR® Refrigerator		▬			
4. Install Built-In Recycling and Composting Center				▬	
5. Upgrade to Energy-Efficient Lighting		▬			
6. Install Low-Mercury Fluorescent Lighting		▬		▬	
7. Install Lighting Controls		▬			
▶ N. Other					
1. Incorporate Green Remodeling Checklist in Blueprints	▬	▬	▬	▬	▬
2. Develop Homeowner Manual of Green Features/Benefits		▬	▬	▬	▬
3. Innovation	▬	▬	▬	▬	▬

Chapter Three:
Green Remodeling Methods and Materials

The green methods and materials in these Guidelines benefit building professionals, homeowners and residents, and the environment. This chapter describes each measure that is listed in the Green Remodeling Checklist, discusses the conditions under which it should be used, and describes its benefits. None of these practices are intended to supersede applicable building codes or other regulations.

The Building Basics sidebars throughout this chapter address general building principles and best practices, but are not specifically included in the Green Remodeling Checklist.

"The construction industry is one of the greatest contributors to the depletion of our planet's natural resources. As builders, we have both the opportunity and responsibility to effect a positive change. Over the past five years, we have seen an astounding increase in clients, architects, and engineers requiring a knowledge of green building practices; we continue to train our team to meet this growing market demand."

—Chris Avant, Canyon Construction, Moraga, CA

A. Site

1. Protect Existing Topsoil and Minimize Disruption of Existing Plants and Trees

Description:

Soil is a valuable, living resource that should be protected during remodeling work. Through careful planning and construction practices, valuable soil as well as mature trees and other plants can be preserved.

Application:

Limit and delineate the construction footprint; restrict heavy equipment that compacts soil, including cars, to areas that are or will be paved or built over. Identify areas to be paved as a place to store existing topsoil, if topsoil needs to be removed from an area during construction. Protect stored soil from erosion.

Assess the existing landscape to determine the feasibility of preserving or relocating mature trees, shrubs and native vegetation. Protect trees and shrubs from construction equipment by placing temporary fencing beyond their driplines. If the remodeling project will affect the landscaping, look for opportunities to create or preserve wildlife corridors adjacent to open space, wild lands and creeks.

Design building additions and outdoor features (such as patios) to

BUILDING BASICS | Things to Consider before You Remodel

Green Remodeling Starts with Green Design

With any size remodeling project, take the time to explore design alternatives. If you wait until construction begins to start thinking about greening the home, you will likely miss opportunities to save money, curb waste, increase comfort, protect indoor air quality, and improve energy and water efficiency.

With every design choice you make, ask yourself: How will this choice affect the home's energy or water use? What natural resources will be used or wasted as a result of this design decision? How might this choice affect the occupants' or construction workers' health? And then ask yourself: How can I improve this aspect of the design so that it contributes to a healthier environment and a healthier home?

Evaluating Hazardous Materials

Before starting a remodeling project, consider hazardous materials that may be present, such as asbestos, lead-based paint or mold. If you need help identifying or remediating problems, consult a hazardous materials expert.

Pinpointing Comfort and Energy Efficiency Problems

Home performance contractors can run diagnostic tests that search for air leaks and moisture problems, and gauge the home's overall energy efficiency. This process can help the homeowner to identify opportunities for improving comfort, reducing energy bills, and creating a healthier home. To find contractors who perform these services, go to the websites of CalCERTS (www.calcerts.com), the California Building Performance Association (www.cbpca.org), or California Home Energy Efficiency Rating Services (www.cheers.org).

Choosing Green Products

To find green products, consult Build It Green's free AccessGreen Directory (www.BuildItGreen.org). When evaluating products and processes, ask yourself these questions:

- Will this product make the home more energy efficient and/or comfortable?
- Will this product save water?
- Is this product safe when used or after it is installed? Will it offgas harmful chemicals?
- Is this product durable so it won't have to be replaced or repaired frequently?
- Is this product made from recycled materials?
- Is this product manufactured in an environmentally friendly way?
- Is this product made locally?

Get Paid to Green Your Home

Electric or gas utilities may offer rebates for ENERGY STAR® appliances and energy efficiency upgrades, as well as free online energy efficiency surveys of your home. Water districts may offer free leak detection services, free shower and faucet aerators, landscaping and water audits, and free or rebated toilets, dishwashers and clothes washers. For more information, check with your local utility or water district.

minimize the building and hardscape footprints and to require little or no grading. When grading is unavoidable, stockpile the existing topsoil and re-spread it during final landscape grading.

After construction, evaluate the quality of the stockpiled soil, amend with compost, and re-spread. Any new soil that needs to be added shall be similar to the existing soil in pH, texture, permeability, and other characteristics, unless soil analysis reveals that a different type of soil is appropriate. For more information, refer to the resources offered by the Bay-Friendly Landscaping and Gardening Program at www.BayFriendly.org or the California Friendly Gardening Guide at www.bewaterwise.com.

Benefit:

Plants thrive in healthy soil. Healthy soils can also significantly reduce storm runoff, reduce fertilizer and pesticide requirements, improve water quality and conserve irrigation water. Protection of existing mature landscape features helps prevent soil erosion, keeps the home and surrounding environment cooler in the summer, keeps plant waste out of landfills, preserves nature and adds value to the property.

2. Deconstruct Instead of Demolish

Description:

Deconstruction of existing buildings and building components is a good way to salvage quality building products that have not yet reached the end of their usable life, even if the building or part of it has. Salvaged materials may be less expensive, of higher quality, or have more character than new materials.

Application:

Deconstructing a whole house or significant portions of it requires a team of workers experienced in dismantling buildings. Locate a demolition contractor who offers deconstruction services or an organization that specializes in salvaging building materials. In some cases, deconstruction may cost more than traditional demolition, but donating the salvaged materials to a nonprofit or charity may result in a substantial tax deduction that can offset the cost.

Common salvageable materials include timber, doors, sinks, fencing, bricks, tile, hardware and light

BUILDING BASICS | Reduce, Reuse, Recycle

You've heard of the 3-Rs—reduce, reuse, recycle. In green remodeling, the 3-Rs start at the earliest stages of design, by thinking creatively about how to reduce waste. Design the project so that you reuse as much as possible of the structure, finishes and furnishings. Keep in mind, though, that sometimes it makes sense to replace items, such as electricity-guzzling refrigerators, with new energy-saving products.

Keep usable materials out of landfills by deconstructing instead of demolishing the rooms that will be remodeled. Deconstruction involves manually unbuilding and salvaging building materials, trim and fixtures. Reuse the salvaged materials on the current project, or sell or donate them so that someone else can use them.

The other side of the deconstruction coin is design for deconstruction. How will the decisions you make today affect the ease with which people can deconstruct the home in the future? Materials that are screwed together rather than glued, for example, are easier to dismantle and reuse.

Recycling of construction and demolition waste is a common-sense practice, but don't stop with recycling what you don't need. Close the loop by choosing new materials that have a high recycled content. And find salvaged materials at local salvage stores and demolition sales, or through websites such as Craigslist.org and Freecycle.org. Other helpful resources include Seattle's Salvage and Reuse Guide (www.seattle.gov/dpd/GreenBuilding), Green Building in Alameda County's *Builders' Guide to Reuse and Recycling* (www.BuildGreenNow.org), and the California Integrated Waste Management Board (www.ciwmb.ca.gov).

fixtures. Reclaimed lumber, in the form of studs, beams, flooring and trim, is among the most valuable and available of salvaged building products.

For Alameda County resources, download the *Builders' Guide to Reuse and Recycling* at www.BuildGreenNow.org (in the Design & Building Professionals section under Construction & Demolition Recycling). For statewide information, contact the California Integrated Waste Management Board at www.ciwmb.ca.gov.

Benefit:

Many salvaged building materials are beautiful and high in quality. Reusing building materials generates less waste and pollution than recycling does, decreases disposal costs and increases landfill capacity. Donations of salvaged building materials to nonprofit groups may be tax deductible.

3. Recycle Construction and Demolition Waste

Description:

Each year over 9 million tons of construction and demolition (C&D) debris is disposed of in California landfills. This represents 22% of the statewide waste stream. Remodeling waste generally consists of wood, drywall, metal, concrete, dirt and cardboard. It can also include plant debris (green waste) from the landscape. Much of this material can be reused or recycled.

Application:

Deconstructing a whole house or significant portions of it requires a team of workers experienced in dismantling buildings. Locate a demolition contractor who offers deconstruction services or an organization that specializes in salvaging building materials. In some cases, deconstruction may cost more than traditional demolition, but donating the salvaged materials to a nonprofit or charity may result in a substantial tax deduction that can offset the cost.

Common salvageable materials include timber, doors, sinks, fencing, bricks, tile, hardware and light fixtures. Reclaimed lumber, in the form of studs, beams, flooring and trim, is among the most valuable and available of salvaged building products. Refer to the resources listed in item #2, Deconstruct Instead of Demolish.

Benefit:

Many salvaged building materials are beautiful and high in quality. Reusing building materials generates less waste and pollution than recycling does, decreases disposal costs and increases landfill capacity. Donations of salvaged building materials to nonprofit groups may be tax deductible.

1. Replace Portland Cement in Concrete with Recycled Flyash or Slag

Description:

Flyash is a byproduct of coal-burning power plants. It is typically landfilled, but can be an inexpensive and quality substitute for a portion of the Portland cement in concrete. Concrete suppliers routinely replace 10 to 15% of the Portland cement in their mixes with flyash. Slag, a byproduct of the steel industry, may also be used like flyash to replace some of the cement.

Application:

Up to 50% of cement can be replaced with flyash or slag in many residential concrete mixes. However, high-volume flyash or slag mixes (35% replacement or more) may require longer cure times and different finishing techniques than standard concrete. Consult a structural engineer for information.

Benefit:

Flyash and slag improve the performance of concrete by increasing strength, reducing permeability and reducing corrosion of reinforcing steel. Using flyash or slag also reduces the amount of cement and water needed, thereby decreasing the overall environmental impacts of cement production and water sourcing. Cement production is energy intensive; it accounts for more than 6% of the world's carbon dioxide emissions that contribute to global warming.

BUILDING BASICS

Incorporate Passive Solar Heating and Cooling

Trellises to reduce heat gain

Although it is easier to incorporate passive solar techniques when building a brand-new home, every remodeling project should also be evaluated to identify passive solar opportunities.

The basic approach involves allowing sunlight to enter the space during the winter, yet be blocked during the hottest times of the summer. This is achieved with proper building and window orientation and with exterior shading.

In the winter, the sun's energy is captured and stored during the day in building materials that have high thermal mass, such as concrete, stone or ceramic tile floors. In the evening, those materials radiate their heat to interior spaces, reducing the need to run the heating system.

Passive cooling involves using roof overhangs and other exterior window shading to keep the sun out in summer, taking advantage of internal thermal mass to moderate temperature swings. In addition, ventilating the home with cool night air reduces or eliminates the need for air conditioner operation.

What follows are some basic passive solar heating and cooling strategies.

- Consider the orientation of the home or addition at the start of any project. South-facing walls and windows will receive the most sunlight. Design roof overhangs for south-facing windows to let sun in during the winter and keep sun out in the summer.
- Use thermal mass wall and floor materials to absorb heat and cold.
- Incorporate awnings, trellises and deciduous shade trees to limit summertime solar heat gain through south-, east- and west-facing windows.
- Design windows and operable skylights to catch prevailing breezes and provide natural ventilation.
- The recommended south-facing window glazing for passive solar buildings is a low U-factor, such as 0.40, and a high solar heat gain coefficient (SHGC), such as 0.65 or higher. See Section D for information about window glazing technologies.
- Insulate the building to a very high level and reduce infiltration so that stored heat won't be lost too quickly.
- Reduce solar heat gain through exterior surfaces by using light exterior colors or paints with reflective pigments, ENERGY STAR® roofing materials, and/or radiant barrier roof sheathing.

For more information about passive solar design for homes, visit the U.S. Department of Energy's website, www.eere.energy.gov/buildings/info/design/integratedbuilding/passive.html.

2. Retrofit Crawl Space to Control Moisture

Description:

Crawl spaces are common in California homes. Unfortunately, most crawl spaces are underventilated and are often the source of moisture problems in the home. Retrofitting crawl spaces can help reduce moisture problems.

Application:

Control ground moisture by covering the entire crawl space floor with a durable vapor barrier (plastic sheeting that is at least 6 mils thick). The vapor barrier can be installed by a building professional or a handy homeowner. Overlap the sheets, pin them to the ground, seal the seams with tape and then apply mastic over the tape. Carry the vapor barrier up the foundation wall at least 12 to 18 inches above the level of the exterior soil.

Prior to installing the vapor barrier, consider installing a French drain system outside the foundation wall and in the crawl space to divert water. Consult a moisture control expert for your specific situation.

If appropriate, consider going a step further by conditioning the crawl space. This involves insulating the crawl space walls, closing the vents, and bringing into the crawl space a small amount of conditioned air from the home's heating and cooling system. Consult with your local building department and follow best building science practices. For more information, visit www.crawlspaces.org and www.buildingscience.com.

Benefit:

Dry crawl spaces can significantly reduce moisture intrusion into a home, thereby improving indoor air quality and the structure's longevity.

3. Design and Build Structural Pest Controls

Description:

Pests are attracted to moisture, darkness, food and rotting wood. Ants, termites and other pests can damage cellulose-based building materials, but some chemical treatments designed to deter pests may also be toxic to humans and other animals. Permanent, structural pest controls can physically hinder pests along their typical pathways of entering the home.

Application:

Include physical pest controls for all new foundations, and retrofit existing foundations with structural pest controls whenever possible. Install a continuous, durable termite shield around all foundation slab penetrations (such as pipes), at the junction of the foundation or piers and the wall framing, and wherever slab perimeter insulation is installed.

When structural wood elements (such as posts, stairs and decks) are in constant contact with concrete or soil, they remain moist for prolonged periods. Create a separation to allow water to drain and wood to easily dry out.

Locating all plants at least 36 inches from the foundation keeps roots away from the foundation, reduces the chance of pests traveling from nearby branches onto the home, and allows the homeowner to more easily inspect for termite tunnels around the home's foundation wall.

Make framing materials difficult for pests to reach by keeping the soil that is adjacent to the foundation away from the home's framing and siding. For new construction, the distance between the soil and the framing/siding materials should be 12 inches.

Also consider deterring pests by using low toxicity borate-based wood preservatives on oriented strand board (OSB), plywood and pressure-treated lumber. Borates are naturally occurring mineral preservatives that are not appetizing to carpenter ants and termites, thus protecting the wood from damage due to pests. Another option is to use building materials that do not contain cellulose.

Benefit:

Physical pest controls are permanent controls that reduce the need to use chemicals. They also increase the durability of the home's structural elements, reducing the time and money needed for repairs. Nontoxic pest controls help protect the building from pest damage while also protecting human health.

C. Landscape

To learn more about the practices described in this section, visit the websites of the Bay-Friendly Landscaping and Gardening Program (www.BayFriendly.org), the California Friendly Garden Program (www.bewaterwise.com), and the U.S. Environmental Protection Agency's WaterSense program (www.epa.gov/watersense). Use the AccessGreen Directory at www.BuildItGreen.org to find suppliers of environmentally sound landscaping products, native plants, mulch and compost, soil testing services and more.

1. Construct Resource-Efficient Landscapes

Description:

Conventional residential landscapes are often designed without regard for climate and soil conditions. Typically, they require high inputs of water and chemicals and produce excessive plant debris from pruning and mowing activities. Invasive plants used in landscaping often escape into natural areas, where they can spread rapidly, crowd out native plants, degrade wildlife habitat and increase the wildfire fuel load. Resource-efficient landscapes use plants and techniques that are better suited to local soils, wildlife, rainfall and climate.

Application:

Evaluate the climate, exposure and topography of the site. Assess the soil quality. Have the soil professionally analyzed for texture, nutrients, organic matter content and pH, especially if the topsoil was not protected during construction activities. If soil amendments are advised, ask the laboratory to recommend organic or environmentally friendly amendments. The AccessGreen Directory at www.BuildItGreen.org lists soil testing laboratories.

Select drought-tolerant species that are appropriate for the site's soil and microclimates, such as California natives, Mediterranean or other well-adapted species. Plant a variety of trees, shrubs and other perennials and limit annuals. Find out which invasive species are problematic locally; do not include them in the planting palette and eliminate any from the site before planting. See the California Invasive Plant Council website at www.Cal-IPC.org for a list of local invasive species for your area.

Give plants plenty of room to mature, reducing the need for pruning and shearing. Limit turf to the smallest area that will meet recreational needs (see Minimize Turf Areas, below). Include a site for composting and mulching plant debris.

Benefit:

A diverse landscape of native species supports beneficial birds, bees and other insects and may resist disease and other pests better than one with little variety. Choosing and placing plants appropriately will also reduce the amount of plant debris sent to landfills and water used for irrigation.

2. Use Fire-Safe Landscaping Techniques

Description:

California's hot, dry climate makes fire protection an important consideration for landscape design, especially because many homes are adjacent to areas that may be prone to wildfires. Simple landscaping design practices can help defend the homes by reducing fuel accumulation and interrupting the fire path.

Application:

Determine whether the site is in a high-risk area. Map the site, identifying exposure to prevailing winds during the dry season and steep slopes that can increase wind speed and convey heat. Identify adjacent wildlands or open space, as well as south- and west-facing slopes and their vegetation, particularly species that burn readily.

For sites adjacent to fire-sensitive open space or wildlands, create defensible space around buildings; this is an area where vegetation is modified to reduce fuel load and allow firefighters to operate. Use irrigated, low-growing, fire-resistant vegetation, patios, paving stones and other low-risk features in the

zone immediately surrounding the structure.

Specify plants with low fuel volume and/or high moisture content. Avoid plants with high oil content or that tend to accumulate an excessive amount of dead wood or debris. For information about choosing fire-resistant plants, visit the websites of the Bay-Friendly Gardening and Landscaping Program (www.BayFriendly.org) or the California Friendly Gardening Guide (www.bewaterwise.com).

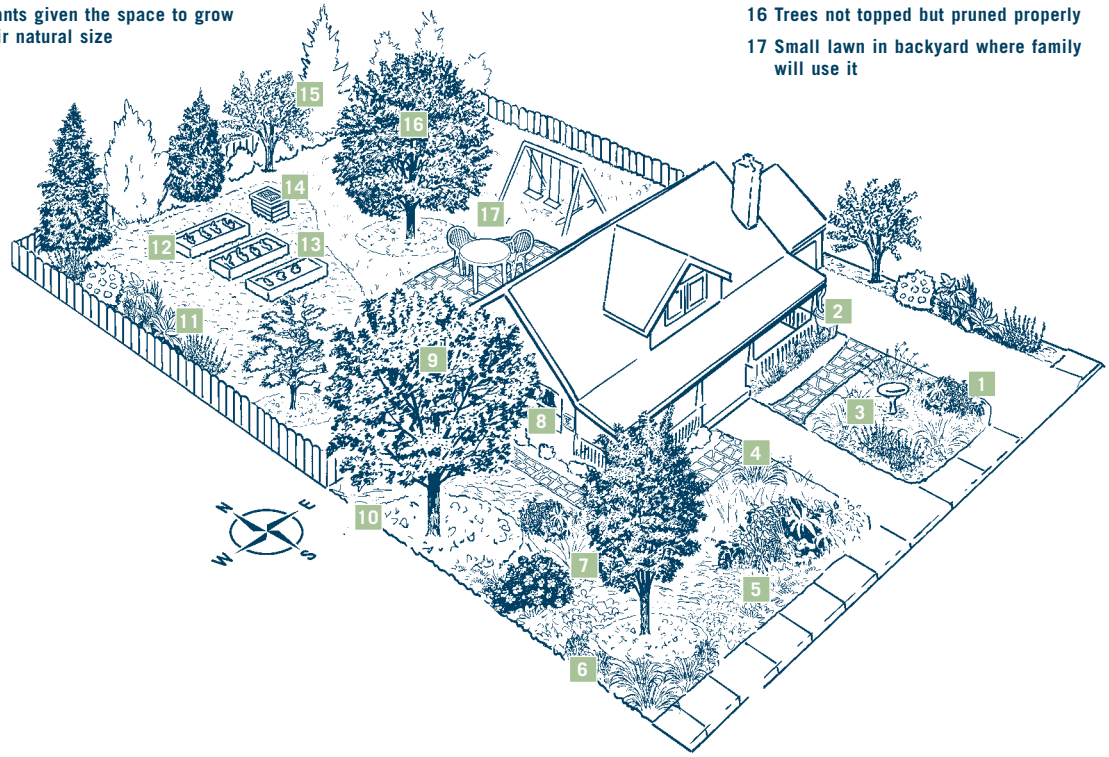
Also see the City of Oakland's publication, Fire Wise Native Plants, at www.oaklandnet.com/wildfirePrevention/Plants.html.

Do not plant trees and shrubs at distances where limbs and branches will reach the house or grow under overhangs as they mature. To minimize fire ladders, do not plant dense hedges or space tall vegetation too closely together. Use mulch (except fine shredded bark) and decomposed granite to control weeds and reduce fuel for fires. Construct roofs, siding and decks with fire-resistant materials. Consider alternatives to wood fences, such as rock or concrete walls.

Benefit:

Fire-safe landscaping reduces risks of harm to residents and firefighters, and protects valuable personal and community assets.

1 Permeable paving on driveway and walkway to front door
2 Water from roof channeled to cistern
3 Water for wildlife habitat
4 Pavers with spaces and low water use plants between
5 Front lawn replaced by diverse plantings with many California native groundcovers, shrubs and trees, but no invasive species
6 All plants given the space to grow to their natural size
7 Plants selected to match the microclimates
8 Irrigation controller waters hydrozones according to plant needs, soil moisture and weather
9 Deciduous trees placed to the west & southwest of the house & patio for summer cooling
10 Repository for leaves to collect under trees as mulch
11 Mulched paths keep soil covered
12 Drip irrigation for vegetable beds, shrubs, trees and elsewhere where feasible
13 Raised beds are constructed from plastic or composite lumber
14 Compost bin recycles plant and kitchen debris
15 Evergreen windbreak blocks north winter winds
16 Trees not topped but pruned properly
17 Small lawn in backyard where family will use it



3. Minimize Turf Areas

Description:

Lawns (or turf) are useful for recreation and relaxation, but turf requires frequent cutting, watering and application of fertilizers or other chemicals to stay green during California's long dry season.

Application:

Replace decorative lawns with water-conserving California native groundcovers or perennial grasses, shrubs and trees. If lawns are desired, plant in small areas where they are most likely to be used for play and relaxation. Choose plant species that are native or regionally appropriate and have a water requirement less than or equal to tall fescue. Avoid planting turf on slopes greater than 10% or in irregularly shaped areas that cannot be irrigated efficiently. Avoid turf in isolated areas (driveway strips) or other areas less than 8 feet wide on the shortest side, unless irrigated with subsurface irrigation or micro spray heads.

Benefit:

Minimizing turf conserves water. If a 1,000-square-foot lawn needs 1 inch of water per week, reducing it to 500 square feet can save approximately 10,000 gallons of water per dry season. Minimizing turf reduces the need for mowing and removing grass clippings. Chemical use may also be decreased, thereby protecting the quality of local waterways and aquifers.

4. Plant Shade Trees

Description:

During summer months, the sun heats up homes, which makes air conditioners work harder and drives up peak electricity demand. Large shade trees keep direct sun off the roof, walls and windows in the summer, thereby lowering cooling costs and increasing comfort while providing an attractive and valuable landscape.

Application:

Augment the existing tree cover on the site, particularly to the west of the building, by planting California native or other Mediterranean tree species that are drought tolerant and appropriate for the site's soil and microclimates. Plant trees to shade walls, windows and paved areas. If the building design includes passive solar heating, do not plant trees too close to the home's south side. Avoid planting trees too close to utilities. Plant a variety of deciduous trees and give them plenty of room to mature, reducing the need for pruning and shearing.

Benefit:

Shade trees can create a microclimate that is up to 15°F cooler than the surrounding area, and can reduce summer air-conditioning costs by 25 to 40%. Peak electricity demand is at its highest during late afternoons in the summer; shade trees play an important role in reducing this demand. Trees provide numerous additional benefits including absorbing carbon dioxide, cleansing the air, creating habitats for birds and other creatures, providing play places for children, making the neighborhood more beautiful and increasing property values.

5. Group Plants by Water Needs (Hydrozoning)

Description:

Different plants have different water requirements. Hydrozoning involves dividing the landscape into zones of low, medium and high water use to prevent overwatering.

Application:

Group plants by water needs, creating irrigation zones based on the plants' water requirements and their exposure. Delineate each hydrozone on the site, irrigation and planting plans. Place thirstier plants in relatively small, highly visible areas and if possible, in spots that

Landscape before and after an upgrade that reduced lawn size, increased diversity, improved property values, cut water bills by 50% and reduced maintenance costs by 20%.

naturally collect water. Plant the larger areas with drought-tolerant species. Install separate irrigation valves for different zones. Consider that some California natives do not tolerate water in the summer after they are established; be sure to separate them from plants that need ongoing irrigation.

Benefit:

Hydrozoning matches irrigation to the plants' water requirements, conserving water and fostering resistance to pests and disease. Plant mortality is also reduced, saving time and money.

6. Install High Efficiency Irrigation Systems

Description:

With increasing demand on supplies of fresh water, efficient landscaping irrigation is vital in California. Efficient irrigation systems apply only the amount of water that the plants need, with little or no waste through runoff, overwatering or misting.

Drip and bubbler irrigation technologies apply water to the soil at the plant root zones at the rate the soil can absorb it, and are often more appropriate than overhead sprinklers in areas that are narrow, oddly shaped or densely planted, or in areas such as parking lots and medians. Low-flow sprinkler heads apply water uniformly and slowly. Smart controllers regulate the irrigation program based on weather or moisture sensors, historic data or a signal. A rain sensor overrides the system in the event of rainy weather.

Application:

Design the irrigation system to meet or exceed the requirements of your local water conservation ordinance. Install drip, subsurface drip or low-flow irrigation systems in place of standard systems for all landscape applications.

A smart irrigation controller will provide even more water savings. Choose a smart irrigation controller that has at a minimum the following capabilities: 1) automatic periodic adjustments to the irrigation program, accomplished through external sensors, internally stored historical weather data or a provider-supplied signal, 2) multiple start times, 3) run-times able to support low-volume applications, 4) irrigation intervals for days of the week or same day intervals, and 5) more than one operating program (for example A=turf, B=shrubs, C=water features). If necessary, turn off the irrigation system or valve for the landscape or hydrozone that includes only low water use California natives, once the plants are fully established.

Benefit:

High efficiency irrigation systems minimize overspray and evaporation and reduce runoff, dramatically reducing landscape water use while preventing disease and minimizing weed growth that results from overwatering.

7. Add Compost to Promote Healthy Topsoil

Description:

A robust, living soil with sufficient organic content is the foundation of a water-conserving, resource-efficient, thriving landscape. Adding good quality compost before planting brings life to the soil and feeds existing soil organisms, fueling many natural processes that supply nutrients, minimize disease and improve soil quality.

Application:

Assess the soil quality on site. Have the soil professionally analyzed for texture, nutrients, organic matter content and pH, especially if the topsoil was not protected during construction activities. If soil amendments are advised, ask the laboratory to recommend organic or environmentally friendly amendments. For soil testing services, check with your local landscaping professional or agricultural extension service; also, the AccessGreen Directory at www.BuildItGreen.org lists soil testing laboratories.

Incorporate 2 to 4 inches of compost into the top 6 to 12 inches of soil, or as much as is required to bring the soil organic matter content to 3.5% for turf and 5% for planting beds, except for plant species that will not thrive in such soils. Use fully stabilized, certified compost as a soil amendment where appropriate (stabilized compost has been properly matured and can be safely handled, stored and applied to the soil). Loosen all planting and turf areas to a minimum depth of 6 inches prior to final landscape grading. Topdress with compost on turf and around established shrubs and trees.

Benefit:

Compost can increase permeability, water-holding capacity and plant nutrient availability. This encourages healthy plant growth, improves the

ability of the soil to filter pollutants, improves water quality, reduces irrigation needs and lowers water bills.

8. Mulch All Planting Beds

Description:

Mulch is any material spread evenly over the surface of the soil. Organic materials, including chipped landscape debris, are preferable over inorganic materials because they supply nutrients over time and provide wildlife habitat.

Application:

Apply and maintain a minimum of 2 to 3 inches of natural mulch to all soil surfaces or at least until plants grow to cover the soil. Do not place mulch directly against any plant stem or tree. Designate areas under trees and away from hardscapes or storm drains as repositories for fallen leaves to remain as mulch. Buy mulch produced from urban plant waste debris, or from local suppliers within a 150-mile radius.

Benefit:

Mulch can conserve water, reduce weed growth and simplify maintenance operations.

9. Use Salvaged or Recycled-Content Materials for Landscape Elements

Description:

Landscape elements present many opportunities for using salvaged or recycled materials. Recycled-plastic lumber or recycled-composite lumber makes a very durable landscape edging. Broken concrete can be used to make a very attractive retaining wall or path, and tumbled glass cullet can be used to create beautiful walkways.

Application:

Use salvaged or recycled-content materials for hardscapes (planting beds, patios, edging, walls, walkways and driveways) and other landscape features (for example, benches and play equipment). If recycled-plastic or composite lumber is not appropriate, use FSC-certified sustainably harvested wood.

Benefit:

For landscaping and hardscaping, recycled plastics or composites are generally much more durable than wood, because they do not rot, crack or splinter or require ongoing wood treatments.

10. Reduce Light Pollution

Description:

Light pollution occurs when outdoor light fixtures let light escape onto neighboring properties and into the night sky.

Application:

Avoid outdoor lighting where it is not needed. Rather than leaving outdoor lights on all night, use lighting controls such as motion sensors, timers and photosensors so that the lights are only on when and where needed. Exterior lighting that provides low contrast on critical areas, such as sidewalks and home entrances, is better for visual acuity than overlighting.

Eliminate all unshielded fixtures that let light escape skyward or trespass on neighboring properties, such as floodlights. Look for fixtures certified by the Dark Sky Association for light pollution reduction (www.darksky.org).

Benefit:

Reducing light pollution minimizes neighborhood or wildlife habitat disruption and saves energy.

11. Collect and Retain Rainwater for Irrigation

Description:

Rainwater can be channeled through gutters and downspouts to an above-ground cistern or underground gravel dry well, and then used later for landscape irrigation. It can also be retained in bioswales or rain gardens.

Application:

Install wherever there is guttered roof runoff and room for the cistern, dry well, bioswale or rain garden. Bioswales are gently sloped drainage courses that slow the flow of rainwater, allowing it to percolate into the soil. A rain garden is a planted depression that absorbs or slows rainwater runoff.

Benefit:

Water catchment reduces the need to use municipal or well water for irrigating lawns and gardens, and reduces the volume of rainwater flowing into municipal sewage systems.

Recycled concrete wall (urbanite)

D. Structural Frame and Building Envelope

1. Apply Optimal Value Engineering

Description:

Optimal Value Engineering (OVE), also known as advanced framing, refers to techniques that reduce the amount of lumber used in framing a home, while maintaining structural integrity and meeting the building code.

Application:

Many OVE techniques are suitable for residential remodeling projects, including placing rafters and studs at 24-inch on center framing instead of 16-inch, using the right-sized headers for the load, using only jack and cripple studs required for the load, using insulated headers on exterior walls, and building two-stud corners with drywall clips.

Benefit:

Using OVE techniques saves wood and construction costs without a significant reduction in structural strength. Many OVE techniques also allow more of the wall to be better insulated, which improves energy efficiency and comfort.

2. Use Engineered Lumber

Description:

Solid-sawn lumber in sizes 2x10 and greater typically comes from old-growth forests or large diameter trees. Engineered lumber products, on the other hand, come from small-diameter, fast-growing plantation trees. These products include glued laminated timber (glulam), laminated veneer lumber (LVL), laminated strand lumber (LSL), parallel strand lumber (PSL), wood I-joists, wood floor trusses, finger-jointed studs and oriented strand board (OSB).

Application:

Use engineered lumber instead of solid-sawn lumber wherever applicable. Review structural building plans to make sure that engineered lumber is called out on the plans. The AccessGreen Directory (www.BuildItGreen.org) lists suppliers of engineered lumber products.

a. Beams and Headers

Engineered beams and headers can easily replace any solid-sawn member of similar size or even larger. In addition, large solid-sawn lumber is often used for headers and beams when smaller dimension lumber would suffice.

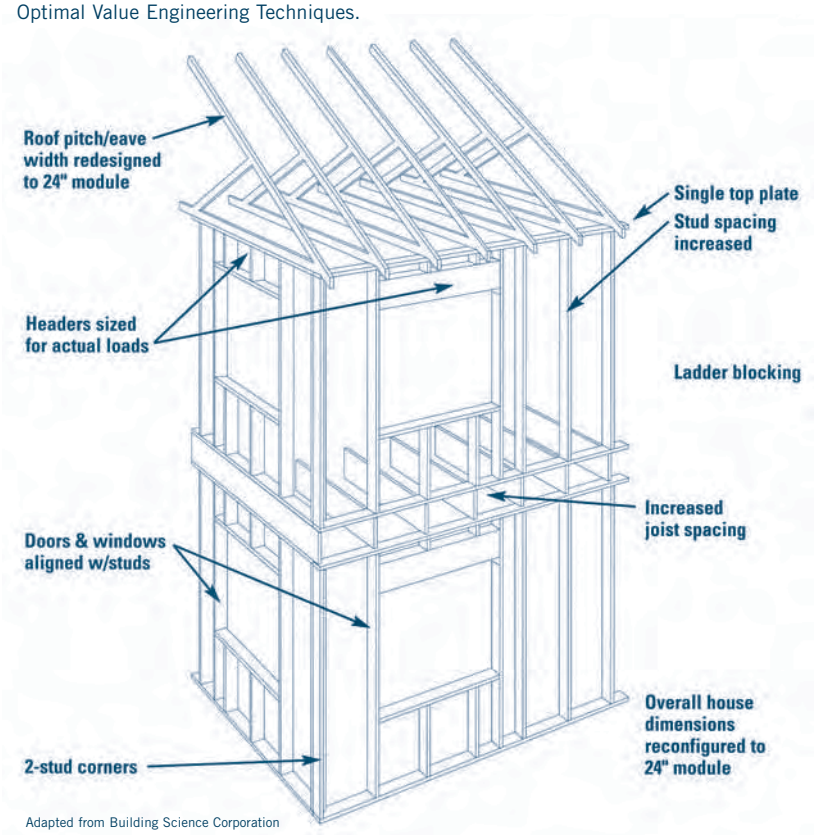
b. Insulated Engineered Headers

Engineered headers with preinstalled insulation are lighter than solid wood headers, do not shrink (reducing cracks in drywall), and insulate better than solid wood.

c. Wood I-Joists or Web Trusses for Floors

The typical 2x10 and larger solid lumber used for floor joists can be replaced with engineered lumber in most applications. Not only are I-joists and web trusses stronger than solid beams, they are lighter. Some have knock-outs or cavities that allow ducts, pipes and wires to easily pass through them, resulting in quicker installation.

Optimal Value Engineering Techniques.



Adapted from Building Science Corporation

d. Wood I-Joists for Roof Rafters

For roof rafters, use I-joists instead of solid lumber.

e. Engineered or Finger-Jointed Studs for Vertical Applications

Use engineered or finger-jointed studs wherever conventional studs are typically used. Finger-jointed studs use short pieces of 2x4 or 2x6 wood glued together to form standard stud lengths, while engineered lumber is typically veneers, strands or flakes of wood glued to form studs. These studs are all dimensionally straight and save on labor and material costs associated with culling crooked lumber, and shimming and straightening crooked walls.

Construction using SIPs.

f. Oriented Strand Board for Subfloor

OSB is a type of engineered wood product manufactured from fast-growing farm trees. OSB comes in sheets and is used as an alternative to plywood for subfloors.

Benefit:

Reducing demand for large dimensional lumber decreases pressure to harvest old-growth or large-diameter trees. Engineered lumber uses wood fiber more efficiently than conventional lumber. Most engineered wood products are straighter and stronger than solid-sawn equivalents, eliminating crooked walls and reducing material waste.

g. Oriented Strand Board for Wall and Roof Sheathing

Use OSB as an alternative to plywood for wall and roof sheathing.

3. Use FSC-Certified Wood

Description:

Forest Stewardship Council (FSC) certification assures that the forest from which the wood was harvested is managed in an environmentally, economically and socially responsible manner. FSC is the only lumber verification rating that maintains chain-of-custody certification throughout the cutting, milling and final delivery of products, thus ensuring that the end product originated from a certified sustainably managed forest.

Application:

Use FSC-certified solid wood framing, engineered lumber, oriented strand board and plywood. For more information about FSC certification, go to www.fscus.org. For a list of FSC-certified wood suppliers, refer to the AccessGreen Directory at www.BuildItGreen.org.

Benefit:

FSC certification assures that forests are managed in a way that protects the long-term availability of wood resources, the health of forest ecosystems, and the sustainability of local economies.

4. Use Solid Wall Systems

Description:

Solid wall systems include structural insulated panels (SIPs), insulated pre-cast concrete, insulated concrete forms (ICFs), autoclaved aerated concrete (AAC), and similar systems that are not constructed of wood studs.

Application:

Each of these wall systems involves specialized installation techniques. Always follow manufacturer specifications. The AccessGreen Directory (www.BuildItGreen.org) lists suppliers of solid wall systems.

Forest Stewardship Council

The FSC logo on a product provides consumers with an assurance that the wood they use comes from forests managed in an environmentally and socially responsible manner.

Smart Wood and Scientific Certification Systems

These groups verify that forest management is accomplished according to the FSC program.

Benefit:

These walls replace wood stud construction by including structure, sheathing and insulation in a single durable, energy-efficient system. Most solid wall systems improve home comfort and save significant amounts of wood.

5. Reduce Pollution Entering the Home from the Garage

Description:

According to the U.S.Environmental Protection Agency (EPA), an attached garage is the biggest contributor to poor indoor air quality in a home. Car exhaust contains many known carcinogens and can migrate into living spaces through doors and cracks in walls and ceilings adjacent to the garage. Other pollutants commonly found in garages include benzene from lawn mowers and power tools, pesticides for gardens, toxic cleaning agents, and chemicals in paints and adhesives.

Application:

Use foams, weatherstripping and caulking to create an air barrier between the garage and living areas. Completely seal garage walls and ceilings adjacent to the interior. Doors should have full weatherstripping and sealed thresholds. Spray-applied foam insulation that creates a complete air barrier is recommended.

For added protection, install an exhaust fan in the garage on the opposite wall from the door to the house. It can be triggered by an electric garage door and put on a timer to run after the door has been opened or closed.

Detached garages provide the most effective means of keeping garage pollutants out of the home.

Benefit:

Properly designed and isolated garages keep polluted air out of the home.

6. Design Energy Heels on Roof Trusses

Description:

At the intersection of perimeter walls and the roof framing, there is often increased heat loss, because conventional roof trusses reduce the area available for insulation to less than 6 inches. An energy heel is a framing technique that raises the height of the truss at exterior wall top plates to accommodate the full depth of insulation at the home's perimeter.

Application:

Install where conventional trusses are used. The increased height may require modifications to exterior soffit and trim details.

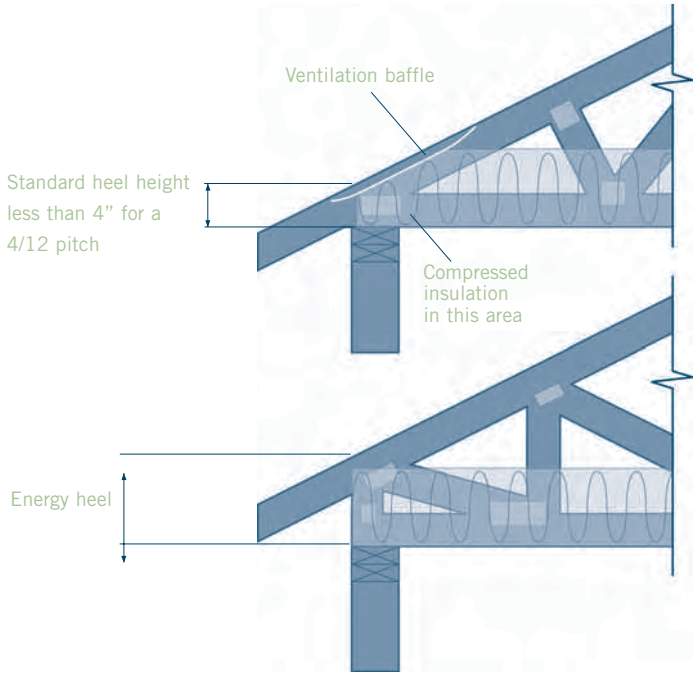
Benefit:

Energy heels on trusses allow for full insulation around the perimeter, saving energy and reducing utility bills.

7. Install Overhangs and Gutters

Description:

Overhangs increase a home's durability by protecting it from the elements and helping regulate the amount of rain striking walls. Overhangs also provide shading for windows. Gutters provide a pathway for water to exit the roof without entering walls and splashing back onto the foundation and siding.



Energy heels on trusses allow more insulation

Application:

Design at least a 16-inch overhang with gutters. This practice is preferable for the entire roof, but at a minimum should be done for any new additions or substantially remodeled areas of the house. Consider adding deeper overhangs where needed to shade walls and windows to provide cooling during summer. Drain gutters at least 24 inches from the home and into a rainwater cistern or toward adjacent landscaped areas that are graded to receive the excess water so as to recharge groundwater, filter pollutants and water vegetation. Check with the local building department for applicable codes.

Benefit:

Overhangs and gutters protect siding, windows and doors from water intrusion, thereby reducing the likelihood of rot and mold issues. Overhangs also provide protection from the sun's harsh UV rays, which can degrade building materials and furnishings.

Overhang

8. Install Reflective Roof and Radiant Barrier

Description:

When radiant energy from the sun strikes the roof surface, it is converted to heat energy, which radiates downward into the attic and the adjoining rooms. Installing a "cool roof" material that is rated high in reflectivity and emissivity will reduce the amount of heat that is driven through the roofing assembly and into the attic. Another method of blocking radiant heat is to use a radiant barrier foil. In retrofit situations, the foil is installed at the roof rafters. In reroofing situations, you can use a roof sheathing product that is laminated at the factory with the radiant barrier foil.

Application:

Install cool roofing materials in the same fashion as standard roofing. Radiant barrier sheathing can be used in place of conventional roof sheathing or applied as a reflective material (foil or paint) to the underside of rafters and decking. The AccessGreen Directory lists radiant barrier sheathing products and some cool roof materials. ENERGY STAR® lists cool roof products at www.energystar.gov.

Benefit:

Cool roofing materials and radiant barriers reduce heat build-up in attic spaces by not re-radiating heat from the roof into the home. They can prevent up to 97% of the sun's radiant heat from entering the home and can bring attic temperatures

Radiant barrier sheathing

down as much as 30 to 40ºF on hot days, keeping the whole home cooler and reducing energy consumption for air conditioning.

9. Replace Single-Pane Windows with High Performance Windows

Description:

Windows play a big role in the energy efficiency of homes. In the summer, they can allow unwanted heat into the house, and in the winter, they can account for as much as 25% of the home's heat loss. High performance windows reduce heating and cooling costs and keep the home more comfortable.

Application:

When replacing windows, look for models with a low U-factor of 0.40 or less. U-factor is a measure of heat transferred by the entire window (frame, sash and glass) either into or out of the building. Windows with a lower U-factor do a better job of insulating, and therefore provide more comfort and energy savings when it is cold outside.

In addition to a low U-factor, the windows should have a solar heat gain coefficient (SHGC) that suits your climate and the window's orientation. SHGC is a measure of the solar radiation entering the room through the entire window. An SHGC of 0.40 or less will reduce air-conditioning costs and provide more comfort in warmer climates. A higher SHGC will allow more sun to heat the room, which is desirable in colder climates and in homes designed for passive solar heating. Wood, fiberglass and vinyl frames generally insulate much better than aluminum frames.

For more information about window options, see the Building Basics sidebar on page 32. Visit www.efficientwindows.org for help in choosing the best criteria for windows in your climate and for your specific application. Check with your local utility company for rebate programs for high performance windows.

Benefit:

High performance windows make the home more comfortable and energy efficient. Some wood windows also contain FSC-certified wood, further reducing their environmental footprint. Fiberglass window frames are often made with recycled glass.

10. Retrofit with Storm Windows

Description:

Storm windows are temporary windows installed over the standard window (on the interior or exterior) to improve energy efficiency and comfort.

Application:

Measure existing windows and order storm windows from a window supplier. Storm windows are normally installed in winter to provide additional insulation and wind protection.

Benefit:

Storm windows improve energy efficiency and comfort without the need to replace the entire window.

11. Install Low-SHGC Window Film on Single-Pane Windows

Description:

Window film with a low solar heat gain coefficient (SHGC) or shading coefficient (SC) can be applied to existing windows to reduce solar heat gain through the glass while still transmitting light and visibility.

Application:

Window film should only be used on single-pane windows. Look for an SHGC of 0.40 (or SC of .44) or lower. Consider using on all east- and west-facing windows to reduce heat gain into the home. Window films can be applied by a commercial installer; do-it-yourself products are also available at most home improvement stores.

Benefit:

Low SHGC and SC window film reduces overheating, improves comfort and can significantly reduce the need for air conditioning. Window film can also help protect furniture, fabrics and floors from fading.

12. Retrofit Structure for Earthquakes

Description:

Many older homes in earthquake-prone areas were not built with sufficient structural support to withstand a major earthquake. In most cases, structural retrofitting work can be done to help reduce the risk of earthquake damage.

Application:

Engage a structural engineer for recommendations on how to retrofit the home. Refer to local requirements, if any. For more information about earthquake retrofitting, visit the websites of the California Seismic Safety Commission (www.seismic.ca.gov/hog.htm) and the Association of Bay Area Governments (www.abag.ca.gov/bayarea/eqmaps).

Benefit:

Homes that are prepared to withstand an earthquake will be safer for residents. Earthquake retrofits may also protect the home from extensive damage and therefore reduce replacement costs and minimize waste from demolition.

BUILDING BASICS | Window Fundamentals

Once upon a time, windows were rarely more complicated than a single pane of glass mounted in a wood or metal frame. These days, windows are available in a dizzying array of options. Today's high performance windows have many features that make them stand out over basic single-pane windows, including:

- Multiple panes of glass, with an air- or gas-filled space between them, to provide better insulation. In most instances, dual-pane windows are required by Title 24.
- Improved frame materials to reduce heat transfer and insulate better. Wood, fiberglass and vinyl frames generally insulate much better than aluminum frames.
- Special low-e coatings on the glass to keep heat inside in the winter and outside in the summer.
- Warm edge spacers between the panes of glass to reduce heat flow and prevent condensation.

Choosing the Right Window

It is worth taking the time to understand window technology, because the right windows can make a tremendous difference in a home's energy consumption, as well as its thermal and acoustic comfort.

Manufacturers apply low-e coatings to glazing on double-pane windows to reduce heat loss from inside the building and reduce solar heat gain from outside. A low-e coating can significantly improve a window's energy efficiency. However, when choosing a window, it's not enough to request a low-e coating. It's important to know the specific U-factor and solar heat gain coefficient (SHGC) that's appropriate for your climate, the window's orientation, and other special circumstances, such as whether the home is designed for passive solar heating and cooling.

Section D, Replace Single-Pane Windows with High Performance Windows, provides general guidance on choosing energy-efficient windows. For more specific guidance, go to www.efficientwindows.org or www.energystar.gov.

Factory-made windows have a National Fenestration Rating Council (NFRC) label showing the product's U-factor, SHGC and other performance characteristics (visit www.NFRC.org for more information). This information is also usually available on the manufacturer's website.

Some suppliers offer a limited number of low-e options, so it may be challenging to get the exact window performance characteristics you desire. Telling suppliers and window representatives what you want—even if it is not available today—may help expand product availability in the future.

Replacing Existing Windows

If you plan to replace existing windows, you will need to choose between retrofit and new construction windows. Retrofit windows are installed quickly by removing the existing window glass and slipping in a new window frame assembly within the existing window frame. Be aware that if the existing windows have moisture problems, retrofit windows will not necessarily fix the problems.

New construction windows require the entire window assembly (glass and frame) be removed prior to installation. Flashing, building paper and sealants must all be reapplied. Additionally, stucco or siding may need to be cut away during installation and repaired after completion. Replacing the entire window frame and substrate requires more effort and money than installing retrofit windows, but it's a better option if water damage has occurred.

E. Exterior Finish

To find suppliers of the exterior finish products and materials described in this section, go to the AccessGreen Directory at www.BuildItGreen.org.

1. Use Recycled-Content or FSC-Certified Decking

Description:

Besides being exposed to the weather, the deck often gets heavy foot traffic. Environmentally sound alternatives to conventional lumber can extend the life of the deck and conserve natural resources.

Application:

Recycled-content lumber is a durable, environmentally sound option for nonstructural deck components. There are two types of recycled-content lumber: recycled plastic lumber, which contains only recycled plastic, and composite lumber, which combines recycled wood fiber and recycled plastic. Both can be used in place of redwood, cedar and pressure-treated lumber for the top planks and railing. These products accept screws and nails, and cut like wood. Follow the manufacturer's installation recommendations closely. Choose recycled-content lumber that contains no virgin plastic.

Recycled-content decking

If you prefer wood decking, choose FSC-certified wood, which comes from forests managed in an environmentally and socially responsible manner. Use FSC-certified lumber for all exterior-decking applications or as structural deck members in conjunction with recycled-content decking. Choose a species of FSC-certified wood that is appropriate for exterior decking.

Benefit:

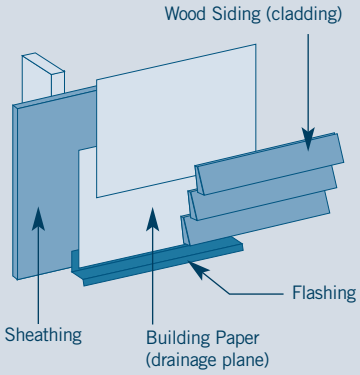
Recycled-content plastic or composite decking is more durable than most wood. It doesn't rot, crack, splinter,

BUILDING BASICS | Proper Flashing Techniques

Most major building failures and construction defect lawsuits are related to water intrusion into the building's walls, ceilings and floors due to incorrectly installed or missing flashing. Water intrusion can lead to rot, mold and material damage, and may eventually result in structural problems for the building and health problems for the residents. Most of these problems can be avoided by taking the appropriate measures during design and construction.

Properly flash all roofs, windows, doors, utility penetrations, deck connections to the structure, and anywhere else that water can enter the home. Contractors should provide on-site training for workers and/or send workers to attend classes offered by experts or manufacturers that explain proper flashing techniques.

In the building plans, include detail drawings that show how to properly flash windows, doors and roofs. Water should follow a natural drainage path that drains away from building elements through overhangs, downspouts and sloped yards. Show proper shingle flashing of all penetrations and joints such as roofs, windows, doors, chimneys, pipes, vents, decks, sill plates, steps, railings and other attachments. For more information about flashing and other moisture control techniques, go to www.buildingscience.com.



or require staining, and isn't treated with potentially toxic preservatives. Using recycled-content decking also reduces pressure to harvest forests. FSC certification guarantees that forests are managed in a way that will assure the long-term availability of wood resources and the health of forests.

2. Install Rain Screen Wall System

Description:

A rain screen wall system or ventilated drainage plane is an effective solution to external moisture penetration. It allows for an air space between the siding and wall structure, protecting the home from damaging rain intrusion.

Application:

When re-siding or building an addition, install siding with an air space between it and the structural wall. Flash all wall openings correctly and create vent strips at the top and bottom of the wall.

Benefit:

This system will significantly help protect a home from moisture intrusion and associated problems with rot in the wall structure. Drainage planes can also reduce the potential for indoor air quality problems associated with window and siding leaks. They also increase the life of siding materials and provide shading on walls to reduce heat gain in summer.

3. Use Durable and Noncombustible Siding Materials

Description:

Sidings made of metal, stone, brick, stucco and fiber-cement offer a durable and noncombustible home exterior.

Application:

Use in place of conventional wood siding.

Benefit:

Using these siding materials can reduce repainting and other maintenance needs, protect the home from fire, and possibly lower the homeowner's insurance rates, especially in fire-prone areas.

4. Use Durable and Noncombustible Roofing Materials

Description:

Forty- to fifty-year asphalt shingles, tile, slate, fiber-cement, recycled plastic and metal are examples of durable roofing materials. The Class A fire rating offers a home the highest in fire protection.

Application:

Applicable anytime roofing materials are specified. The Class A fire rating is achieved through the roofing material itself and/or through the roof assembly as a whole.

Benefit:

Short-lived roofing materials result in more waste going to landfills and more money spent on roof replacement. In extreme cases, early failure of a roofing material can result in water damage.

Fiber-cement siding

F. Insulation

1. Install Insulation with 75% Recycled Content

Description:

Fiberglass insulation typically contains 25 to 30% recycled glass, with a combination of post-industrial and post-consumer content. Materials such as recycled cotton or cellulose insulation contain up to 80% post-industrial or post-consumer recycled materials.

Application:

Choose products with high recycled content. Post-consumer recycled content comes from products that have been used and discarded by a consumer and are then reprocessed as a raw material for a new product. Post-industrial recycled content is waste material from a manufacturing process that is reused to create a new product. The AccessGreen Directory (www.BuildItGreen.org) lists product information.

Benefit:

High recycled content reduces reliance on virgin raw materials. High post-consumer recycled content closes the loop in the curbside recycling process and reduce landfill deposits.

2. Install Insulation That Is Low Emitting

Description:

Many insulation products emit formaldehyde and other volatile organic compounds (VOCs). Look for products that have been tested for low emissions by a reputable third-party organization or government agency.

Damp-blown spray cellulose wall insulation

Application:

Select a product that has been tested for low emissions according to California's "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers." For information about this standard, go to www.ciwmb.ca.gov/GreenBuilding/Specs/Section01350.

Benefit:

Minimizing formaldehyde and VOCs in the home improves indoor air quality.

Recycled-content batt insulation

3. Upgrade Insulation to Exceed Current Title 24 Requirements

Description:

Insulation in attics, roofs, and exterior walls and floors can reduce energy use for air conditioning and heating and make the home more comfortable. Exceeding the insulation levels required by California's Building Energy Efficiency Standards, known as Title 24, may provide additional savings and comfort.

Application:

Upgrade insulation to exceed the current Title 24 standards. Check with a Title 24 energy consultant or your building department for recommended insulation R-values for your climate.

An effective method of insulating is with a loose fill (cellulose or

fiberglass) or spray-applied foam insulation. These are better able to surround pipes and fill gaps, thereby allowing the insulation to achieve its full rated R-value as well as effectively seal air gaps.

The ceiling insulation is generally intended to be installed in ceilings below the attic space, with appropriate gable or soffit ventilation.

Insulate walls of existing wood frame houses to the capacity of the wall cavity. Wall cavities with existing loose-fill insulation can be blown full of new cellulose or fiberglass to increase the density, thereby increasing the R-value.

Insulate floors over crawl spaces to the capacity of the floor joist depth as appropriate. Rigid insulation can also be installed to the underside of floors to improve thermal performance.

Benefit:

Increased ceiling, wall and floor insulation improves comfort, decreases heating and cooling requirements, saves money and makes the home quieter.

4. Inspect Quality of Insulation Installation before Applying Drywall

Description:

Studies show that poorly installed insulation severely decreases the material's insulating value. Many homes have poorly installed insulation, so have your home professional inspected for a quality installation of insulation in walls, floors and ceilings.

Application:

Pay proper attention to installation detail and quality assurance. Install insulation with no gaps or voids. Size insulation correctly to fill the cavity side-to-side, top-to-bottom and front-to-back. Cut or fill batts to fit around wiring and plumbing without compression. Compared to batts, blown-in fiberglass, blown-in cellulose or spray-foam insulation typically do a much better job of filling gaps and sealing around pipes. Don't be tempted to skip the insulation of cavities that are difficult to access.

Use a certified Home Energy Rating System (HERS) technician to inspect the quality of the insulation installation. For information about HERS providers, go to the California Energy Commission's website www.energy.ca.gov/HERS. Have the insulation contractor correct any problems before the drywall is applied.

Benefit:

Effectively installed insulation creates a more comfortable home and reduces the owner's utility costs. Lower energy demand reduces pollution and improves public health.

5. Apply Caulking and Weatherstripping

Description:

Air leaks in a home often contribute as much to high utility bills and discomfort as poor insulation or single-pane windows. Air leaks can also allow in unwanted moisture, pollen, mold, dust and other contaminants. Weatherization involves sealing leaks by applying caulk, foam and weatherstripping to all cracks and seams where unwanted air might be able to leak in.

Application:

Sealing leaks does not require specialized training or tools, just attention to detail. Replace or add new weatherstripping around doors, windows and attic access hatches. Behind the faceplates of electrical outlets and heating/cooling registers, apply caulk where the outlets meet the drywall. Use caulk or spray foam around air spaces where pipes and wires penetrate walls such as under sinks and tubs, around exhaust and vent pipes and flues, through exterior walls, and in the attic at the top plates of the walls. Caulk the bottom plates of the wall framing either at or behind the floor trim.

Benefit:

Reducing air infiltration lowers energy bills, increases comfort and helps keep out indoor air contaminants.

G. Plumbing

1. Distribute Domestic Hot Water Efficiently

Description:

Much of the energy used to heat water at home is lost in long piping runs to fixtures located far from the water heater. Locating the water heater close to usage points reduces heat loss, speeds the rate of hot water delivery to the faucet or shower, and most importantly, reduces water wasted down the drain while waiting for hot water to arrive at a plumbing fixture. Larger houses may require hot water circulation systems to reduce waiting time, but continuous or timed pump operation wastes too much energy; a better option is an on-demand hot water circulation pump.

Application:

One easy way to reduce energy loss is to insulate the entire length of hot water pipe from the water heater to the kitchen. An even better option is to insulate all accessible hot water pipes in the home.

The most effective means of reducing energy and water loss is to locate the water heater within 8 to 15 feet (in plan view) of all hot water fixtures, including bathrooms, the kitchen and laundry. This can be accomplished by stacking or clustering rooms that need water, and creating a central core mechanical space that could house the water heater and pipes and integrates the furnace, air conditioner and ductwork.

To reduce the amount of water wasted while waiting for hot water to arrive at a fixture, pay attention to hot water pipe layout and pipe diameter. Design the layout so that it has the shortest runs possible, and use the smallest diameter possible for the appropriate fixture flow rate. The system should be designed so that no more than two to four cups of water would be wasted by a person waiting for hot water at a shower or faucet.

In larger homes, another way to greatly shorten hot water delivery times is to install an on-demand hot water circulation system. These systems consist of a pump with on-demand controls (push button or motion-sensor activated) that circulate water from the existing hot water line through the cold line or via a dedicated return loop to the water heater. Only one pump is needed to supply hot water to all fixtures in the same loop. All pipes carrying circulated hot water must also be insulated. On-demand hot water circulation works for all systems: tanked or tankless water heaters, and copper or PEX pipe.

Benefit:

Efficient design and distribution of domestic hot water saves energy, conserves water, uses less piping and speeds hot water delivery.

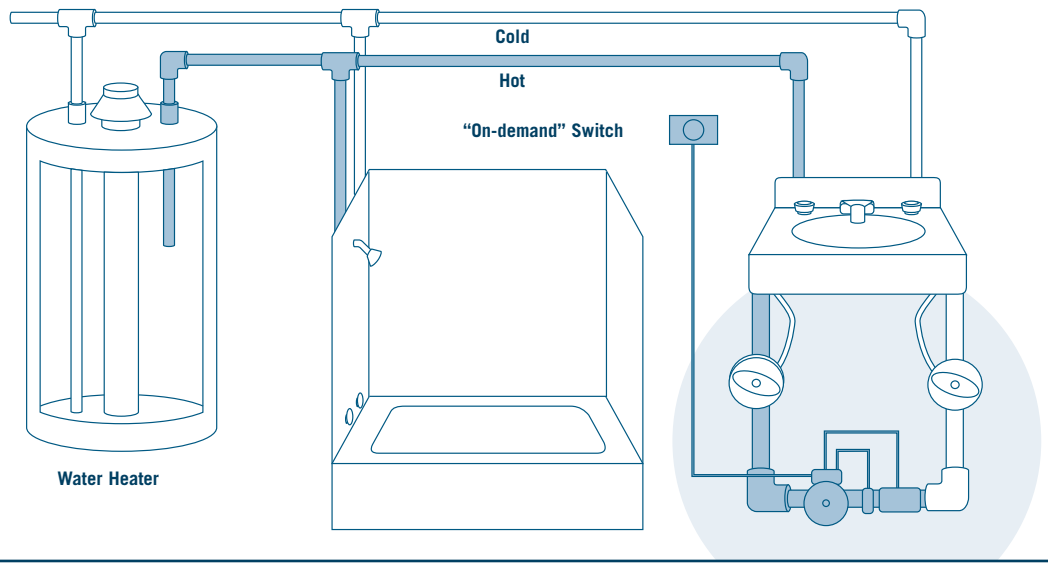
BUILDING BASICS | Improving Your Water Heater's Energy Efficiency

Older storage water heaters do not have as much internal insulation as newer models sold in California. To reduce the standby energy loss of older models, install jacket insulation—an inexpensive product available at most home-improvement stores. Jacket insulation wraps around the tank and reduces the heat loss of older water heaters by about 10% or more. For new water heaters, make sure that installing jacket insulation will not void the warranty.

Also consider installing heat traps. Heat traps, or back flow preventers, reduce convection heat loss by preventing hot water from circulating in the hot water pipes above the tank. Heat traps are installed in pairs at the tank: one on the hot water side and one on the cold water side. The traps are inexpensive, but require professional installation.

One of the most important aspects of water heater maintenance involves checking, and occasionally replacing, a water heater's sacrificial anode. This metal rod keeps your water heater's inside elements from corroding. It should be removed from the water heater's tank every few years for inspection and replaced when more than six inches of core wire is exposed at either end of the rod. This can be done by a plumber or handy homeowner. Refer to your Use and Care Manual for the sacrificial anode location, and make certain the cold water supply is turned off before removing it. Information on water heater maintenance can be found at www.waterheaterrescue.com.

On-Demand Water Circulation Pump



2. Replace Toilets with High Efficiency Toilets

Description:

Older toilets typically use 3.5 gallons of water per flush or more. Standard new toilets use 1.6 gallons per flush (gpf). Toilets that use 1.3 gpf or less are called High Efficiency Toilets (HETs). HETs are available in dual-flush, pressure-assist and conventional gravity-flush models.

Application:

Replace at least one older toilet with a HET. In the past, some models of ultra low-flow toilets didn't work well, but the majority of today's HET toilets perform well and don't require multiple flushes. Choose models that meet or exceed the performance requirements of the Maximum Performance (MaP) testing report or Uniform North American Requirements (UNAR). Download a listing of HETs, MaP reports and UNAR qualifying toilets from the California Urban Water Conservation Council: www.cuwcc.org/toilet_fixtures.lasso.

The U.S. EPA's WaterSense program also provides information about high efficiency toilets; go to www.epa.gov/watersense. For a list of high efficiency toilet suppliers, see the AccessGreen Directory at www.BuildItGreen.org.

Benefit:

HETs perform well and allow residents to reduce their water and sewer costs. Water providers benefit from reduced demand on their water supplies. Municipalities and wastewater agencies benefit from less wastewater to treat. Check with the local water provider for possible rebates.

3. Upgrade to High Efficiency Water Heater

Description:

There are five basic options for water heating: 1) a storage water heater, which stores hot water in a large tank until you need it; 2) a tankless water heater (also called flash or on-demand heater), which heats water instantly when you need it rather than storing hot water; 3) a heat-pump water heater; 4) a combination water/space heating system; and 5) a solar water heater, which is discussed in Section I, Renewable Energy.

Water heaters may be fueled by either natural gas or electricity. Gas water heating is significantly more energy efficient than electric water heating.

Tankless water heater

Application:

Homes with Gas Service

If the home has gas service, choose a gas-fired storage or tankless water heater with an Energy Factor (EF) of 0.62 or greater. EF is the ratio of energy output to energy consumption of a water heater in a typical day. A tankless water heater requires much less space and is typically more energy efficient than a storage water heater. However, tankless water heaters typically cost more to purchase and install than storage water heaters.

Homes without Gas Service

An electric storage water heater is the least efficient water heating option. A tankless electric water heater is only slightly more energy efficient than an electric storage water heater. If switching from electric to gas water heating is not an option, consider replacing the electric storage water heater with a heat-pump water heater. Heat pumps are about three times as efficient as the most efficient electric water heaters.

Tankless Water Heater

If choosing a tankless water heater, choose gas over electric and install it as close as possible to the points of use. The unit should have a variable-set thermostat and an electronic ignition, and be appropriately sized. Gas tankless water heaters typically have more capacity than electric tankless heaters; however, that extra capacity to supply hot water may tempt some people to take longer showers, which would reduce their energy saving opportunities.

Combined Space and Water Heating

Look for ways to save energy and get the most out of equipment by combining water heating and space heating. These systems include boilers or water heaters that serve a home's heating system as well as providing domestic water.

For more information about water heating options, visit www.consumerenergycenter.org.

Benefit:

Water heating accounts for a significant portion of a household's energy use. A high efficiency water heater may save money and energy.

4. Install Water-Efficient Faucets and Showerheads

Description:

Standard faucets in kitchens and bathrooms manufactured after 1992 use 2.5 gallons of water per minute (gpm) or more (older fixtures use more). Flow reducers come in many forms and are easy to retrofit into existing sinks and faucets. Flow control valves are installed under the sink at the junction of the angle-stop and faucet, and can limit water flow down to 1.5 to 0.5 gpm per side (hot and cold). If you are going to replace faucets, look for products with built-in aerators or laminar flow devices. If existing faucets are to remain, buy aerators that screw into the faucets' tips.

Federal law since 1994 mandates that all showerheads sold in the United States use 2.5 gpm or less. Despite this, some showerheads actually use much more than 2.5 gpm, and shower towers that include multiple showerheads or jets can total 12.5 gpm or more. A better option is a good quality low-flow showerhead designed to use less than 2.0 gpm while providing a satisfying shower.

Application:

Measure the flow rate of existing faucets and showerheads (use a bucket marked with volume measurements and a watch). Then, install flow-reduction devices on fixtures that use a high volume of water. Follow the water conservation flow rates recommended by the East Bay Municipal Utility District (EBMUD):

- Kitchen faucets: 2.0 gpm or less
- Bathroom faucets: 1.5 gpm or less

Showers should use less than 2.0 gpm. Shower towers should also use no more than 2.0 gpm total. Don't install more than one showerhead per shower.

For more information about high efficiency faucets, go to www.epa.gov/watersense. The AccessGreen Directory (www.BuildItGreen.org) lists suppliers of high efficiency faucets and showerheads.

Benefit:

Flow reducers and low-flow showerheads can cut water usage by as much as 40% with little noticeable effect. They also save money by saving water and reducing energy used to heat water.

H. Heating, Ventilation and Air Conditioning

1. Design and Install HVAC System to ACCA Recommendations

Description:

The Air Conditioning Contractors of America (ACCA) has developed a set of calculation manuals—Manuals J, D and S—to determine the appropriate size and design of a home's heating, ventilation and air conditioning (HVAC) system.

Application:

Design and install the HVAC system according to results obtained from Manual J (the home's heat load calculation), Manual D (ductwork design and sizing) and Manual S (equipment selection and sizing).

Benefit:

Doing these calculations correctly and installing the system correctly and as indicated by the calculations will result in an efficient and effective HVAC system that will deliver comfort and energy savings.

2. Install High Efficiency, Sealed Combustion Heating Systems

Description:

High efficiency heating equipment increases comfort, reduces pollution, and lowers energy use and associated greenhouse gas emissions. High efficiency systems include ENERGY STAR®–qualified sealed combustion furnaces and boilers, and ENERGY STAR®–qualified heat pumps.

Some heating systems are designed to provide both space heating and hot water; the heat source may be a boiler, furnace, solar water heater or heat pump.

Application:

Furnaces and Boilers

When replacing the furnace or boiler, select a sealed-combustion ENERGY STAR®–qualified model with a 90% or greater AFUE (annual fuel utilization efficiency) rating.

Sealed combustion furnaces, boilers and water heaters duct outdoor air directly into a sealed jacket around the combustion chamber so that air from inside the house isn't used for combustion. These products also vent combustion gases directly outdoors so that they don't pollute the home.

Heat Pumps

In many climates and in locations where switching from electric to gas is difficult, electric air-source or ground-source heat pumps are an alternative to combustion furnaces and boilers. Unlike combustion heating systems that convert fuel into heat, heat pumps use the difference between outdoor air temperatures (or ground temperatures) and indoor air temperatures to cool and heat your home. Select ENERGY STAR®–qualified models for better energy efficiency.

For more information about high efficiency heating systems, go to www.energystar.gov or www.consumerenergycenter.org

BUILDING BASICS | When to Replace the Furnace

Pacific Gas and Electric Company (PG&E) suggests that if your heating system is more than 15 years old, you should consider upgrading it for increased comfort and energy savings. What makes a newer furnace more efficient? Some older furnaces have pilot lights that burn all the time, wasting energy, while new models have electronic ignition. Even more significant is the Annual Fuel Utilization Efficiency (AFUE), which is a rating of how much energy the furnace turns into usable heat in your home. The higher the AFUE, the less energy the system will use and the less money it will take to heat the home. The AFUE of older furnaces may be as low as 50% to 70%.

When replacing a furnace choose an ENERGY STAR®–qualified furnace with an AFUE of 90% or higher (see Section H, High Efficiency, Sealed Combustion Heating Systems). For a list of qualifying products, go to www.energystar.gov. Contact your local utility for information about potential rebates for high efficiency furnaces.

And if the house doesn't already have a programmable thermostat, consider having one installed. It can be set to automatically turn the temperature up or down at programmed times. For example, it can be set to deliver less heat after you go to bed, and to turn the heat up an hour before you get up. It's a relatively inexpensive upgrade that offers energy savings and convenience.

Radiant floor heating

Benefit:

Properly sized, high efficiency heating equipment reduces heating bills and protects air quality. Sealed combustion furnaces, boilers and water heaters prevent backdrafting. This can occur when exhaust fans, clothes dryers or leaky ducts negatively pressurize a house; this negative pressure can pull carbon monoxide into the house from the furnace's or boiler's vent flue.

Electric heat pumps can often provide more efficient heating and cooling than standard separate furnace and air conditioning units.

3. Install Zoned, Hydronic Radiant Heating with Slab Insulation

Description:

Instead of providing warm air via ducts, hydronic radiant heating systems circulate hot water through under-floor tubing, wall radiators or baseboard convectors. Their heat source can be a boiler, conventional water heater or solar water heater.

Application:

Hydronic radiant heating is most appropriate in cold climates or in homes where air conditioning is not needed. Design the system in accordance with Radiant Panel Association guidelines (www.radiantpanelassociation.org) and use an RPA-certified installer. To reduce heat loss to the ground, the entire slab should be insulated to a minimum of R-5.

Benefit:

Many people find hydronic radiant heating to be more comfortable than forced air heating. Hydronic radiant heating can provide even heat throughout a room, reduce drafts and eliminate duct leakage. Hydronic radiant heating systems are also easily zoned, which allows residents to turn off the heat in areas of the home that aren't being used.

4. Install High Efficiency Air Conditioning with Environmentally Responsible Refrigerants

Description:

Energy-efficient air conditioning equipment saves homeowners money and reduces demand for electricity from power plants. Environmentally sound refrigerants reduce the risk of damage to the ozone layer.

Air conditioners are rated according to SEER, or Seasonal Energy Efficiency Ratio and according to EER, or Energy Efficiency Ratio. Higher SEER and EER ratings mean greater energy efficiency.

Application:

Choose an air conditioner with a SEER of 14 or higher or an EER of 11 or higher. While these units usually have higher upfront costs, they are a good investment. Many utilities offer rebates for higher efficiency units.

The air conditioner should have a thermostatic expansion valve (TXV), which is a refrigerant regulation device that can help ensure that the system operates at maximum efficiency over a wide range of conditions. Some air conditioning equipment comes with a factory installed TXV and others accept a TXV that can be bolted on by an HVAC contractor.

Another good strategy for energy efficiency is a zoned central air conditioning system, which allows two to four zones to be conditioned at different temperatures so only the spaces being used are cooled.

When choosing a new air conditioner, make sure that it doesn't use hydrochlorofluorocarbon (HCFC) refrigerants. HCFCs can destroy the ozone layer if the refrigerant leaks out of the air conditioner. R-22 (HCFC-22) is an HCFC refrigerant commonly used in many residential cooling systems. The federal Clean Air Act requires that HVAC manufacturers discontinue using R-22 in new air conditioners by 2010.

Some new models already use alternatives to R-22 refrigerant, including: R-410a, R-134a, or R-407C. Common trade names for these refrigerants are Puron®, SUV-410A®, GENETRON AZ20®, DuraCool®, and more.

Make sure that refrigerants are handled properly; always select a reputable dealer that employs service technicians who have been EPA certified to handle refrigerants.

For more information about high efficiency air conditioning systems, go to www.energystar.gov or www.consumerenergycenter.org.

Benefit:

High efficiency air conditioners save money and energy, and reduce peak electricity demand. Installing air conditioning systems with a TXV lowers utility bills and saves energy.

If the refrigerant leaks during replacement, a non-HCFC refrigerant will not damage the ozone layer.

5. Install Effective Ductwork

Description:

Poorly designed and installed ductwork lowers heating and cooling system efficiency and capacity, and can contribute to poor indoor air quality and comfort problems.

Application:

Consider having ducts tested for airflow and leakage before and after any new work on the HVAC system. The following six strategies will improve ductwork effectiveness:

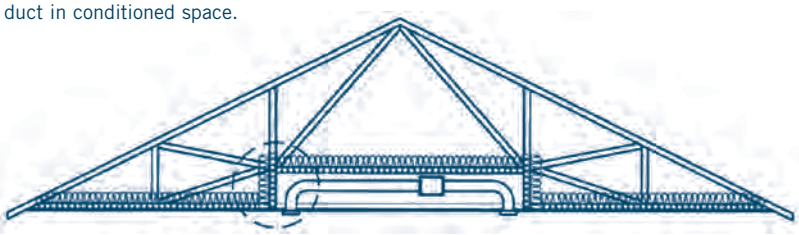
a. Install New Ductwork within Conditioned Space

Install any new ductwork inside the insulated envelope of the home. The unit and duct runs may be installed in closets, chases, and soffits purposefully designed to accommodate them, or they may be installed in an attic that is insulated at the roof deck (unvented attic).

b. Use Duct Mastic on All Ducts and Joints Seams

Leaks in the joints between ductwork have been shown to allow, on average, 20 to 30% of conditioned air to leak out. Leaky air ducts can cause negative pressure in the house, which can draw many outdoor and indoor contaminants into the home, including carbon monoxide from gas water heaters and furnaces. Don't use duct tape to seal ducts; it loses its effectiveness in a few years. To maintain a tight seal for decades, use a water-based mastic at every duct joint and seam or have professionally installed aerosol sealant sprayed into the ducts.

Truss with insulated recess keeps duct in conditioned space.



Steven Winter Associates

c. Install Ductwork under Attic Insulation (Buried Ducts)

As a low cost alternative to installing ductwork in conditioned space, the insulation value of ductwork can be significantly improved by burying ducts in loose-fill ceiling insulation. For this approach to be most effective, duct connections must be tightly sealed.

Instead of suspending ducts from rafters or trusses, allow ducts to lay over ceiling joists or the bottom chord of trusses and blow insulation over them. To achieve moderate coverage, insulate to at least R-38. Using supply boots with side instead of top connections keeps ducts low and aids burial.

d. Pressure Balance the Ductwork System

When a bedroom door is closed, it typically cuts off the return airflow path. This restricts air movement, leading to comfort problems and a pressure imbalance, with the bedroom pressurized and the rest of the house depressurized. This may cause infiltration of contaminated air from the attic or crawl space, or backdrafting of combustion appliances. Install an additional return duct in the master bedroom and other large rooms that can be closed off with a door. Or install a jump duct or transfer grille between the hall or main living area and these rooms with doors.

e. Protect Ducts during Remodeling and Clean All Ducts before Occupancy

Debris and dust from construction can lodge in HVAC units and the ductwork, potentially causing occupants to have allergic reactions and reducing the effectiveness of the blower fan and heating/cooling elements. As soon as the ducts are installed, completely seal off each duct register and the HVAC unit to block out any construction dust. Use methods and materials that

will stay in place under the abuse of a typical construction site. After construction is completely finished, vacuum the blower unit and ductwork as necessary.

f. Insulate Existing Ductwork

Insulate, to present building code levels or greater, any existing ductwork that is accessible and has no insulation or damaged insulation.

Benefit:

Effective ductwork practices significantly reduce energy loss, minimize indoor air quality problems and improve occupant comfort.

6. Install High Efficiency HVAC Filter

Description:

HVAC filters remove particulates from the air. MERV, or Minimum Efficiency Reporting Value, is a metric used to measure an air filter's efficiency. The MERV scale ranges from 1 to 20. The higher the MERV number, the more efficient the filter is at removing particulates.

Application:

Use HVAC air filters rated at MERV 6 to 10. These filters are recommended for cleaner air without compromising the performance of standard mechanical systems. Filters with MERV ratings of more than 10 create too much resistance to airflow, because the filter media becomes denser as efficiency increases. Only use a filter with a MERV of greater than 10 if the HVAC system is specifically designed for it.

Clean or replace the filter regularly. Dirty filters reduce air flow and make the HVAC equipment work harder.

Benefit:

The U.S. EPA has identified microparticulates as a leading cause of respiratory discomfort. By reducing these particles in the indoor air, a high efficiency filter protects the HVAC equipment and makes the living space healthier.

7. No Fireplace or Retrofit Wood-Burning Fireplaces

Description:

Burning wood in fireplaces is a major source of air pollution in the winter, generating up to one-third of outdoor air particulates on cold nights. In addition, conventional open fireplaces suck air out of the house and send more heat up the chimney than they provide to the room. In recent years, a number of cities and counties in California have enacted local ordinances that permit the installation of only gas-burning fireplaces or U.S. EPA certified wood-burning appliances.

Existing wood-burning fireplaces should be retrofitted with airtight doors and working dampers to reduce down-drafting, heat loss and the amount of air drawn from the house for combustion. An even better alternative is a gas insert with sealed combustion; these products have efficiencies up to 85%, compared to typical fireplaces which are only about 13% efficient.

Application:

Retrofit conventional wood-burning fireplaces with EPA-certified wood or pellet stoves. All units should have combustion air vented directly into them from the outside. For gas units, the listed efficiency should exceed 60% (only from Natural Resources Canada, CSA P.4.1-02, "Testing Method for Measuring Annual Fireplace Efficiency").

If it is not feasible to totally retrofit the existing fireplace, then at least replace the old damper if it no longer seals the flue due to mechanical failure, rust or soot buildup in the chimney. Also retrofit fireplaces with sealed doors and bring outside air for combustion from behind the doors.

For more information about retrofitting wood-burning fireplaces, see the Bay Area Air Quality Management District's website, www.baaqmd.gov/pio/wood_burning; South Coast Air Quality Management District's website, www.aqmd.gov; and the U.S. Environmental Protection Agency's website, www.epa.gov/woodstoves.

Benefit:

EPA-certified wood-burning stoves and CSA-rated gas fireplaces reduce the amount of particulate pollutants by 75 to 90% compared to a standard fireplace. A properly operating damper reduces drafts in the house when the fireplace is not in use. Airtight doors can reduce the heat taken from the house as well as reduce drafts when the fireplace is not in use. Finally, efficient gas fireplaces consume less gas and save money compared to conventional gas fireplaces.

8. Install Effective Exhaust Systems in Bathrooms and Kitchen

Description:

Excessive moisture resulting from poor ventilation is one of the main causes of mold issues and building failures. Bathrooms and kitchens produce odors and a lot of moisture that can cause problems if the rooms are not properly ventilated. Gas ovens and gas cooktops produce carbon monoxide, nitrogen dioxide and other pollutants. Additionally, cooking food produces odors and particulates.

Application:

These three strategies will help regulate the home's indoor air quality:

Install ENERGY STAR® bathroom fans vented to the outside.

Exhaust all bathroom ventilation fans to the outdoors, not to the attic. Choose ENERGY STAR® qualified bathroom fans; quieter fans will have a rating of 1.5 sones or less.

Put all bathroom fans on timer or humidistat.

Bathroom fans should be controlled by a timer or humidistat to ensure proper run-time to adequately remove moisture from the room. Timers are triggered when the lights are turned on, and then run for a set time; 15 to 30 minutes usually works well. Humidistat controllers are even better, as they automatically switch on when moisture in the air reaches a threshold level, and shut down when the moisture level subsides.

Install kitchen range-hood exhaust system vented to the outside.

Use high efficiency range-hood exhaust systems that are ENERGY STAR®–qualified and vent them to the outside. ENERGY STAR® units are typically designed to be quieter (less than 4 sones) so that people will be more likely to use them. Don't buy overpowered hoods that may cause backdrafting of fireplaces and other combustion appliances.

Benefit:

ENERGY STAR®–qualified bathroom ventilation fans use 65% less energy, on average, than standard models. They also provide better efficiency and comfort with less noise, and use high performance motors that last longer. Bathroom fans controlled by timers or humidistats will ensure proper use and reduce moisture problems.

Venting range hoods to the outdoors reduces the amount of moisture inside the home, and helps prevent adverse health effects from combustion gases and cooking emissions.

9. Install Mechanical Ventilation System for Cooling

Description:

Ceiling fans improve a home's comfort by circulating air. ENERGY STAR®–qualified models are energy efficient thanks to improved motors, blade designs and fluorescent light kits; also, they can be operated to either draw warm air upward in the summer or push it downward in the winter.

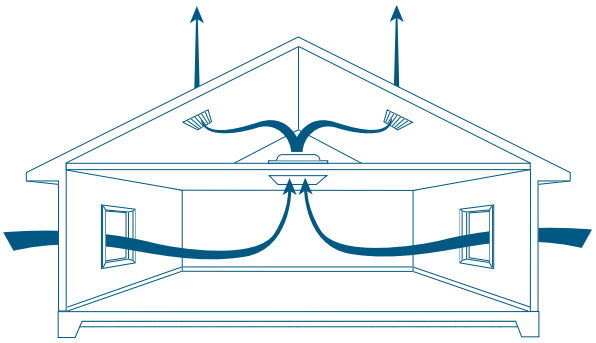
Whole house fans are used instead of an air conditioner to cool a house at night. They exhaust warm indoor air and bring in large volumes of cool outdoor air.

Application:

Install ENERGY STAR® ceiling fans and light kits in areas where occupants tend to spend more time, such as bedrooms and family rooms. Anchor ceiling fans to ceiling joists. For fans with built-in lights, select models with ENERGY STAR®–qualified compact fluorescent light fixtures. If the fan doesn't include lighting, purchase an ENERGY STAR®–qualified light kit.

Install a whole house fan with variable speeds. A whole house fan is appropriate for single-story and multistory homes. In a multistory home it must be mounted in a hallway ceiling on the top floor. An insulated, airtight seal is necessary to prevent air leakage through the fan in winter. Fans should be sized to produce between four to five air changes per hour and should have two speeds: low speed for continuous ventilation and high speed. When the fan is running, you must keep

Air Flow with Whole House Fan



a few downstairs windows open to allow the outdoor air in and to avoid backdrafting of carbon monoxide from gas appliance flues.

The AccessGreen Directory (www.BuildItGreen.org) lists suppliers of energy-efficient ventilation products.

Benefit:

Ceiling fans can make residents feel more comfortable while cutting back on their use of heating and air conditioning systems. ENERGY STAR®–qualified models provide greater energy savings thanks to improved blade and motor design and integrated compact fluorescent lighting.

An average whole house fan uses one-tenth the electricity of an air conditioner. Moving large volumes of air can achieve indoor comfort at higher temperatures without air conditioning.

10. Install Mechanical Ventilation for Fresh Air

Description:

An air-to-air heat exchanger (also called a heat or energy recovery ventilator) is a mechanical fresh air ventilation system that recovers heat from exhausted indoor air and transfers it to the incoming fresh air stream.

Application:

Install an air-to-air heat exchanger to deliver fresh air to high occupancy areas like bedrooms and living rooms. Use of this equipment is particularly appropriate if a blower door test of the home shows less than 0.35 Natural Air Changes per Hour (NACH).

Benefit:

Air-to-air heat exchangers introduce fresh air into the home while reducing energy loss by capturing heat from the exhausted air stream and transferring it to the incoming air.

11. Install Carbon Monoxide Alarms

Description:

Carbon monoxide (CO) is emitted from fuel-burning appliances such as stoves, cooktops, water heaters, furnaces and fireplaces, as well as from cars and some landscape equipment. If a home is tightly built for energy efficiency but has leaky HVAC ducts, the air leaks may depressurize the home and reverse the flow of exhaust vent pipes. This can introduce carbon monoxide from fuel-burning appliances back into the home, a process known as backdrafting.

Application:

Install a carbon monoxide alarm per manufacturer's instructions. Alarms must comply with both UL 2034 and CSA 6.19 standards. Alarms must be replaced every three to five years, as they lose their sensitivity over time.

Benefit:

A carbon monoxide alarm provides an added level of home safety.

I. Renewable Energy

1. Install Solar Water Heating System

Description:

Solar water heating systems use solar panels and water storage to collect and store heat from the sun for domestic hot water use or space heating. Solar water heating systems are typically used to deliver preheated water to a standard water heater. Solar water heating is more cost effective than ever, as a result of new technologies, reliable products and rising energy prices.

Application:

Use only solar water heaters that are SRCC (Solar Rating and Certification Corporation) certified. Ensure that there is sufficient south-facing roof area for the collectors, that the roof structure will accommodate the system's weight, and that there is adequate area near the conventional water heater for additional mechanical equipment such as storage tanks, pumps, pipes and controllers.

Federal tax credits are currently available for installing solar hot water systems. Consult a tax advisor or solar energy installer for more information. For more information about solar hot water systems, go to the California Energy Commission's website, www.consumerenergycenter.org.

Benefit:

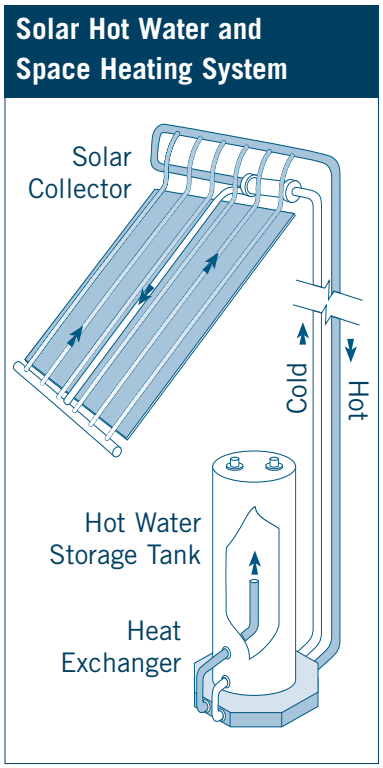
Many solar water heating systems can provide all the hot water needed during summer months. For many households, these energy savings can offset the cost of the system in less than ten years.

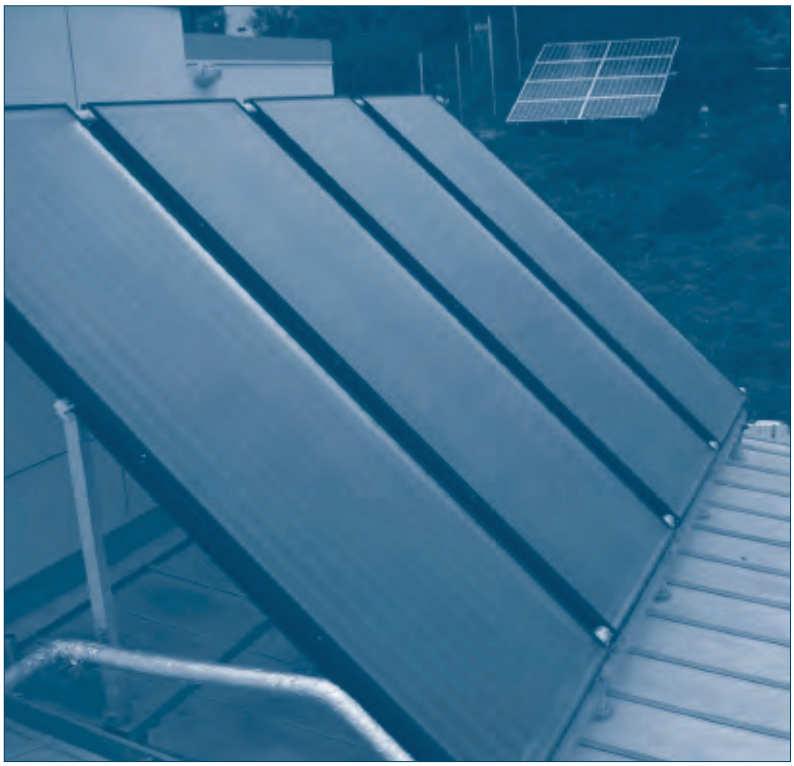
2. Install Photovoltaic (PV) System

Description:

PV systems convert solar energy into electricity when sunlight strikes the PV cells. Most residential systems are grid connected; when the PV

Solar water heating system





system is providing more power than the home uses, additional electricity is fed back into the utility grid. This effectively spins the home's electricity meter backward in what is known as net metering.

When the sun is not shining or when the home requires more electricity than the PV system can produce, the home draws power from the grid. If there is a power outage, a home with a grid-connected PV system will lose power just like homes without PV systems. Adding battery back-up to the PV system is expensive but allows the homeowner to keep some electrical systems running during power outages.

Application:

For cost and appearance, the best location for PV modules is flush on south-or west-facing roofs. South-facing modules produce more energy annually, but west-facing modules can take better advantage of time-of-use rates that are available from some utilities, and help reduce the electricity grid's peak load.

If re-roofing a tile or metal roof, building-integrated modules can be easier to install and are designed to blend in well with the existing roof. For other roof types, specially designed racks that anchor to the rafters are typically used to mount the PV panels.

The AccessGreen Directory (www.BuildItGreen.org) lists PV suppliers. For current rebate and tax credit information, check the California Energy Commission's website, www.consumerenergycenter.org.

Benefit:

Benefits include lower energy costs, reduced greenhouse gas and other emissions from fossil fuel–burning power plants, reduced need to develop new power plants, and improved national energy security.

Power meter showing the amount of solar electricity generated and used.

Photovoltaic panel system, Centex Homes, Livermore.

J. Building Performance

1. Conduct Whole House Inspection/Diagnostic Testing and Make Improvements

Description:

Homes designed to be very energy efficient may still perform poorly. Diagnostic evaluations and inspections can help uncover errors and fix potential problems with installation or maintenance.

Application:

It is a good idea to have the home tested for thermal envelope and HVAC effectiveness at any time, whether remodeling or not. Inspection and diagnostic evaluations should include the following three measures:

Use a certified Home Energy Rating System (HERS) technician to test the duct system's air delivery in cubic feet per minute (cfm). The results should be within 10% of design flow calculations. Pressurize ducts and verify that leakage is under 15%. If leakage is greater than 15%, make the necessary improvements to the duct system and test again. For information about HERS providers, go to the California Energy Commission's website www.energy.ca.gov/HERS.

Have a blower door test performed to estimate the interior natural air changes per hour (NACH) for the whole house. The NACH should be close to or less than 0.35; if it isn't, make any necessary improvements and test again.

Perform a combustion safety test if needed to ensure carbon monoxide is not backdrafting into the home from an open-combustion fireplace, water heater or furnace.

Benefit:

Testing of a home, especially before beginning a remodeling project, can reveal unforeseen issues that affect the home's energy efficiency, comfort and indoor air quality.

BUILDING BASICS | Exceeding Title 24 Energy Efficiency Standards

California's Building Energy Efficiency Standards, or Title 24, as they are commonly called, establish minimum energy efficiency requirements for all new building construction and major remodeling projects in the state. When you remodel a home, Title 24 dictates the amount of insulation required in new walls, the performance of new windows, the size of a new furnace, and much more.

Thanks to Title 24 and other energy efficiency policies, the average California resident uses 40% less energy than residents in the rest of the country. Even though California's energy regulations are more stringent than in the rest of the nation, simply meeting code isn't necessarily the best path. Efforts such as upgrading insulation beyond code, choosing higher efficiency heating and cooling equipment, and using fluorescent lighting throughout the home can further reduce energy consumption and related greenhouse gas emissions, as well as reduce utility bills.

For more information about Title 24, contact the California Energy Commission at www.energy.ca.gov/title24 or call the State's Energy Efficiency Hotline at (916) 654-5106 or (800) 772-3300 (toll free in California).

K. Finishes

To find suppliers of the finish products and materials described in this section, go to the AccessGreen Directory at www.BuildItGreen.org.

1. Design Entryways to Reduce Tracked-In Contaminants

Description:

Up to two-thirds of dust and particulates in houses is tracked in on shoes. These tracked-in contaminants contain everything from soil and pesticides to abrasive sand, mold, road grime and bacteria. Once these particulates are inside the home, they can be difficult to get rid of.

Application:

The most effective way to avoid tracking contaminants into the home is for people to remove their shoes upon entering. Provide features near entryways that encourage the removal and storage of outerwear and shoes, such as benches or a mudroom. For entryways, avoid carpet, and choose easily cleaned flooring with a hard surface, such as hardwood, bamboo, concrete, ceramic tile or natural linoleum.

Shoe storage at entryway

Benefit:

The home will be cleaner, with less dirt and other pollution tracked in.

2. Use Low-VOC or Zero-VOC Interior Paint

Description:

Most interior paints contain volatile organic compounds (VOCs), a major class of indoor and outdoor air pollutants. Besides affecting indoor air quality, certain VOCs react with other chemicals in the atmosphere, producing ground-level ozone (smog) that can affect human health. Low- and zero-VOC paints reduce these sources of pollution.

Application:

Interior paints with low or zero levels of VOCs are available from most major manufacturers. They are applied and perform like conventional paint.

Low-VOC paints contain less than 150 grams per liter (gpl) of VOCs for nonflat finishes, and 50 gpl or less for flat finishes. Paints that contain less than 5 gpl of VOCs are classified as zero VOC. The AccessGreen Directory (www.BuildItGreen.org) lists zero- and low-VOC paints.

Benefit:

Low- or zero-VOC paint reduces the emissions of VOCs, improving indoor air quality and reducing the formation of smog.

3. Use Low-VOC, Water-Based Wood Finishes

Description:

Conventional petrochemical-based wood finishes can offgas for months and be harmful to children and chemically sensitive individuals. Offgassing means the solvents

BUILDING BASICS | Protecting Indoor Air Quality during Construction

During construction, the contractors should take appropriate steps to protect occupants from dust, chemicals and other airborne contaminants. Separate work zones from living quarters and take steps to physically isolate contaminants. Zippered plastic barriers installed at hallways or doorways, for example, allow workers to enter areas of the home under construction while protecting the air quality in the rest of the house.

Protect duct registers from pollutants such as dust, paint spray, adhesive fumes and more. Ensure that supply ducts going into furnaces or air conditioners are sealed and are not in use during construction activities, which could spread contaminants throughout the home's duct work. Lastly, consider having ducts cleaned after major remodeling work is completed.

in the product are released into the air, contaminating indoor air quality. Low-VOC finishes, such as waterborne urethane and acrylic or plant-based oils, are lower in toxic compounds compared to conventional oil-based finishes while providing similar durability.

Application:

Use wood finishes with VOC concentrations of 250 gpl or less. If oil-based wood finishes must be used, they should be applied off-site or allowed to offgas for three to four weeks prior to occupancy. The AccessGreen Directory (www.BuildItGreen.org) lists low-VOC wood finishes.

Benefit:

Using low-VOC wood finishes reduces offgassing, improving indoor air quality and reducing the formation of smog.

4. Use Low-VOC Caulk and Construction Adhesives

Description:

Unlike conventional caulks and construction adhesives that may offgas toxic compounds for months, low-VOC products reduce toxic gases such as aromatic hydrocarbons and other petroleum solvents that contribute to indoor and outdoor air pollution.

Application:

Use caulks and adhesives with VOC concentrations of 70 gpl or less in place of standard caulks and adhesives for all interior applications such as installation of framing, subfloors, finish flooring, countertops, trim, wall coverings, paneling and tub/shower enclosures. The AccessGreen Directory (www.BuildItGreen.org) lists low-VOC caulks and construction adhesives.

Benefit:

Low-VOC caulks and adhesives work as well as or better than conventional products, emit fewer pollutants and reduce the risk of potentially harmful health impacts.

5. Use Recycled-Content Paint

Description:

A number of manufacturers have developed high quality recycled-content latex paints and primers. The recycled content (ranging from 20% to 100%) comes from unused consumer or industrial stock, as well as paint recovered from household hazardous waste collection facilities. The paint is checked for quality and then sent to paint manufacturers for recycling and blending with a portion of new paint.

Application:

Latex paint with recycled content is applied like conventional paint. Due to the blended nature of the paint, it tends to come in a limited range of colors, and therefore is more typically used for exterior or utility room applications. Look for products that are certified by Green Seal to meet quality, performance, safety and environmental standards. The AccessGreen Directory (www.BuildItGreen.org) lists recycled content paints.

Benefit:

Recycled paint is often less expensive than new paint. It also reduces the need to manufacture new paint and supplies a market for unused paint, rather than putting it into the waste stream.

6. Use Environmentally Preferable Materials for Interior Finishes

Environmentally preferable options for interior finishes include materials that are FSC-certified, reclaimed or refinished, rapidly renewable, contain recycled-content or are finger-jointed.

For a listing of environmentally preferable finish materials and suppliers, go to the AccessGreen Directory at www.BuildItGreen.org.

a. Use FSC-Certified Materials

Description:

Forest Stewardship Council (FSC)–certified wood comes from forests managed in accordance with stringent sustainable forestry practices.

Application:

Use FSC-certified wood and wood products in any application that normally calls for conventional plywood or stain-grade materials, such as cabinets, trim, doors, shelving and window frames.

Benefit:

FSC certification assures that forests are managed in a way that protects the long-term availability of wood resources and the

Samples of low VOC paints

health of forest ecosystems and local economies.

b. Use Reclaimed or Refinished Materials

Description:

Refinishing rather than replacing existing floors, cabinetry and other interior materials is one of the best environmental choices you can make. High quality finish materials can often be salvaged from other buildings that are being deconstructed.

Application:

In addition to reusing the home's existing materials, you can purchase high quality salvaged products that were removed from demolished or remodeled buildings. These include reclaimed lumber for nonstructural applications, such as mantels, nonstructural beams, casing, trim, cabinets and doors; cabinetry; wood flooring; sinks and tubs; electrical products or fixtures; and roofing materials.

Numerous salvaged building material suppliers in the state as well as materials exchange groups such as Craigslist.com and Freecycle.org can help locate materials for your project. The California Integrated Waste Management Board (www.ciwmb.ca.gov) also provides information about material reuse.

Benefit:

Reclaimed and refinished building materials reduce resource consumption and landfill deposits. Many salvaged products are of higher quality than new materials, such as lumber taken from deconstructed buildings or vintage claw-foot bathtubs. Salvaged products also can cost less than new materials.

c. Use Rapidly Renewable Materials

Description:

Rapidly renewable materials are made from agricultural products that grow quickly and can be harvested on a relatively short cycle compared to slower-growing wood. Examples include bamboo, a fast-growing grass that can be harvested in three to five years, and straw, the stalk of wheat, rice, barley and other grains.

Application:

Instead of using solid wood, plywood or wood-based medium density fiberboard (MDF) for interior finishes, consider rapidly renewable materials such as straw-based MDF and bamboo plywood.

Benefit:

Rapidly renewable materials are attractive, durable and reduce pressure to harvest forests. Bamboo is as durable as most hardwoods typically used for interior finishes.

Salvaged wood countertop

d. Use Recycled-Content Materials

Description:

Some recycled-content interior finishes, such as molding, are made from recycled polystyrene or other plastics. Recycled-content countertops include recycled glass tiles, terrazzo-like materials that blend recycled glass and concrete, and natural fiber composites derived from rapidly renewable or recycled resources.

Application:

Use recycled-content finish materials in any application where virgin materials are typically used. Recycled-content products are available for kitchen and bathroom applications such as trim, countertops, backsplashes, shower walls and vanity tops.

Benefit:

Recycled-content products keep valuable resources out of the waste stream. Recycled-content trim materials are often straighter and more stable than conventional clear wood.

e. Use Finger-Jointed Materials

Description:

Finger-jointed trim, studs and fascia are manufactured from short pieces of wood glued together to create a finished material.

Application:

Use finger-jointed materials in any application where the materials are to be painted.

Benefit:

Finger-jointed elements are straighter and more stable than conventional clear wood, and use wood more efficiently.

7. Reduce Formaldehyde in Interior Finishes

Description:

Formaldehyde is often used as a binder in home-building products such as plywood, particleboard and other composite wood products. These binders come in two basic forms: urea and phenol. Urea-formaldehyde binders are common in interior-grade products. Phenol-formaldehyde binders are used in exterior applications because they are more water resistant. This water resistance quality makes phenolic glues offgas more slowly and in lower quantities than urea glues, reducing some of the harmful effects on indoor air quality.

Application:

Whenever possible, use interior materials (including subfloor and stair treads, cabinets and countertops, interior trim and shelving) that emit little or no formaldehyde.

Select materials that have been tested for low emissions and certified to meet California's Section 01350 criteria, "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers." Currently there is little information available about Section 01350-compliant products for homes, but the Collaborative for High Performance Schools' website, www.chps.net, lists products tested for schools; some of these may also be appropriate for homes.

Benefit:

Reducing formaldehyde exposure helps protect the health of residents, particularly children, who are most susceptible.

8. Test Indoor Air for Formaldehyde after Installation of Finishes

Description:

The California Air Resources Board (ARB) has classified formaldehyde as a Toxic Air Contaminant. ARB recommends that formaldehyde levels inside buildings be as low as possible (no greater than 27 parts per billion) because of formaldehyde's cancer-causing potential. Formaldehyde, a colorless gas, is usually present at higher levels in indoor air than outdoor air, in part because it is used as a binder and preservative in many common building products and furniture. Formaldehyde evaporates from products into the home's interior, often for many years after the product is installed.

Application:

Using low-emitting products such as those mentioned in these Guidelines will usually lower formaldehyde to below ARB's thresholds for any newly remodeled spaces. Existing areas of the home that aren't being remodeled, especially in houses more than 10 years old, will likely have formaldehyde concentrations well below the ARB recommended threshold.

A home test can be performed to measure average indoor concentrations of formaldehyde. Test the building after installation of all finishes. For information about formaldehyde and home test kits, go to the California Air Resources Board website, www.arb.ca.gov/research/indoor/indoor.htm.

Benefit:

Reducing formaldehyde can decrease the risks associated with exposure.

Recycled-content glass tile and concrete bathroom counters

L. Flooring

1. Use Environmentally Preferable Flooring

a. Use Forest Stewardship Council (FSC)–Certified Wood Flooring

Description:

FSC-certified wood flooring comes from forests managed in accordance with stringent sustainable forestry practices. FSC-certified products are available in a wide variety of domestic and exotic species.

Application:

Use FSC-certified wood in place of conventional hardwood flooring.

Benefit:

FSC certification assures that forests are managed in a way that protects the long-term availability of wood resources, the health of forest ecosystems, and the sustainability of local economies.

b. Use Reclaimed or Refinished Materials

Description:

Refinishing your existing floors instead of replacing them is one of the best environmental choices you can make. An alternative to refinishing existing floors is to purchase high quality salvaged wood flooring or other salvaged flooring products removed from demolished or remodeled buildings.

Application:

Use low-VOC sealers when refinishing existing or reclaimed wood floors. If existing ceramic or stone tiles are in good shape, consider cleaning and polishing them rather than replacing them.

Find salvaged flooring from building materials reuse stores or through online resources such as Craigslist.org and Freecycle.org. The California Integrated Waste Management Board (www.ciwmb.ca.gov) also provides information about material reuse.

Benefit:

Reclaimed and refinished building materials reduce resource consumption and landfill deposits. Many salvaged products are of higher quality and often cost less than new materials.

c. Use Rapidly Renewable Flooring Materials

Description:

Bamboo, cork and natural linoleum flooring are alternatives to conventional hardwood flooring, carpet or vinyl flooring. Bamboo, which is as durable as most hardwoods, is a fast-growing grass that can be harvested in three to five years. Cork is harvested from the outer bark of the cork oak tree; the tree regenerates its bark within about 10 years. Natural linoleum is manufactured primarily from renewable materials such as cork, wood flour and linseed oil.

BUILDING BASICS | Universal Design

Universal design strives to make the home easier to use for all residents, not just the elderly or disabled. It includes a wide range of accessibility features, from easy-to-use door handles to adequate lighting to zero-step entrances in homes.

During remodeling projects as well as routine maintenance, apply as many universal design strategies as possible. In the long run, it may save money and resources to include universal design features during the current remodeling project than to have to retrofit the home in the future if the owner's needs change. Some universal design features may even allow people to live in their home longer than might otherwise be possible.

Here are some common universal design strategies:

- Install lever handles on doors and plumbing fixtures instead of knob handles that are harder to grip.
- Locate one bedroom and full bathroom on the lower floor of the multistory home.
- Provide at least one zero-step entrance threshold that has a 36-inch wide entry door.
- Allow a 60-inch turning radius in bathrooms, kitchens and small areas.
- Install grab bars in the bathroom, or provide blocking in the bathrooms' wall framing to accommodate grab bars in the future.
- Design for a roll-in shower to provide easy access for people in wheelchairs.

AARP has good information on universal design basics at www.aarp.org/families/home_design.

Application:

Use these rapidly renewable flooring materials in place of conventional hardwood, carpet or vinyl flooring.

Cork can also be used as an underlayment for hard-surfaced flooring to reduce impact noise between rooms.

Benefit:

Rapidly renewable flooring materials are attractive, durable, low-toxic, perform well and reduce pressure to harvest forests. Bamboo is as durable as most hardwoods used for floors. Cork and linoleum are naturally fire and moisture resistant as well as sound absorbent.

d. Use Recycled-Content Flooring

Description:

Recycled-content ceramic tiles can contain up to 70% recycled glass or other recycled materials. Recycled-content carpet is made from recycled plastic bottles, recycled nylon and wool, or recycled cotton.

Application:

Install recycled-content ceramic tiles wherever conventional tiles are specified. Recycled-content carpet can be used in all applications where conventional carpet is specified, and is comparable in appearance, performance and price to conventional synthetic carpet made from virgin materials.

Benefit:

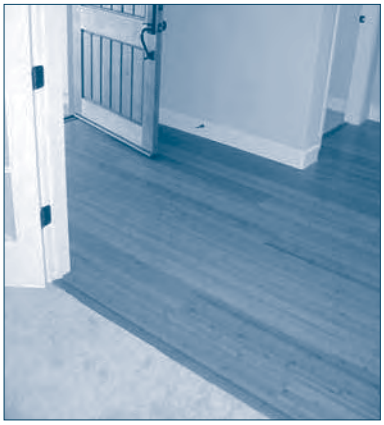
Recycled-content products keep valuable resources out of the waste stream. Recycled-content carpet saves resources and diverts waste from landfills. Approximately 40 two-liter soda bottles are recycled per square yard of carpeting.

e. Use Exposed Concrete as Finish Floor

Description:

With slab-on-grade construction, the concrete can be polished, scored with joints in various patterns, or stained with pigments to make an attractive finish floor. This approach is especially appropriate for use with in-floor radiant heating systems and passive solar designs.

Bamboo flooring and recycled-content carpet



Application:

Use this approach for slab-on-grade construction. The finish must be designed and constructed when the slab is being poured, and well protected throughout construction.

Ingredients of natural linoleum

Benefit:

Using the slab as a finish floor eliminates the need to use other flooring materials. It is also durable and easy to clean.

2. Use Thermal Mass Floors

Description:

Use flooring materials that improve thermal mass.

Application:

Low-cost thermal mass includes using hard floor coverings such as tile and wood. Wood flooring over a concrete slab also provides reasonably good thermal mass. See the Building Basics sidebar on page 20 for information about using thermally massive materials with passive solar design.

Benefit:

Increasing thermal mass will reduce heating and cooling energy use and will moderate indoor temperature swings, keeping the home more comfortable.

3. Use Flooring That Is Low Emitting

Description:

Flooring products may emit formaldehyde and other volatile organic compounds. To protect indoor air quality, look for products that have been tested and approved for low emissions by a reputable third-party or government organization.

Application:

Choose carpet that meets or exceeds the CRI Green Label Plus requirements (www.carpet-rug.org) or a flooring product that has been tested for low emissions according to the California "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers."

Currently there is little information available about Section 01350-compliant products for homes, but the Collaborative for High Performance Schools' website, www.chps.net, lists products tested for schools; some of these may also be appropriate for homes.

Benefit:

Minimizing formaldehyde and volatile organic compounds in the home improves indoor air quality.

Stained concrete floor

M. Appliances and Lighting

1. Install Water- and Energy-Efficient Dishwasher

Description:

High efficiency dishwashers use less water and energy than conventional dishwashers. They reduce energy use by at least 25% compared to the federal minimum standards. Some dishwashers are more water efficient than others, even among ENERGY STAR®–qualified models. The most water-efficient models (which in general are also the most energy efficient) use 6.5 gallons or less per cycle in their normal setting, and less if run in the model's water-saving mode.

Application:

Select water- and energy-efficient dishwashers. They use an internal water heater to boost temperatures inside the dishwasher. This means that household water heaters can be turned down to 120°F, saving water-heating costs. To find models that use less than 6.5 gallons of water per cycle in their normal setting, see the Oregon Department of Energy website at: www.oregon.gov/ENERGY/CONS/RES/tax/appdish.shtml.

Benefit:

High efficiency dishwashers reduce water and energy use.

2. Install ENERGY STAR® Clothes Washing Machine

Description:

ENERGY STAR® clothes washing machines use 50% less energy and 45 to 60% less water while performing as well as a standard washer. To maximize water efficiency, choose models with a water factor rating of 6.0 or less and a modified energy factor of 2.0.

Application:

Most ENERGY STAR® washing machines save energy and water through a front-loading design (horizontal axis) that tumbles clothes in a small amount of water. Most models also include a high-speed final spin cycle that extracts more moisture than standard washers. Less moisture means less drying time, which saves additional energy. Find energy-saving models with a water factor rating of 6.0 or less and a modified energy factor of 2.0 at www.energystar.gov. Check with your local water utility for rebates on these types of machines.

Benefit:

ENERGY STAR®–qualified washing machines use substantially less water and energy than conventional washers.

3. Install ENERGY STAR® Refrigerator

Description:

Refrigerators and freezers are among the largest users of electricity in most homes. They can account for up to 25% of household energy use.

Horizontal axis washing machines

ENERGY STAR® refrigerators save at least 10% over the federal minimum standards. Larger refrigerators tend to use more energy than smaller models.

Application:

Select an ENERGY STAR®–qualified refrigerator that has less than 20 to 25 cubic feet of capacity (refrigerator and freezer). For a list of qualifying models, visit www.energystar.gov.

Benefit:

ENERGY STAR® refrigerators can reduce the total annual electricity bill by more than 10%. Choosing a refrigerator that's not too big will further reduce electricity costs.

4. Install Built-In Recycling and Composting Center

Description:

Recycling needs to be as easy as throwing out the garbage or many people won't do it. And composting must also be easy and odor-free. If you design the kitchen with enough space and dedicated bins for recycling and composting, it will be much easier for residents to keep recyclables and compostables out of the trash.

Application:

Install a built-in recycling area in the kitchen's base cabinets. Some waste haulers allow recyclables to be mixed, while others require that glass, paper, plastic or other materials be separated. Check local requirements and design the built-in recycling area accordingly.

Design a kitchen compost bin that is protected from pests and is odor-resistant. Food scraps can be added to a backyard compost pile, or in some cities can be set out at the curbside in a designated food scraps bin.

Benefit:

Recycling and composting reduces the amount of material entering landfills and can save money for homeowners through reduced disposal fees (many waste haulers charge a lower fee for smaller garbage bins). Composting creates high quality soil amendments useful in gardens.

5. Upgrade to Energy-Efficient Lighting

Description:

Lighting accounts for as much as 20% of the energy we use in our homes. In many homes, some areas don't have enough light, while other areas have too much light. Remodeling projects present the perfect opportunity for improving lighting so that it is more effective and energy efficient.

Application:

Wherever feasible, replace incandescent lights with fluorescent lights. Be sure to understand the lighting needs of that location (for example, general, task and spot lighting) and choose strategies to deliver appropriate lighting. Choose the best bulbs based upon lighting efficacy (lumens per watt), color rendering index (CRI) and temperature (Kelvin).

Title 24 sets energy-efficiency requirements for lighting; still, it can be challenging to design lighting for the home that is effective, efficient and attractive. Consider consulting a residential lighting expert for advice. For more information about energy-efficient residential lighting, including principles, definitions and design recommendations, visit the U.S. Department of Energy's website, www.eere.energy.gov/consumer.

Benefit:

Energy-efficient and effective lighting practices and products save energy and improve the quality of lighting in and around the home.

ENERGY STAR® qualified compact fluorescent lighting lasts up to eight times longer than incandescent lighting. Save $22 to $65 in energy costs over the life of a compact fluorescent bulb. You'll replace an incandescent eight times to match the life expectancy of a single compact fluorescent.

How do you choose the right compact fluorescent bulb? The following is a general guide to assist you:

Source: www.pge.com

Existing Incandescent Lamp	Proposed ENERGY STAR® Compact Fluorescent Bulb	Savings over the life of the bulb
40 - 60 watts	9 - 15 watts	$22 - $35
75 watts	18 - 20 watts	$43 +
90 - 100 watts	23 - 25 watts	$52 +

You will find the ENERGY STAR® label on products that exceed energy performance guidelines for energy efficiency. If all consumers, businesses, and organizations in the United States chose ENERGY STAR® products over the next decade, the national annual energy bill would be reduced by about $200 billion. For more information, visit www.energystar.gov.

6. Install Low-Mercury Fluorescent Lighting

Description:

All fluorescent light bulbs contain a small amount of mercury, an environmental toxin. Some manufacturers now offer fluorescent light bulbs in both linear tube and compact fluorescent styles that contain only a fraction of the mercury used in standard fluorescent lamps.

Application:

Choose fluorescent lamps with low mercury content. Look for manufacturer labels and literature that show that the light bulb complies with the U.S. EPA's Toxicity Characteristic Leach Performance (TCLP) test. Some manufacturers use green print on the bulb or green end-caps to signal that the product has a low mercury content.

Benefit:

Low-mercury fluorescent bulbs help keep mercury pollution out of the environment and our bodies. An added advantage to low-mercury bulbs that pass the TCLP test is that they are not considered hazardous waste so when they burn out they can go in the garbage rather than be disposed of at a hazardous waste facility.

7. Install Lighting Controls

Description:

Lighting controls include dimmers, occupancy sensors (also called motion sensors), photosensors and timers. They save energy by reducing light levels, or turning lights off in unoccupied areas or during times when lighting is not needed.

Application:

Install lighting controls either at specific locations or as a whole house system. Lighting controls are especially applicable for exterior uses.

An occupancy sensor turns on the light when it detects that a person has entered the area, and turns off the light after a preset period of time after the area is no longer occupied. Occupancy sensors make good sense in areas where there the occupancy is less regular such as utility rooms, bathrooms and outdoors. Photosensors can be used to automatically turn lights on at dusk and off at dawn; they're particularly useful for porch lights and when used in conjunction with an occupancy sensor. Dimmable compact fluorescent bulbs are available for interior use, although they cost more than regular compact fluorescent bulbs.

Benefit:

Lighting controls reduce energy use by decreasing the amount of time the lights are on.

Green Remodeling Ends with Green Maintenance

Whether you have just finished remodeling your home or are dreaming about getting started someday, how can you make sure that your home doesn't waste energy and resources and that it remains healthy year after year? Follow green maintenance practices.

With every operations and maintenance choice you make—whether it's replacing light bulbs or choosing new plants for the yard, ask yourself these questions: How will this choice affect the home's energy or water use? What natural resources will be used or wasted? How might this choice affect my family's or the community's health? And then ask: What can I do differently to contribute to a healthier environment and a healthier home?

Heating, Cooling and Electricity

We've been living in homes all our lives, but few of us are actually taught how to properly operate and maintain them for peak efficiency, longevity, comfort and health. Consider taking a class to learn about your home's operations. Also consider hiring a home performance contractor to test your home and recommend improvements.

In the summer, instead of automatically turning on the air conditioning when temperatures rise, keep the house cooler by blocking the sun at the windows with shades, solar screens or drapes. In the evening, open the windows and use the whole house fan to bring in cooler evening air.

In the winter, allow the sun to come through the windows and warm the home. In the evening, close the shades and drapes to reduce heat loss out of the windows.

When you have to resort to the air conditioning or heating system, set the air conditioner as high and the heater as low as is comfortable. Install a programmable thermostat or be diligent about manually adjusting the thermostat. Also, do not close off any supply registers and try to keep your interior doors open as much as possible to allow the system to circulate conditioned air everywhere.

Follow these additional recommendations:

- Put indoor and outdoor lights on timers and motion or photosensors.
- Check the HVAC system's air filter monthly and replace when dirty.
- Caulk and weatherstrip all the holes and seams of your home to reduce air leakage.
- Have your heating and cooling systems checked and maintained annually by a professional.
- Annually, pour a cup of hot water and 10% bleach solution down the air conditioning condensate drain pipe to keep it clear of mold and other contaminants.

Water

Save money and protect our future supply of water by implementing these practices:

- Take advantage of your local water district's free or rebated leak detection services, shower and faucet aerators, landscaping and water audits, and high efficiency toilets, dishwashers and clothes washers.
- Use dishwashers and clothes washers only when you have a full load and use the water/energy saving settings.
- Check regularly for leaks (especially in your toilets and irrigation system) and repair them promptly.
- Adjust your landscape watering schedule based on time of the year and the true needs of each of the planting beds. For more information, see Section C in these Guidelines.

Health and Safety

These recommendations will help make your home safer and healthier:

- Use healthier cleaning, pest control and landscaping products and employ professionals who share that philosophy. Take chemicals you no longer need to a household hazardous waste facility.
- Remove shoes before entering your home, because as much as half of the dirt in a home comes in on our shoes.
- Run your kitchen range hood and bathrooms fans to exhaust odors, humidity and combustion gases.
- Install smoke and carbon monoxide alarms by the kitchen and bedrooms. Check the batteries annually and replace the alarms every five years.
- Install a fire extinguisher within easy reach of the kitchen stove.

Durability

Good maintenance will keep up your home's health and longevity, so use the following tips:

- Clean out gutters and downspouts annually. During and after rains, make sure water flows away from the home.
- Check caulking and flashing around windows, doors and siding every few years.
- Quickly address leaks and other maintenance issues before further, potentially expensive damage occurs.

N. Other

1. Incorporate Green Remodeling Checklist in Blueprints

Description:

The Green Remodeling Checklist (see Chapter Two) provides remodeling contractors and homeowners with an easy way to assess how green their remodeling project is. Attaching the checklist to the blueprints makes it easier for everyone involved—including the building professionals, homeowner and municipality—to see which green features are included in the remodeling project.

Application:

In one of the first few pages of the project blueprints, include the Green Remodeling Checklist, with the applicable points checked off. To make it easier to verify the project's achievements, next to each item on the checklist note the blueprint page number that corresponds to that particular item and make an obvious note on that blueprint page.

Benefit:

Including the Green Remodeling Checklist in the blueprints raises the visibility of green building. This may encourage contractors to incorporate more green features. It also provides a quick reference and benchmark for the builder, homeowner and municipality.

2. Develop Homeowner Manual of Green Features and Benefits

Description:

A green homeowner manual describes all of the home's green features and their benefits. It also gives important information about best practices for maintaining and operating the home.

Application:

Develop a green homeowner manual. A comprehensive manual for a whole house should include the information listed below; remodeling projects that are smaller in scope might contain more limited information:

- description of the home's green building features
- explanation of importance of maintenance and operations to achieve ongoing green building benefits
- warranty, operation and maintenance instructions for equipment and appliances
- household recycling opportunities
- ways to optimize water and energy use
- ways to maintain good indoor air quality
- clear labeling of safety valves and controls for major house systems
- information about periodically checking foundation and crawl space for termite tubes and about nontoxic pest control methods
- information on environmentally sound landscape maintenance and healthier home cleaning products
- instructions for proper handling and disposal of hazardous chemicals

Benefit:

Including the Green Remodeling Checklist in the blueprints raises the visibility of green building. This may encourage contractors to incorporate more green features. It also provides a quick reference and benchmark for the builder, homeowner and municipality.

3. Innovation

Description:

The measures in these Guidelines are not an exhaustive list of all the green elements that could be incorporated into your remodeling project. Rather, they are a list of field-tested options that are more likely to be used in typical remodeling projects. Look for opportunities to go beyond these measures and incorporate innovative techniques and materials that will conserve natural resources and improve the home's energy efficiency, durability and healthfulness.

Chapter Four:

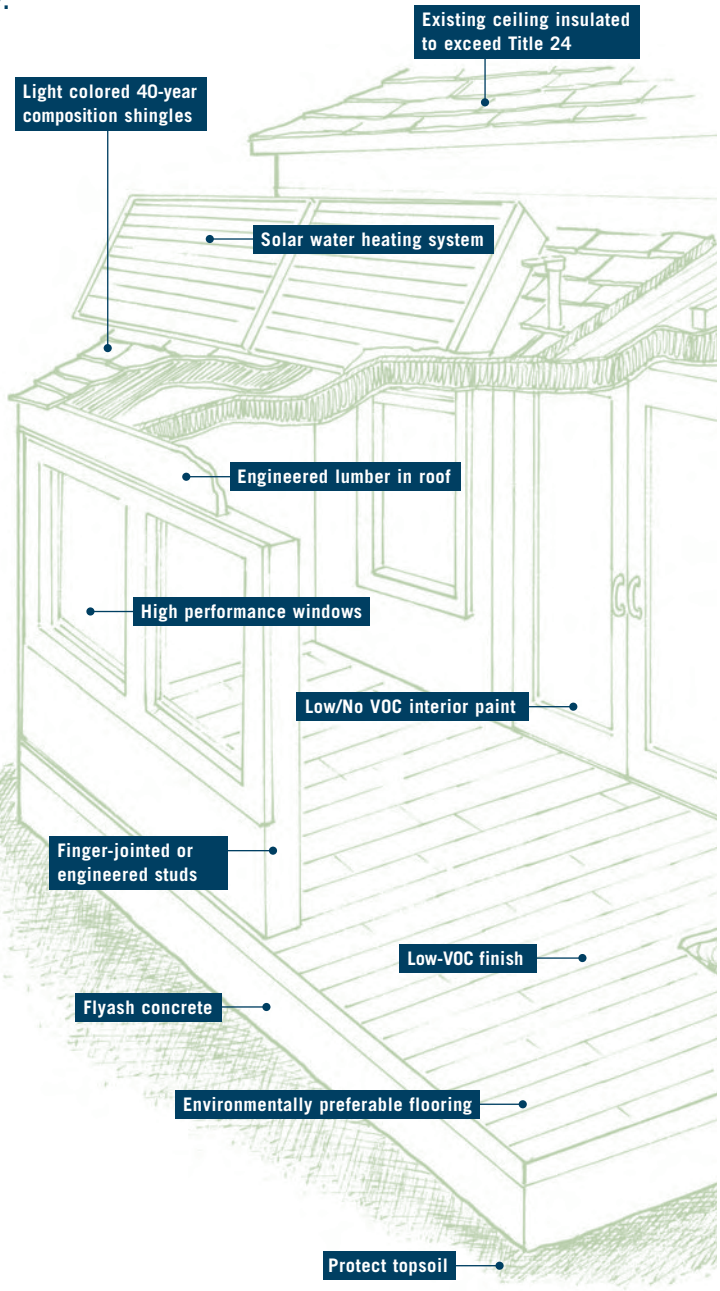
Green Remodeling Illustrations

"We believe that homeowners deserve a home that is not only beautiful, but one that is more energy-efficient, comfortable and healthier for the family."

—Fred Brecht, Brecht Construction, Lafayette, CA

Addition or Major Remodel

Consider these green remodeling options when building an addition or renovating a major portion of the home.



Site

- Protect Existing Topsoil and Minimize Disruption of Existing Plants and Trees
- Deconstruct Instead of Demolish
- Recycle Construction and Demolition Waste

Foundation

- Replace Portland Cement in Concrete with Recycled Flyash or Slag
- Retrofit Crawl Space to Control Moisture
- Design and Build Structural Pest Controls

Landscape

- Construct Resource-Efficient Landscapes
- Use Fire-Safe Landscaping Techniques
- Minimize Turf
- Plant Shade Trees
- Group Plants by Water Needs (Hydrozoning)
- Install High Efficiency Irrigation Systems
- Add Compost to Promote Healthy Topsoil
- Use Salvaged or Recycled-Content Materials for Landscape Elements
- Reduce Light Pollution
- Collect and Retain Rainwater for Irrigation

Structural Frame

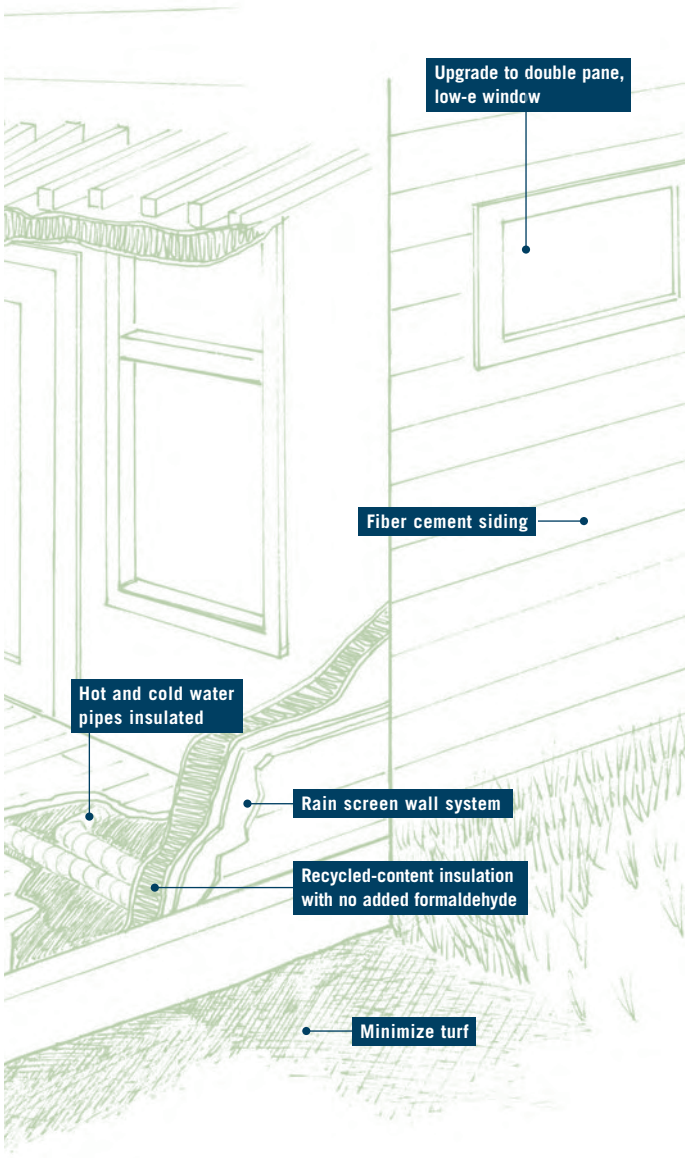
- Apply Optimal Value Engineering
- Use Engineered Lumber
- Use FSC-Certified Wood
- Design Energy Heels on Roof Trusses
- Use Solid Wall Systems
- Install Reflective Roof and Radiant Barrier
- Replace Single-Pane Windows with Double-Pane Windows
- Retrofit with Storm Windows
- Install Low-SHGC Window Film on Single-Pane Windows
- Retrofit Structure for Earthquakes
- Reduce Pollution Entering the Home from the Garage

Exterior Finish

- Use Recycled-Content or FSC-Certified Decking
- Install Rain Screen Wall System
- Use Durable and Noncombustible Siding Materials
- Use Durable and Noncombustible Roofing Materials

Plumbing

- Choose High Efficiency Water Heaters
- Distribute Domestic Hot Water Efficiently
- Replace Toilets with High Efficiency Toilets
- Install Water-Efficient Faucets and Showerheads



Heating, Ventilation and Air Conditioning

- Design and Install HVAC System to ACCA Recommendations
- Install High Efficiency Heating System
- Install High Efficiency Air Conditioning with Environmentally Responsible Refrigerants
- Install Effective Ductwork
- Install High Efficiency HVAC Filter
- Retrofit Wood-Burning Fireplaces to Improve Energy Efficiency and Air Quality
- Install Whole House Fan, Ceiling Fans or Air-to-Air Heat Exchanger for Ventilation
- Install Effective Exhaust Systems in Bathrooms and Kitchen

Renewable Energy

- Install Solar Water Heating System
- Install Photovoltaic (PV) System

Insulation

- Install Recycled-Content Insulation
- Install Insulation That Emits Zero/Low Levels of Formaldehyde and VOCs
- Weatherize the Home
- Upgrade Insulation to Exceed Current Title 24 Requirements

Building Performance

- Conduct Whole House Inspection/ Diagnostic Testing and Make Improvements

Finishes

- Design Entryways to Reduce Tracked-In Contaminants
- Use Low/Zero-VOC Interior Paint
- Use Low-VOC, Water-Based Wood Finishes
- Use Low-VOC Construction Adhesives
- Use Recycled-Content Paint
- Use Environmentally Preferable Materials for Interior Finishes
- Reduce Formaldehyde in Interior Finishes
- Use Environmentally Preferable Flooring

Appliances

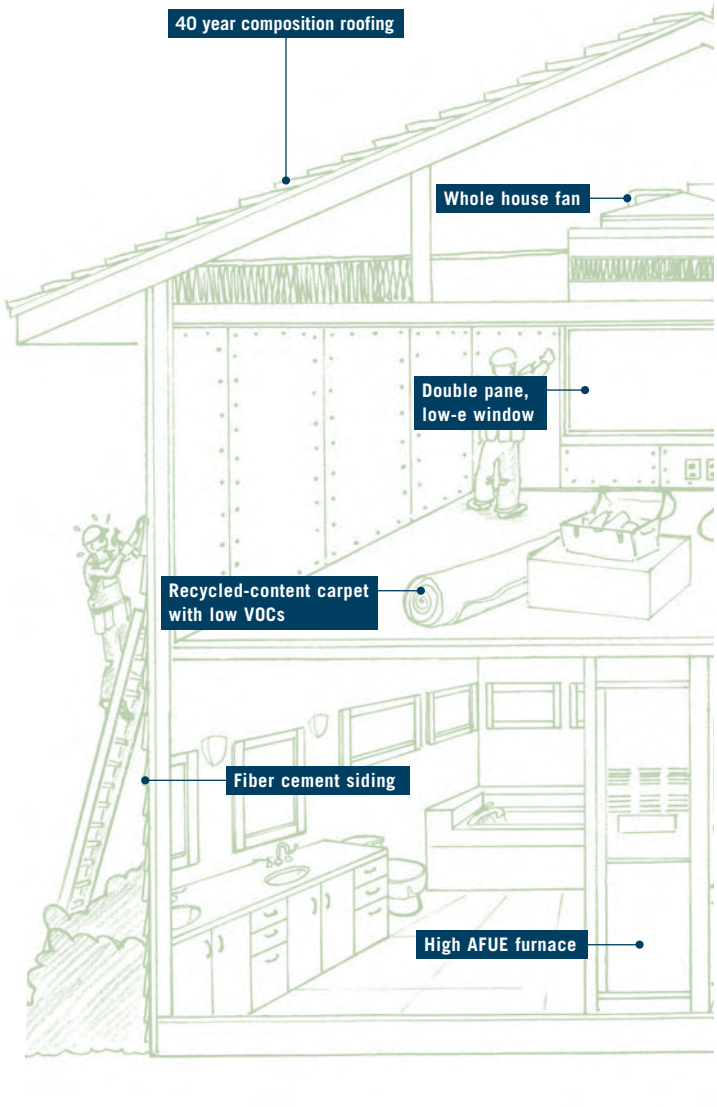
- Install Water- and Energy-Efficient Dishwasher
- Install ENERGY STAR® Clothes Washing Machine
- Install ENERGY STAR® Refrigerator
- Install Built-In Recycling and Composting Center
- Upgrade to Energy-Efficient Lighting
- Install Low-Mercury Fluorescent Lighting
- Install Lighting Controls

Other

- Incorporate Green Remodeling Checklist in Blueprints
- Develop Homeowner Manual of Green Features and Benefits

Second Floor

Consider these green remodeling options in a second floor addition.



Site

- Deconstruct Instead of Demolish
- Recycle Construction and Demolition Waste

Structural Frame

- Apply Optimal Value Engineering
- Use Engineered Lumber
- Use FSC-Certified Wood
- Design Energy Heels on Roof Trusses
- Install Reflective Roof and Radiant Barrier
- Replace Single-Pane Windows with Double-Pane Windows
- Retrofit with Storm Windows
- Install Low-SHGC Window Film on Single-Pane Windows
- Retrofit Structure for Earthquakes

Exterior Finish

- Install Rain Screen Wall System
- Use Durable and Noncombustible Siding Materials
- Use Durable and Noncombustible Roofing Materials

Plumbing

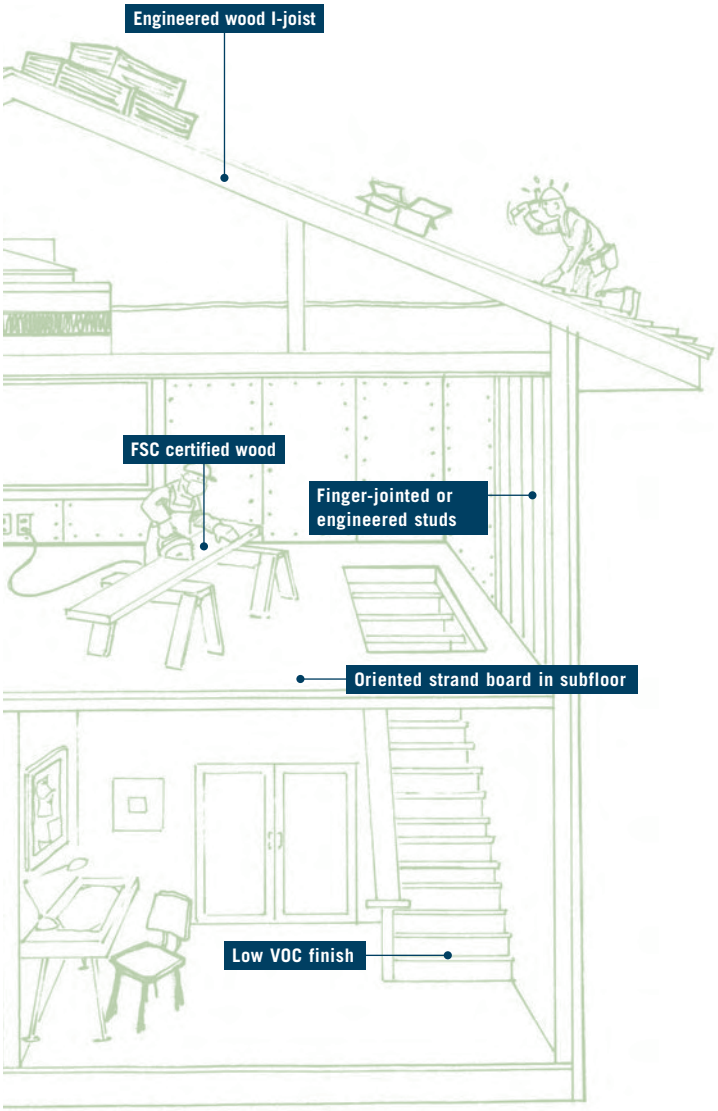
- Choose High Efficiency Water Heaters
- Distribute Domestic Hot Water Efficiently

Heating, Ventilation and Air Conditioning

- Design and Install HVAC System to ACCA Recommendations
- Install High Efficiency Heating System
- Install High Efficiency Air Conditioning with Environmentally Responsible Refrigerants
- Install Effective Ductwork
- Install High Efficiency HVAC Filter
- Retrofit Wood-Burning Fireplaces to Improve Energy Efficiency and Air Quality
- Install Mechanical Ventilation System for Cooling

Renewable Energy

- Install Solar Water Heating System
- Install Photovoltaic (PV) System



Insulation

- Install Recycled-Content Insulation
- Install Insulation That Emits Zero/Low Levels of Formaldehyde and VOCs
- Weatherize the Home
- Upgrade Insulation to Exceed Current Title 24 Requirements

Building Performance

- Conduct Whole House Inspection/ Diagnostic Testing and Make Improvements

Finishes

- Use Low/Zero-VOC Interior Paint
- Use Low-VOC, Water-Based Wood Finishes
- Use Low-VOC Construction Adhesives
- Use Environmentally Preferable Materials for Interior Finishes
- Reduce Formaldehyde in Interior Finishes
- Use Environmentally Preferable Flooring

Appliances

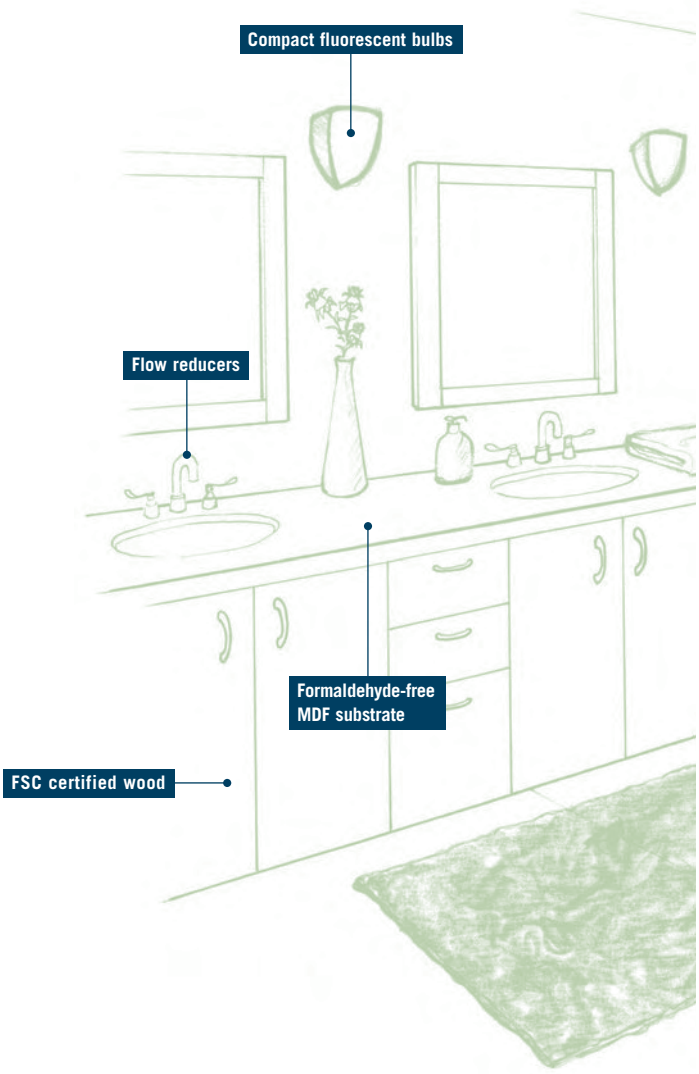
- Install ENERGY STAR® Clothes Washing Machine
- Upgrade to Energy-Efficient Lighting
- Install Low-Mercury Fluorescent Lighting
- Install Lighting Controls

Other

- Incorporate Green Remodeling Checklist in Blueprints
- Develop Homeowner Manual of Green Features and Benefits

Bathroom Remodel

Consider these green remodeling options in a bathroom.



Site

- Deconstruct Instead of Demolish
- Recycle Construction and Demolition Waste

Structural Frame and Building Envelope

- Apply Optimal Value Engineering
- Use Engineered Lumber
- Use FSC-Certified Wood
- Replace Single-Pane Windows with Double-Pane Windows
- Retrofit with Storm Windows
- Install Low-SHGC Window Film on Single-Pane Windows

Plumbing

- Choose High Efficiency Water Heaters
- Distribute Domestic Hot Water Efficiently
- Replace Toilets with High Efficiency Toilets
- Install Water-Efficient Faucets and Showerheads

Heating, Ventilation and Air Conditioning

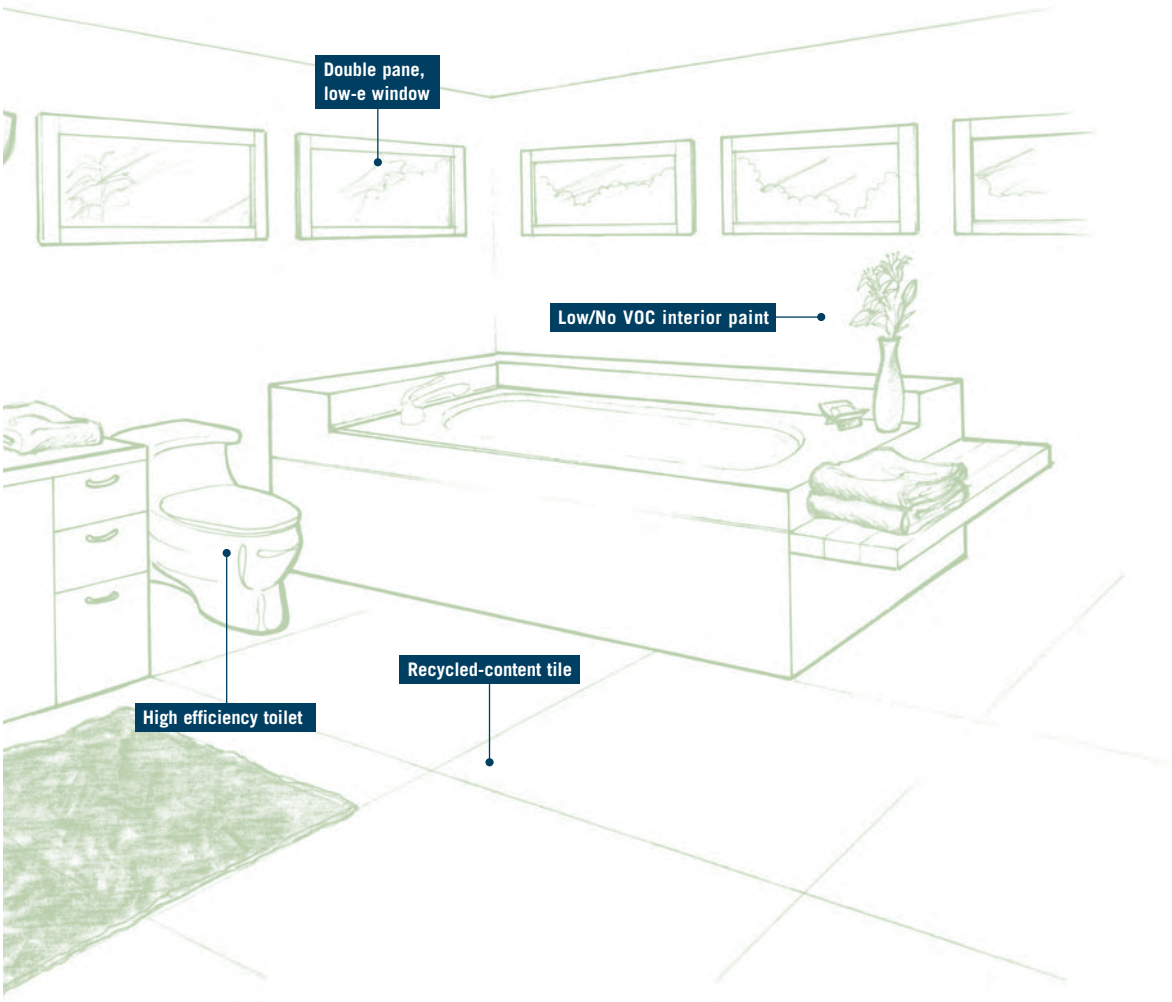
- Install Effective Ductwork
- Install Effective Exhaust System

Insulation

- Install Recycled-Content Insulation
- Install Insulation That Emits Zero or Low Levels of Formaldehyde and VOCs
- Weatherize
- Upgrade Insulation to Exceed Current Title 24 Requirements

Finishes

- Use Low/No-VOC Interior Paint
- Use Low-VOC, Water-Based Wood Finishes
- Use Low-VOC Construction Adhesives
- Use Environmentally Preferable Materials for Interior Finishes
- Use Environmentally Preferable Flooring



Appliances

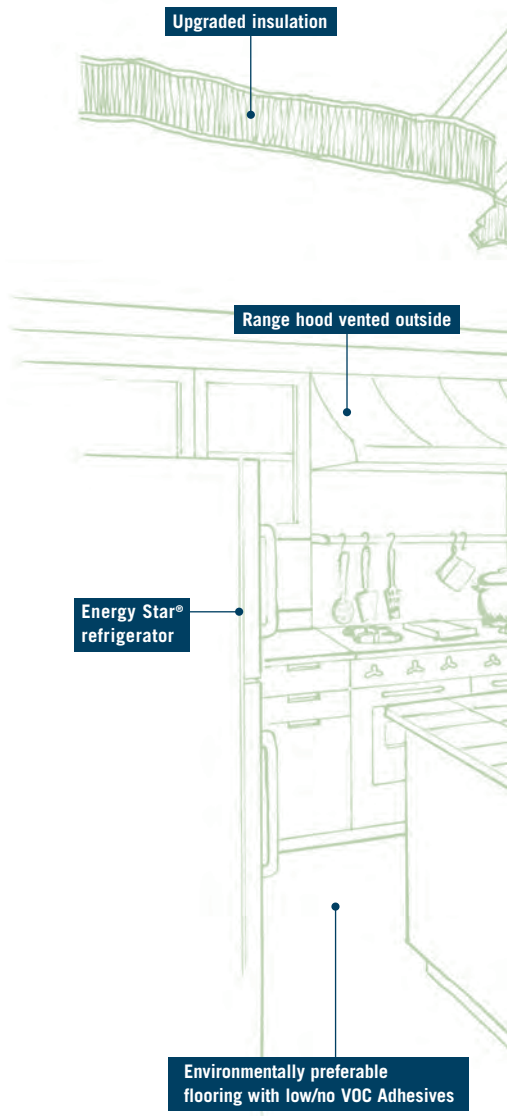
- Install ENERGY STAR® Clothes Washing Machine
- Upgrade to Energy-Efficient Lighting
- Install Low-Mercury Fluorescent Lighting
- Install Lighting Controls

Other

- Incorporate Green Remodeling Checklist in Blueprints
- Remodel for Universal Design

Kitchen Remodel

Consider these green remodeling options in a kitchen.



Site

- Deconstruct Instead of Demolish
- Recycle Construction and Demolition Waste

Landscape

- Plant Shade Trees on West and South Sides

Structural Frame and Building Envelope

- Replace Single-Pane Windows with Double-Pane Windows
- Retrofit with Storm Windows
- Install Low-SHGC Window Film on Single-Pane Windows

Plumbing

- Distribute Domestic Hot Water Efficiently
- Install Water-Efficient Faucets

Heating, Ventilation and Air Conditioning

- Install Effective Exhaust System
- Install Mechanical Ventilation System for Cooling

Insulation

- Install Recycled-Content Insulation
- Install Insulation That Emits Zero or Low Levels of Formaldehyde and VOCs
- Weatherize
- Upgrade Insulation to Exceed Current Title 24 Requirements

Building Performance

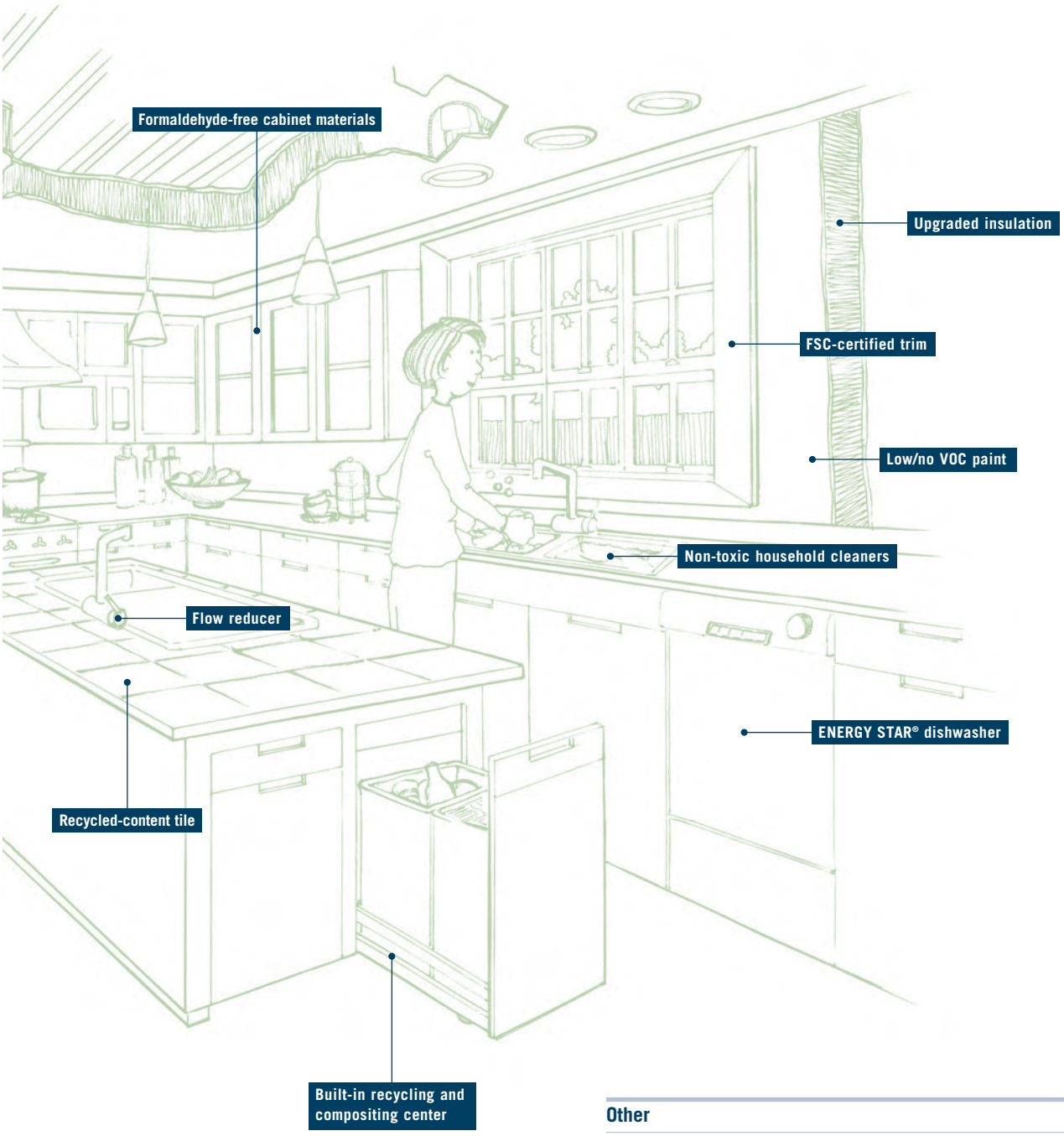
- Conduct Whole House Inspection/ Diagnostic Testing and Make Improvements

Finishes

- Design Entryways to Reduce Tracked-In Contaminants
- Use Low/No-VOC Interior Paint
- Use Low-VOC, Water-Based Wood Finishes
- Use Low-VOC Construction Adhesives
- Use Environmentally Preferable Materials for Interior Finishes
- Use Environmentally Preferable Flooring

Appliances

- Install Water- and Energy-Efficient Dishwasher
- Install ENERGY STAR® Clothes Washing Machine
- Install ENERGY STAR® Refrigerator
- Install Built-In Recycling and Composting Center
- Upgrade to Energy-Efficient Lighting
- Install Low-Mercury Fluorescent Lighting
- Install Lighting Controls



Other

- Incorporate Green Remodeling Checklist in Blueprints
- Develop Homeowner Manual of Green Features and Benefits

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Build It Green™

Smart Solutions From The Ground Up