KING COUNTY DEPARTMENT OF
LOCAL SERVICES, PERMITTING DIVISION

King County Green Building Handbook

King County
Department of
Natural Resources and Parks
Solid Waste Division

King County Green Building Handbook

Provided by the Department of Local Services, Permitting Division

Acknowledgments

The King County Green Building Handbook was prepared in 2015 and updated in 2024 by the Department of Local Services (DLS), Permitting Division, in partnership with the Department of Natural Resources and Parks (DNRP). The Handbook would not have been possible without the leadership of King County Executive Dow Constantine and reflects the goals and directives of the King County Green Building Ordinance and Strategic Climate Action Plan.

Updates to the Handbook were led by Nicole Sanders (DLS, Permitting), Kathleen Petrie (DNRP, SWD, GreenTools), Kim Barker (DLS, Permitting), and Kinley Deller (DNRP, SWD, GreenTools).

Consultant assistance was led by Säzän Group, along with their team of sub consultants: Site Story, Design2Last, RE-USE Consulting, Herrera, and Sphere Solar Energy.

Sarah St. George (DNRP, SWD Communications) produced the graphic layout of the updated Handbook.

The outreach plan and implementation were provided by Stepherson & Associates Communications, Timothy Randazzo (DNRP), and Nha Khuc, (DNRP).

The team behind the Handbook is very appreciative for the many contributions by King County staff across multiple departments and divisions who reviewed and provided technical content, as well as our many external subject matter experts.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

Introduction

Whether you are building new, remodeling, or just replacing a broken system, green building can save you money, protect your health, contribute to your community, and preserve King County's great natural resources as well as resources that are imported to manufacture building materials. The King County Green Building Handbook is your guide to ways you can increase efficiency in your project and reap rewards.

The Green Building Handbook is comprised of a series of green building strategies called "Green Sheets." Whether you are replacing an appliance, remodeling your existing home, or building a new home, these Green Sheets will help you make healthier and potentially cost-saving decisions that will benefit you and your family as well as the planet. Each Green Sheet identifies a topic (such as insulation), and explains when a strategy applies, the benefits of "making it green", costs, and provides guidance and resources to help you implement it. This handbook is also beneficial in the following ways:

- Lowering the cost of operating and maintaining your home.
- Protecting air quality and health in your home and community.
- Supporting regional green businesses and local jobs.
- Keeping local services like drinking water and our energy supply available and reliable.
- Protecting natural resources and the global environment.
- Adding features that can increase the long-term value of your home and its resale potential

DPER GREEN BUILDING HANDBOOK | BUILDING ENVELOPE

Advanced Framing

Overview

The majority of homes in King County are built using lightweight wood framing, often referred to as "stick built." Advanced framing is a tried and tested approach to stick framing that allows you to do more with less – more performance with less wood. By using standardized dimensions and optimizing the layout and alignment of the joists, studs and trusses, you can build a structurally-sound, code-compliant building that uses less wood, takes less labor to build it, and leaves more space in the walls for insulation to save energy and keep you comfortable.

Definitions

Advanced Framing
Wall studs, floor joists, and rafters framed 24 inches apart (instead of the typical 16"), both reducing the amount of lumber used and waste generated, as well as creating more space for insulation, which increases a home's energy efficiency.

Thermal bridging
Heat loss through the wall or roofs where wood studs or other materials cause breaks or reductions in the amount of insulation.

When is This Applicable?

The advanced framing technique can be used in most one- and two- story buildings and additions. On taller buildings it may be applicable for the top two stories only, unless a licensed engineer is involved in the framing design. The Washington State Residential Code includes standard, code-approved advanced framing options (Chapter 6 and Table R602.3 (5) for walls and Chapter 8 for ceilings and roofs).

This framing detail from the U.S. Department of Energy demonstrates shows the use of advanced framing spacing in a two-story structure.

What Makes it Green?

Advanced framing is a win-win technique. It lowers construction cost, resource consumption, and pollution while contributing to a comfortable, more efficient home. Here are some reasons why:

- Advanced framing is environmentally friendly because it reduces the amount of lumber used and waste generated in the construction of a wood-framed house.
- With fewer nails to pound and cuts to make, framers experienced with advanced framing find it saves time and money and reduces waste.
- With wider spacing between studs, and different stud layouts at openings, corners and wall intersections, and features like raised heel trusses, advanced framing allows for more insulation in the walls and ceiling and reduces thermal bridging.
- This increase in insulation and reduced thermal bridging means the walls and ceiling have a more even temperature across the surface to help make your house more comfortable and efficient.
- Reduced energy use for heating reduces utility bills, environmental impacts and air pollution from producing power or burning fossil fuels needed to heat and cool your home.

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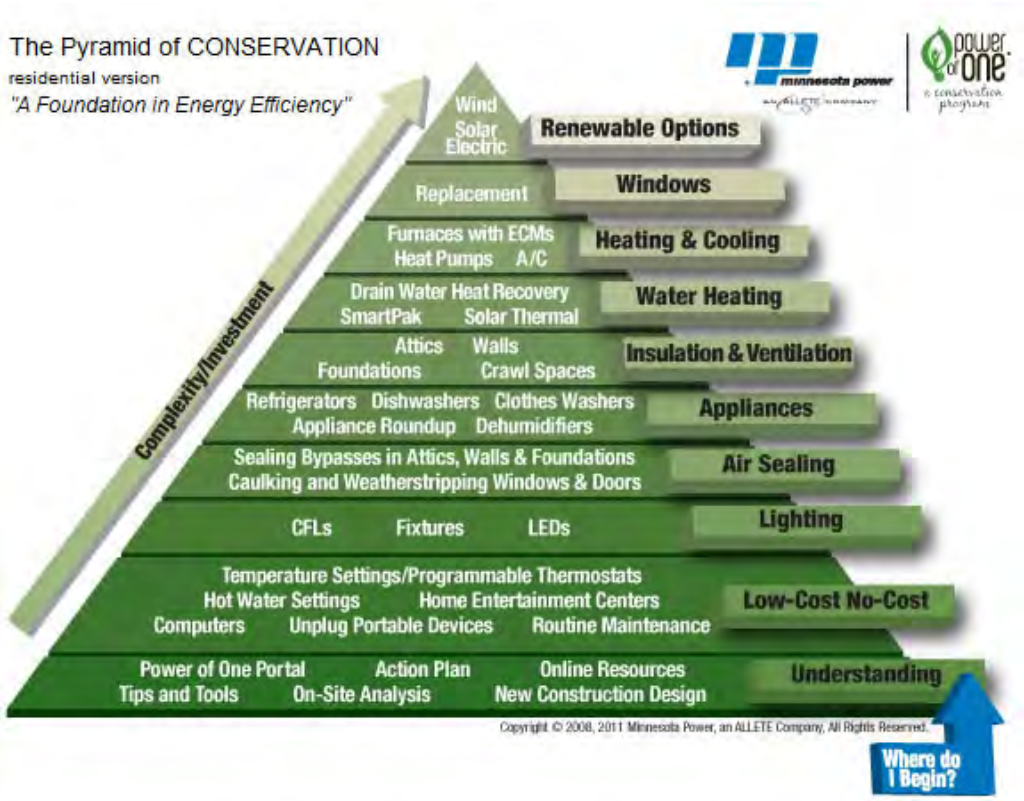
Green Sheets also help identify important County code and permitting requirements, incentives and rebates that may be offered through local utilities.

In addition, use the following resources to help provide funding or guide remodeling and retrofit decisions that support elderly family members, veterans and people living with disabilities:

- United Design Services Foundation
- Care Connection
- Veterans At Home
- Senior Veteran's Grants
- King County Housing Repair

Using Green Sheets to Help with Your Project

The Green Building Handbook is comprised of over 20 Green Sheets designed to help prioritize project decisions. A good example of this important tactic is when you are making your home more energy efficient. The *Pyramid of Conservation* emphasizes a suggested hierarchy for upgrades to a home (start at the base of the pyramid). For example, before you invest in new heating equipment, consider simple low-cost measures to make your home easier to heat and cool like having ducts sealed or sealing around windows and electrical outlets. Leaky buildings require bigger heating and cooling systems to stay comfortable and are more likely to have problems with drafts and mold. Hiring a home professional to test for air-tightness can help you understand how leaky your home is for a few hundred dollars may save you from investing thousands on an over-sized heating system. Investigating the less-complex, lower-cost steps of any project ensures you have achieved the best value for any investment. As a general rule, first gather information to understand the costs and benefits of a building project, then investigate the less-complex, lower-cost steps first.



Simple, low-cost measures are the first step to save energy in your home or business. Do these first before investing in more complex, higher-cost system or changes to the building. *Source: Minnesota Power*

Each Green Sheet also provides incentives and rebates where available, so talk with your local utility when making these decisions since many utility companies offer incentives and cost offsets to encourage green home upgrades.

Here in the Pacific Northwest we have an excellent education source for residential workshops and classes with the Northwest EcoBuilding Guild. The Guild is a non-profit community-based organization of builders, designers, suppliers, homeowners, and partners concerned with ecological building in the Pacific Northwest. The Guild empowers people through education to transform the built environment for long term sustainability.

For some do-it-yourself home projects you may need special equipment. Rather than purchase these tools that you may only use once, we recommend you search the many tool libraries located in King County.

Built Green hosts the Eco-Cool Remodel Tool which allows you navigate all the different rooms of a single family residence, select the various icons in order to view tips on remodeling green – many of which are demonstrated in these Green Sheets.

Green Sheets can be referenced individually such as in the replacement or new purchase of an appliance. Multiple sheets can also be bundled together like a series of ingredients creating a comprehensive recipe of success on certain types of projects. For example, building a new addition or home might benefit from the use of several sheets since strategies can build on or connect with one another.

The following matrix shows ideas for how certain Green Sheets can be bundled together:

	Envelope: Keeping the Outside Out and the Inside In	Site and Landscaping	Heating and Cooling Your Home	Materials: How to Select, Use and Manage Them	Energy & Water Equipment, Fixtures, and Appliances	How to Convert to Electric
Green Building Handbook Introduction						
Where to Start						
Hiring the Best Professional for Your Project						
Green Products and Building Components						
Routine Home & Yard Maintenance						
Landscaping Elements & Surfaces						
Amended Soils						
Permeable Surfaces, Walkways, & Driveways						
Rain Barrels, Cisterns, & Rain Gardens						
Building Envelope						
Insulation						
Advanced Framing						
Roofing Materials						
Indoor Water Systems						
Efficient Water Heating						
Toilets, Showers & Faucets						
Heating & Cooling Systems						
Air Sealing Your Home						
Duct Sealing						
Fresh Air Ventilation						
Heat Pumps and Efficient Heating and Cooling Systems						
Thermostats						
Passive Solar						
Solar Energy						
Appliances						
High Efficiency Appliances						
Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces						
Material Management						
Construction & Demolition (C&D) Materials Management						
Deconstruction and Reuse						

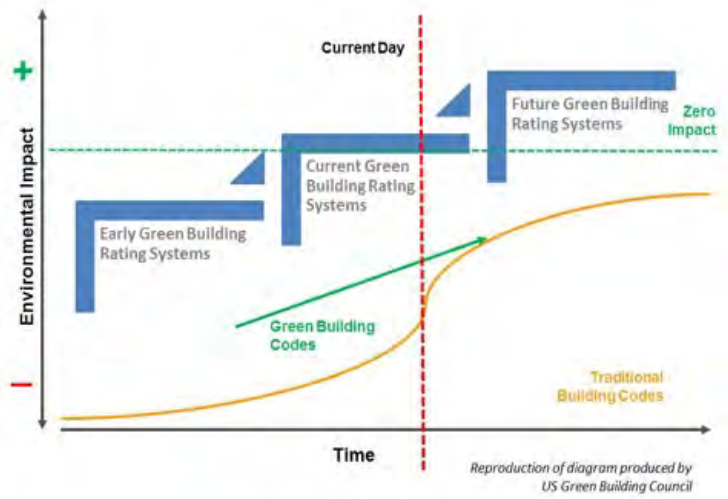
How Green Codes and Green Building Rating Systems Relate to this Handbook

The King County Strategic Action Plan goals include growing vibrant, thriving and sustainable communities, as well as safeguarding and enhancing King County's natural resources and environment. Green building is a key way that all buildings, including your project, can contribute to achieving these goals.

The County's commitment to these goals is reflected in green building requirements in our local building, energy, stormwater, and plumbing codes. Increasingly, national and international code agencies that set guidelines for local jurisdictions understand there is a critical link between the fundamental life safety purpose of codes and the necessity to build in a way that doesn't put our built environment and the people that it serves at greater risk. Ecological building practices can significantly reduce negative impacts from air or water pollution, interruption of important services from natural disasters, and enhance our climate change resilience. This knowledge has led to a growth of green building codes that set a higher baseline of what is safe, healthy, and responsible when building. King County's green codes, which are designed to safeguard human health, sustain regional energy and water systems, and protect our natural resources, are a great example.

Green building rating systems help demonstrate and quantify the benefits of stretching beyond green codes and set up structures to reward and support those that commit to construction and building practices that exceed code expectations.

King County's Green Building Ordinance requires most King County-funded projects to achieve the highest level of recognition available in an applicable green building rating system. While this doesn't apply directly to your home, the combination of green codes, use of green building rating systems, and leadership by municipalities like King County will make it easier to build green and will lessen the impact of the built environment, reduce risk, and increase our community's resiliency.



Traditional building codes, green codes and green building rating systems work together to lessen the impact of the built environment, reduce risk, and increase our community's resiliency.

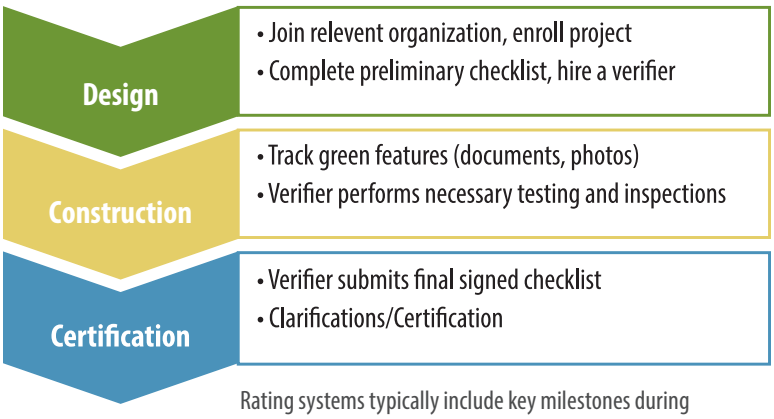
By using this handbook, you will better understand how you can capture additional financial, health, and environmental benefits from incorporating these green strategies into the "recipe" for your project, and where those strategies contribute to certification in green building rating systems if you choose to pursue that.

Choosing and Using Green Building Rating Systems

Many of the green building methods described in the Green Building Handbook will actually help toward achieving a green building certification if you chose to do so. There are currently about a half-dozen green building rating systems to select from (detailed below). The first question, however, is why certify your project at all? There are three key benefits to using a green building rating system:

- **Information and Accountability.** The first reason is the information and support available through the program. This can be as simple as reading the rating system checklist to get a broad view of strategies or measures that might be right for your project, up through registering your project to pursue certification and having the advantage of a third-party verifier who ensures that the measures you chose were implemented. Third-party verification is required in most rating systems and comes at an additional cost, however, third-party verification can be particularly valuable if you are hiring a contractor who may or may not be familiar with all the green strategies you or your designer selected.
- **Property Valuation.** The second is to strengthen your property value whether you are planning to sell soon or hold for the long-term. The Multiple Listing Service (MLS) now includes information about green building certifications in their data about properties and many buyers in the Northwest consider green properties more desirable. Even during recent economic downturns, green residential properties had higher average valuations.
- **Project Goal Reassurance**. The third is that working with a certification team can evoke a greater sense of confidence that your project achieved the green building goals you identified from the beginning.

So what is involved with certification? The following graphic depicts typical tasks necessary to meet the requirements of most green building rating systems.



Rating systems typically include key milestones during design, construction, and certification, as shown here.

The following table describes the most applicable green building rating systems for your project :

BUILT GREEN	**Built Green®** Built Green is an environmentally-friendly, non-profit, residential building program of the Master Builders Association of King and Snohomish Counties. The program certifies new single family buildings and retrofits to the 3, 4, 5-star and Emerald level based on scoring points across a broad range of environmental categories.
ENERGY STAR	**ENERGYSTAR®** The ENERGY STAR Residential New Construction Program is a regional initiative intended to promote the construction of energy efficient homes using the guidelines set forth by the Environmental Protection Agency (EPA). .
LEED FOR HOMES	**LEED® for Homes** Leadership in Energy & Environmental Design (LEED) is a green building certification program that recognizes best-in-class building strategies and practices. LEED for Homes projects satisfy prerequisites and earn points to achieve Certified, Silver, Gold or Platinum levels of certification.
LIVING BUILDING CHALLENGE	**Living Building Challenge™ or Zero Energy™** The International Living Future institute offers a suite of building certifications. Living Building Challenge (LBC) Certification defines the most advanced measure of sustainability available today. The Challenge is comprised of seven performance categories with total of twenty imperatives that must be met. Zero Energy Certification is awarded to projects that prove to be highly efficient buildings that rely only on clean energy, without onsite combustion of fossil fuels.
PHIUS Passive House Institute US	**Passive House** Passive House is the world's leading standard for energy efficient construction. It combines building enclosure efficiency and passive solar strategies in a system for designing and building cost effective, comfortable, energy efficient buildings.
SALMON SAFE	**Salmon-Safe** Salmon-Safe is a certification program that aims to protect water quality and restore habitat. Although single family projects are not eligible for Salmon-Safe Certification, the tactics can be replicated on your home project.
CERTIFIED WILDLIFE HABITAT	**Habitat at Home** A habitat is a combination of four elements: food, water, shelter, and space to raise young and survive. If your garden or outdoor space provides these elements and you participate in sustainable practices, such as using native plants or reducing pesticide use, then you could be eligible for the Habitat at Home Certification.

Hiring the Best Professional for Your Project

Overview

Incorporating green building materials, appliances, and methods in your home retrofit can improve building efficiency, performance, and indoor air quality - not to mention reducing your energy bills! Green retrofits can include everything from adding insulation, installing more efficient plumbing fixtures, sealing air ducts, to replacing your heating/cooling system.

Hiring a designer, architect, and/or contractor, or team of professionals who are knowledgeable in green building practices and share your project goals is an important first step.

What Makes It Green

Green retrofits reduce water and energy costs and add value to your property. Using green products drives demand and contributes to green jobs. Green retrofits benefit our living environments by increasing indoor health and reducing emissions. Taking green retrofit steps and using green building materials improve the efficiency, comfort and health of your home.

Best Practices

A good place to start may be scheduling a professional to conduct an energy audit on your home that will evaluate current heating and cooling losses in the house and identify which energy improvements to your home will be most beneficial. Sealing gaps and cracks around window and door frames, adding insulation to your attic, replacing single-pane windows with double-pane windows, and installing a high-performance HVAC system are all ways to make your home more energy-efficient. Replacing old water heaters, repairing leaky plumbing fixtures, and insulating hot water pipes can reduce your water usage and ultimately your monthly bills. Using paints and stains with low VOCs, using wood with no added urea formaldehyde, and flooring made from natural materials will reduce indoor air pollutants and contribute to better health for your family.

Seek out professionals who have educated themselves or have experience in green building practices, particularly any professionals that have green credentials. Make sure the professionals you choose understand your goals for the project and that you can all speak easily together around finding green solutions. Your architect or designer may be able to recommend contractors experienced in green building methods. If applicable, ensure your contractor hires subcontractors that also have green building certifications or experience. Design-build-contractors may have all these disciplines under one roof.

These are some common qualifications to look for in a green building contractor:

- Having a degree or certificate involving courses in sustainable building methods and techniques
- A portfolio they can share of previous jobs or projects involving green building practices
- Accreditations or credentials in green building such as LEED AP/Green Associate, WELL Accredited Professional, Certified Green Professionals (CGP), Expert Passive House Designer, Sustainable Homes Professional
- Look for professionals who are members of green building organizations such as the Northwest EcoBuilding Guild, Built Green, or USGBC.

In addition to checking for green qualifications, don't forget to gather basic information as a part of your due diligence:

- Get a contractor involved early in the process
- Check the contractor's listing with the Better Business Bureau in your area (BBB);
- Ask for a copy of their business license;
- Check if they have current insurance and the proper coverage amount;
- Check local references;
- Review draft contracts in advance and ask lots of questions; and
- Request a written estimate.

Cost Information / Incentives

Although it is time-consuming, it is always recommended to talk to a minimum of three contractors to get price comparisons or bids. Be sure to include any green features that interest you in initial conversations. If a contractor tries to direct you away from green project ideas, then write down their specific concerns and note them in conversation with other contractors. Discussing the project with several professionals may help explain whether the concerns apply to your specific situation, or whether the contractor may be trying to steer you towards alternatives with which they are more familiar, more comfortable, or more profitable for them.

There may be multiple types of incentives – please see the applicable Green Sheet in the Green Building Handbook for your project type and scope.

Permit Tips

Most contractors will help you get permits for your projects, such as replacing HVAC equipment or roof replacement.

Incentives

There are a range of incentives that might be available depending on your project type and scope. Refer to other Green Building Handbook Green Sheets for available project-specific incentives,and be sure to check with utilities that provide services to your project site.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Advanced Framing
- Air Sealing Your Home
- Construction & Demolition (C&D) Materials Management
- Deconstruction and Reuse
- Duct Sealing
- Efficient Water Heating
- Fresh Air Ventilation
- Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces
- Heat Pumps and Efficient Heating and Cooling Systems
- High Efficiency Appliances
- Insulation
- Passive Solar
- Permeable Surfaces, Walkways, & Driveways
- Rainwater Harvesting for Outdoor Use
- Roofing Materials
- Solar Energy

The following professional directories may be a good place to start when trying to find industry professionals with knowledge in green building practices:

- U.S. Green Building Council (USGBC) - The USGBC administers the LEED building certification program.
- Built Green - A green home certification program of the Master Builders Association of King and Snohomish Counties.
- Northwest EcoBuilding Guild Directory - The Northwest EcoBuilding Guild is a community of builders, designers, suppliers, homeowners, and partners concerned with ecological building in the Pacific Northwest.

Green Products and Building Components

Overview

Whether you are shopping at a small local specialized store, or a big, all-inclusive building material supply store, the range of products and materials can be overwhelming, especially when trying to make environmentally responsible choices. Increasingly, *third-party certifications* are making it easier to quickly identify building materials and products that have been vetted and given a stamp of approval. By familiarizing yourself with these certifications, you can make more informed and reliable green product purchasing decisions.

When the option exists, it is best to buy local. Multiple studies have shown that local businesses tend to pay higher wages than big chain stores and tend to reinvest in the local economy at a higher rate than big box chains. For every $100 spent at one of these businesses approximately $68 stays in the community, according to Amy Hartzler, director of communications for the Business Alliance for Local Living Economies. That is more than twice the amount chain stores reinvest.

Definitions

Greenwashing

False claims that a product is greener than it really is. Beware of marketing hype and packaging design that suggest green attributes without proof. Third-party labels and certifications help guard against greenwashing.

Third-party Certifications

Agency, institute and non-profit organization evaluations of materials and products against a baseline definition of what they determine to be green. Certifications confirm that that products meet certain minimum requirements or that they comply with the agency's standards. There may also be different levels of compliance such as bronze, silver, and gold to distinguish higher green outcomes among product choices.

Volatile Organic Compounds (VOCs)

Mostly human-made chemicals that are used and produced in the manufacture of paints, pharmaceuticals, and refrigerants. VOCs typically are industrial solvents, such as trichloroethylene; fuel oxygenates, such as methyl tert-butyl ether (MTBE); or byproducts produced by chlorination in water treatment, such as chloroform. VOCs are common ground-water contaminants, and are often components of petroleum fuels, hydraulic fluids, paint thinners, and dry-cleaning agents.

Thermal Break

A construction component with thermal resistance installed to reduce heat loss.

When is This Applicable?

Just about any home project means that you'll be buying materials or products at some point along the way. Often you can repurpose or reuse materials you already have on hand – which is better for your pocketbook and the most resource-efficient approach – but inevitably you'll likely end up shopping online or in stores for at least some of what you need. Whether you're doing the work yourself or hiring a contractor, this shopping guide can help prioritize products that are better for you and the environment.

What Makes it Green?

- When you purchase products that use fewer ingredients or materials, or products made with more renewable materials you are using a product with a lower carbon footprint.
- Selecting equipment that saves energy helps to lower your utility bills.
- Using products that last longer, you reduce replacement costs and the amount of waste that goes into our landfills.
- Products that don't contain harmful chemicals minimize or eliminate toxic fumes in your home.

Being an informed shopper can save you, money and rework, contributes to better health, and can be a source of pride.

Best Practices

The following table provides you with important information to consider and labels to look for when you are shopping for various products.

Practical Shopping Guide

Look for these third-party logos on products

When shopping for...	Consider the following…
Lighting	• Fixtures: Consider repurposing your own fixtures or looking for used fixtures that can be fitted with high-efficiency LED lamps. LED bulbs that fit almost any size socket are readily available and affordable. Many salvage or second-use stores carry fixtures that work with modern lighting, while also adding character to your project. See Resources for Salvage Stores. • Select LED bulbs for long lasting and energy saving lighting. • Use the LED Lighting Facts® Label on the box to choose bulbs with the right light 'temperature' for your needs – a warm white will feel more like an incandescent, while a cool white will have a brighter, daylight-like feel. You can also choose bulbs based on the total delivered lumens, or light output. • Dimmer switches save energy by decreasing the flow of electricity to a light bulb and extends the lifespan of the bulb. Not all fixtures are dimmable, and not all light bulbs/lamps are dimmable. If you desire dimming, look for this on the fixture and /or bulb labels, or ask for the most appropriate fixture/lamp combination that can meet your needs.
Appliances Check out the "High-Efficiency Appliances" Green Sheet for more information	• Choose ENERGY STAR certified air purifiers, clothes washers, dehumidifiers, dishwashers, freezers, refrigerators and water heaters. • Consider tankless (point-of-use) water heaters to avoid standby and transmission heat loss and to save space. They are highly efficient and reduce energy use – thereby saving you money. You can also include a recirculation pump to reduce your wait time for hot water at the tap. • Choose front-loading clothes washers, which are generally more energy and water efficient than top loading - they also use less detergent. • Pick the appliance size that meets your needs – going larger takes up more space, costs more money, and typically uses more energy. • Consider a high efficiency induction stove. If you have natural gas, select a model that has an electric ignition rather than a standing pilot light to reduce indoor air pollution and wasted resources. Want to convert your natural gas stove to electric? Consult this Green Sheet: "Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces."
Paints & Coatings	• Less is more, so use minimal or no finishes. Instead, consider using natural or prefinished materials such as salvaged wood or cork. For more on how to use or where to find salvaged products, see the "Deconstruction and Reuse" Green Sheet. • No- or low-*VOC* paints are readily available and affordable at local home improvement stores. • Look for the GreenSeal label to ensure the product has been tested for performance and environmental and health safety. • Alternatively, consider a GreenGuard-certified product. These have also been evaluated for low emissions and indoor air quality. • Avoid polyurethane products that contain isocyanates as they are powerful irritants to the skin and mucous membranes. They can cause chest tightness and make it hard to breathe.

Wood Products	• Look for salvaged products first because they conserve virgin resources – they can also help make your projects unique and aesthetically interesting. Make sure you bypass salvaged wood products that may contain questionable adhesives, paints, and coatings. • If purchasing new wood, choose lumber products certified through the Forest Stewardship Council (FSC) to ensure sustainable harvesting and land management practices. • If using new material, look for products made from bamboo, agrifiber, and straw. • For engineered wood products, such as oriented strand board (OSB), medium density fiberboard (MDF) or particleboard, make sure there is no added urea formaldehyde (NAUF) in the adhesive binders. Urea formaldehyde can be highly irritating to humans and animals.
Cabinets & Countertops	• Consider reusing your existing cabinet boxes and just installing new or refinishing doors. or salvaged cabinets from a demolition project or salvage retailer. • Consider using salvaged materials for your countertop i.e., salvaged bowling lane flooring, gum flooring, and stainless steel from an industrial kitchen salvage. • If choosing wood/laminate products, choose No Added Urea Formaldehyde (NAUF) products. Select sustainably harvested materials by selecting wood that is FSC- or SCS-certified. • Consider using a product that is made from recycled or industrial waste materials, such as Quartz or Solid Surface
Flooring	• Consider using minimal or no additional flooring products, such as polished or stained concrete. • Cork flooring is a natural and sustainable option. • Prioritize hard surface flooring over carpets. Carpets trap dirt and allergens, which are hard to remove and can contribute to poor indoor air quality. • If you do install carpet, choose a low-pile product certified by the Carpet & Rug Institute under their Green Label Plus program which have low emissions and provide better indoor air quality. Low Pile reduces the amount of dust and debris that can get caught in a higher pile carpet. • Choose carpets with high recycled content from manufacturers that take back their carpet for recycling. • If using hard surface flooring, select local and certified sustainably harvested woods, rapidly renewable species like cork or bamboo; or a plant-based composite. • Look for products with the FloorScore label, which indicates the product has been tested and approved for low indoor air pollutant emissions. • Consider a GreenGuard-certified product. These have been evaluated for low emissions and indoor air quality. • Avoid vinyl flooring entirely. Vinyl flooring contains polyvinyl chloride (PVC) which is made from fossil fuel. Due to the severe environmental impacts caused by PVC manufacturing, the use of PVC should be eliminated as much as possible. • For resilient flooring, look for products containing natural materials such as linoleum and rubber. • Make sure all adhesives used contain low- or no- *VOCs*.

Siding	• Consider prefinished fiber-cement siding. Although it requires a significant amount of energy to produce, it performs very well over a long time, often with a 50-year warranty. For the Pacific NW, remember that it should only be installed over a good drainage membrane, such as polyolefin, breathable house wrap drainage membrane or a rainscreen installation. Otherwise, it can retain water if it has no way to dry out. • Prioritize products with very long warranties, which are low maintenance, and do not require additional products to be applied to preserve them. • If using wood, look for local or certified sustainably-harvested products. • Avoid vinyl siding. Due to the severe environmental impacts of PVC manufacturing, the use of PVC should be eliminated.
Decks & Fencing	• Consider using salvaged products rather than new materials. • If pursuing a new wood product, choose FSC-certified wood. • Prioritize wood that is more resistant to rot (i.e., Cedar, black locust, juniper, cypress, and osage-orange), or wood that doesn't need frequent coatings or treatment. • Composite wood decking is durable and low maintenance but look for products that use recycled plastics rather than PVC. • Avoid the use of pressure-treated wood. Many pressure-treated products leach chromium, copper and arsenic into the soil which can make its way into Puget Sound and harms marine species, such as salmon.
Windows	• Choose Double Pane windows with argon gas fill for maximum efficiency. Triple pane windows are also very good, but the higher cost does not directly correlate to the small increase in efficiency. There may be better ways to spend the additional money these units will cost you. • Low-E (emissivity) coatings minimize the amount of infrared and ultraviolet light that comes through your glass, so it keeps your house cooler in summer and warmer in winter. • Windows are measured using U-value instead of R-value (like insulation). To compare you can convert the U-value using the formula 1/U = R. I.E. If the U-value is 0.2, that is an R-value of about 5. Lower U-values are better as they equate to higher R-values. • Energy Star Windows have a U-factor of < 0.26. • Metal framed windows are the least efficient because metal conducts (loses) heat so quickly. • Avoid PVC frames as they are made from virgin fossil fuels. • Wood and fiberglass windows are more energy-efficient, but wood windows need to be painted for durability, and fiberglass windows are difficult to install in renovations. Hybrids of fiberglass encased wood are readily available and have the best of both materials. • Seal around gaps between the frame and the opening with low expansion spray foam prior to installing the trim.
Doors	• Look for polyurethane foam insulated core doors to reduce heat loss. • Energy Star doors (no glass) have a U-factor of <0.17. • Ensure doors fit tight in their frames once they are hung, to minimize gaps. • Look for insulated garage doors with an R-value of at least 11. • Install foam or brush type weather stripping all the way around the door to eliminate gaps between the frame and the door. • Seal around gaps between the frame and the opening with low expansion spray foam prior to installing the trim. • Install a *thermal break* threshold (2-pieces with a rubber gasket between) and set it in two beads of caulk or on low expansion spray foam.

Cost Information / Incentives

Current federal tax credits for certain energy-efficient improvements for homeowners have been extended through 2032 per the Inflation Reduction Act. If you purchase and install a qualifying product (most of the six elements of an ENERGY STAR Home Upgrade are covered), then you may qualify for this tax credit. Ask your window/door manufacturer and/or installer for more information.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Advanced Framing
- Construction & Demolition (C&D) Materials Management
- Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces
- High Efficiency Appliances
- Thermostats
- Toilets, Showers & Faucets

Northwest Building Salvage Network - A listing of local salvage retailers and deconstruction contractors promoting the salvage, sale, and reuse of building materials.

Sustainable Marketplace: Greener Products and Services - This EPA website provides background information about choosing products as well as numerous additional resources and links.

Green Building Supply - This website provides numerous investigations related to the validity of projects claiming they are green – otherwise known as *greenwashing*.

King County Appliance Disposal Information – This web site identifies how and where to properly dispose an array of materials, appliances, and other products.

LED Lighting Makeover Takeover: Home Depot Shopping Trip – This YouTube video by Puget Sound Energy shows how to shop for lighting at your local hardware store.

Habitat for Humanity ReStores - Features building salvage materials and donation pick-ups from your next project.

Digging Deeper...

Local green building materials stores typically carry only green products. But what about larger retailers with lots of choices? The labels in the Practical Shopping Guide may not always be applicable to products you are seeking. Ask if your store uses Store-specific Green Labels.

For example, True Value stores use "Greener Options" for products that show higher degrees of energy and water efficiency, or indoor air quality than other brands of similar products demonstrate.

Similarly, Home Depot "Eco Options" indicates greener products.

Routine Home and Yard Maintenance

Overview

As with any investment, regular maintenance and upkeep are essential to protect the value and safety of your home. Without this, your home may experience issues such as: pest problems due to vegetation overgrowth; poor indoor air quality from dirty air filters; and even health risks due to dirty fireplaces and dryer vents that can cause house fires.

Through preventive, proactive, and incremental maintenance, you can reduce the need for big, costly replacements and new materials while prolonging the life of existing materials and systems. This Green Sheet helps identify important home maintenance measures, when to perform them, and how frequently.

Definitions

Flashing
A protective waterproof layer installed at points where materials intersect. Flashing prevents moisture from penetrating into the materials below.

Hose Bibs
Outdoor faucet location where a garden hose can be attached.

Rain Gardens
Vegetated depression where surface run-off is allowed to collect and soak into the ground.

Soffit Vents
A vent in the roof soffit that allows air to flow into the attic.

Volatile Organic Compound (VOC)
Toxic chemicals used in the manufacture of paints, building products and materials. VOC's off-gas from these products which are harmful when breathed in, and the also contaminate our ground water.

When is This Applicable?

Maintenance strategies have different schedules, depending on the structure or system in question, but nearly all building structures and systems need some level of maintenance.

What Makes it Green?

Keeping structures strong and systems running efficiently through maintenance activities reduces the demand on natural resources. For example, a properly running heating system will consume less energy, and a well-maintained deck will not need to be replaced as often.

Furthermore, regular, preventative maintenance keeps more 'green' in your pocketbook. By performing these routines at the right time, homeowners can save money (and time!) by:

- Increasing the life of equipment and materials;
- Preventing potentially avoidable maintenance issues;
- Protecting the health of occupants and eliminating costs associated with health issues; and
- Protecting the overall investment in the structure or system.

Compiling a Homeowners Manual for your property can help you stay organized and up to date on proper operations maintenance projects.

Best Practices

The chart below outlines different maintenance strategies and actions with a recommended schedule. The default should always be to follow the manufacturer's recommended maintenance schedules.

Maintenance Action	Timing and Frequency
INSIDE THE HOME	
Indoor Air Quality / Health and Safety	
Check/replace batteries in carbon monoxide/smoke monitors and fire alarms.	Twice a year
Check fireplace chimneys (We recommend calling your local fire department. Some fire departments will do it for free or a nominal donation.)	Every Year and after an earthquake
Clean fireplaces and chimneys	Every Fall
Clean or replace walk-off/welcome mats so dirt and toxins can be removed before entering the house.	Every Spring
Maintain all carpets	Vacuum weekly, clean annually
Clean dryer lint tray	After each drying cycle
Clean main dryer vent	Annually
Inspect Caulking around windows and doors	Annually during the dry season (On average, the industry suggests that caulk be replaced every 5 years)
Inspect seal between garage and home	Twice a year
Move furniture away from walls and look for signs of moisture; moisture can lead to mold.	Annually
Properly dispose of unnecessary chemicals stored in the home or garage.	Twice a year. Take chemicals to a hazardous disposal event as needed.
Heating, Cooling, and Ventilation Systems	
Check furnace filter and replace as necessary. (Vacuum the filter area before replacement)	Check monthly, and more frequently during fire season
Check attic for signs of moisture	Annually, and after a major rain event
Adjust thermostat for seasonal changes; update programs in your smart/ programmable thermostat if applicable.	At the beginning of each season
Service air conditioner and heating system	Every few years, or as suggested by the manufacturer
Remove any leaves or debris around the outside air conditioning condenser.	Each Spring and Fall
Clean in and around grills and registers; vacuum inside of ducts	Every Fall
Check the basement or crawl spaces for moisture and air out if damp; install a dehumidifier if necessary.	Every season change
Confirm that roof *soffit vents* are open and debris-free if vented.	Every Fall
Vacuum ductless heat pump (mini-split) filters	Monthly
Clean whole house or bathroom exhaust fans covers/filters	Twice a year
Hire a professional to conduct a home energy assessment. This person will review of a home's energy use, comfort, and safety. The inspection will reveal where the home is inefficient and prioritize fixes to save money and increase comfort.	Every 2-5 years

Maintenance Action	Timing and Frequency
Lighting	
Replace incandescent bulbs with LED bulbs if possible. Look for ENERGY STAR certified product replacements.	As needed
Make sure time-controlled or light-sensor lighting is operating on schedule.	Every Spring and Fall
Plumbing	
Immediately address any toilet or faucet leaks	As needed, check annually
Clean faucet aerators to improve water quality and flow	Annually, as needed
Avoid frozen pipes by turning off outdoor faucets and install insulating covers over the *hose bibs*.	Every Winter
• Confirm water heater temperature is at 120F • For tank-style water heaters, consider installing a water heater timer which can save money and energy because the water is heated only during programed times when hot water is most likely to be used.	Check every Winter and Summer
• Check hot water heater for mineral buildup, drain, and refill • Clean your tank if you notice reduced water flow, you hear noises from your tank, or if water is discolored or smells bad. Removing built-up sediment will also ensure optimal performance and prevent bacteria from growing. Follow manufacturer guidelines to properly clean and disinfect.	Flush tank annually, or as needed
Update plumbing fixtures with WaterSense labeled products.	When financially able or as utility incentives become available
Appliances	
Use power strips to reduce phantom loads from chargers, TV, etc. Consider a "smart" power strip that will turn off power supply to products in standby mode. Standby power consumption can range from 5% to 10% when your items have completely charged.	Always if possible
Update appliances with ENERGY STAR-labeled appliances.	As needed or as utility incentives become available
Vacuum behind and under all appliances	Annually
Clean refrigerator coils (in back for older models, in front for new models)	Twice a year; more often if there are household pets
Interior finishes	
Inspect and repair caulking and grout in and around showers/baths.	Annually
Touch up scuffs and scratches with Zero *VOC* paint	As needed

Maintenance Action	Timing and Frequency
OUTSIDE THE HOME	
Building Exterior	
Siding: Wash if needed, monitor condition of paint; spot re-paint and caulk as needed	Every Summer
Windows: Wash, re-caulk or replace if needed	Every Summer
Doors: Wash, check weather stripping, re-paint as needed	Every Summer
Inspect roofing and *flashing* for signs of wear or damage and repair or replace damaged areas immediately.	Every Spring and Fall
Roof: Physically (not chemically) remove moss off sloped areas, clear debris from gutters and downspouts. Do not power-wash asphalt shingles as the pressure may dislodge the shingles.	Every Spring and Fall
Decks and stairs: Repair, sand, and seal • Use water-based Zero *VOC* sealants	Every Spring
Fences: Inspect and repair • When building or repairing a fence, use screws and brackets that allow components to be replaced easily. • Use water-based Zero *VOC* sealants on all end cuts to extend the life of fence posts and boards.	Every Spring, after storms
Foundation: Monitor for cracking, check vent covers, check for pests	Every Spring
Inspect address numbers to ensure they are clearly visible from the street, so they are easily seen by emergency responders if necessary.	Every Spring
Septic Systems	
Professional septic tank inspection	Every 3 years for a gravity system (septic tank & drain field); Annually for other types of septic systems
Pump septic tank. Routine pumping can prevent expensive failures such as a clogged drain field, sewage backing up into the home, or unpleasant smells.	As often as indicated by sludge and scum levels determined by the septic professional during the inspection. According to the EPA, "If the bottom of the scum layer is within six inches of the bottom of the outlet, or if the top of the sludge layer is within 12 inches of the outlet, your tank will need to be pumped."
Infiltration / Permeable Surfaces	
To help extend the useful life of the system, the surface of the permeable pavement should be kept clean and free of leaves, debris, moss, and sediment through regular sweeping or vacuum sweeping. Owners are responsible for the repair of all ruts, deformation, and/or broken paving units.	• Sweep or vacuum regularly • After major storm events: check for proper drainage; prolonged ponding or standing water is a sign the system is defective and may need replacing • Annually: inspect for physical defects

Maintenance Action	Timing and Frequency
Rainwater Harvesting	
Inspect the collection area (e.g., roof) for debris and other material that could impede the entrance and/or exit of surface flows	Weekly
Inspect the filtering system for effectiveness and replace or replenish as recommended by the manufacturer.	Periodically / As indicated by manufacturer: inspect the filtering system
Completely drain the storage device during the dry season in order to provide the needed capacity for an entire wet season. *Keep a maintenance log on site with all inspection and maintenance information and dates.*	Drain annually between May 1st and September 30th
***Rain Gardens* & Vegetated Roofs**	
A supplemental watering program may be needed the first year after planting to ensure the long-term survival of the vegetation. Vegetation should be maintained as follows: 1. Replace all dead vegetation as soon as possible 2. Remove fallen leaves and debris as needed 3. Remove all noxious vegetation when discovered 4. Manually weed without herbicides or pesticides 5. For *rain gardens* during drought conditions, use mulch to prevent excess solar damage and water loss.	• Annually inspect for physical defects • After major storm events check for proper working order of the overflow system. • As needed for *rain gardens*, stabilize any bare areas with soil, plant materials, mulch, or landscape rock. • As needed for vegetated roofs, stabilize erosion channels or bare spots with additional soil similar to the original material.
Irrigation Systems	
Make sure sprinklers do not spray areas that do not require irrigation (e.g., sidewalks, home exterior, etc.) and confirm there are no leaks. Time a walk-through when the system is on to perform visual check.	Inspect at the beginning of irrigation season, monitor visually and through utility bill tracking (where applicable) throughout the watering season. We recommend checking with your local water utility to investigate if they have any incentives for sprinkler replacement.
Landscaping	
Confirm landscaping vegetation is at least 2 feet from the home as both a home security measure and to avoid attracting dark spaces for vermin.	Monitor throughout Spring and Summer
Reapply landscaping mulch	Every few years if mulch is 3" deep. Annually or twice/year if mulch is 2" deep or less
Aerate lawn/overseed/top dress with compost	Every Spring
Inspect property for proper drainage grades	Every Spring and Fall, ideally after a rain event
Turn off and drain irrigation systems	Prior to winter temperatures dropping below freezing so pipes don't have the potential to burst.
Store firewood off the ground (to reduce attracting vermin or retaining moisture) and away from the home.	Always
Avoid chemical or toxic de-icers in order to prevent contamination of surface run-off and protect salmon habitat.	Winter
Do not use toxic chemicals for pest control or fertilizer; explore natural alternatives.	Always

Cost Information / Incentives

Rain gardens and stormwater infrastructure:

RainWise Program – Provides rebates for the installation of *rain gardens* and cisterns for properties located in the City of Seattle (only)

RainScapes Program - Funds and installs features such as *rain gardens*, cisterns, and native plant landscaping for properties in unincorporated King County (only)

Green Stormwater Infrastructure Mini Grants – Provides up to $4,500 for *rain gardens*, cisterns, and other green infrastructure for properties within the King County Wastewater Treatment Division service area that are not eligible for other stormwater infrastructure incentive programs.

Stormwater Facility Discount - Residential and non-residential property owners may be eligible for up to a 50% discount in surface water management fees by managing stormwater runoff effectively. Consult the 2021 King County Surface Water Design Manual.

Puget Sound Energy (PSE) Rebates – Rebates may apply toward appliances such as front load clothes washers, heating systems, insulation, lighting, smart thermostats, water heating, windows, etc.

Seattle City Light Rebates – Rebates may apply toward certain heat pumps, washers, and dryers

Saving Water Partnership Rebates – Rebates may apply toward toilet replacements and sprinkler timer replacements.

Sound Generations – The Minor Home Repair Program provides minor repairs and water conservation upgrades for low-income and disabled homeowners.

Codes, Standards, & References

2021 King County Surface Water Design Manual

Resources

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See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Advanced Framing
- Air Sealing Your Home
- Amended Soils
- Duct Sealing
- Efficient Water Heating
- Fresh Air Ventilation
- Heat Pumps and Efficient Heating and Cooling Systems
- High Efficiency Appliances
- Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces
- Green Products and Building Components
- Permeable Surfaces, Walkways, & Driveways
- Rain Barrels, Cisterns, & *Rain Gardens*
- Roofing Materials
- Thermostats
- Toilets, Showers & Faucets

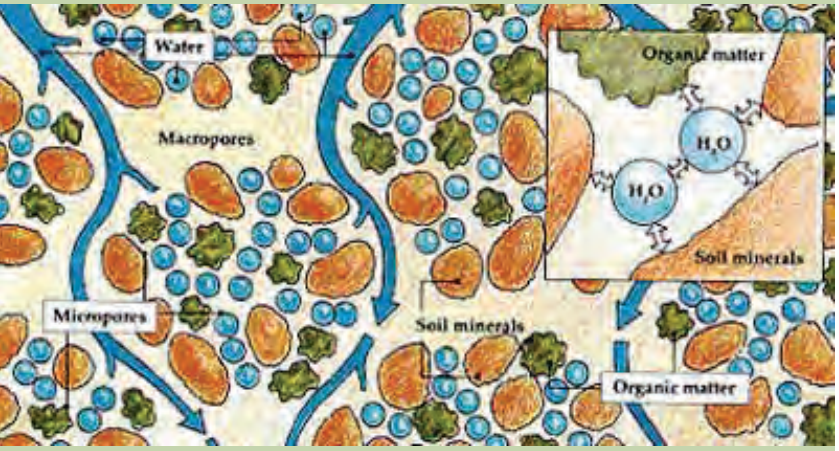
EPA – Septic Smart Home Maintenance Guide

Amended Soils

Overview

Amending your soils is a relatively easy way to improve your landscape while helping support the natural environment. Native soils that have been compacted by construction activity, or where *topsoil* has been removed or eroded, can become impermeable to water infiltration. This can cause high volumes of stormwater to run off your property into local water bodies, or cause flooding in homes, or on sidewalks and roads. This rapid runoff carries sediment (mud), nutrients and pesticides into local water bodies or storm drains that harm aquatic habitat and are expensive for municipalities to treat. Compact soils also reduce water and nutrient availability for plants and may hinder root development.

It is extremely difficult, in the short term, to return compact soils to their original hydrological and biological functions. This is why it is important to not compress soil with heavy machinery, especially when wet. Not only is soil health important for the plants and animals that are part of the region's ecosystem, but high-quality *topsoil* also protects the region's water quality, removes carbon from the air, and will help our region adapt to future climate change impacts. When plants and soils are healthy, they will typically require less watering and or irrigating as well.



Healthy *soil structure* includes plentiful pathways for water, mineral, and nutrients to migrate. *Source: Food and Agriculture Organization*

Definitions

Integrated Pest Management (IPM)

An approach to pest management that relies on a combination of healthy, biologically active soils and natural predators to minimize pest damage with few or no chemical pesticides.

Potential of Hydrogen (pH)

A substance's pH is a measure of its acidity. Soil pH affects the amount of nutrients and chemicals that are soluble, and therefore the amount of nutrients available to plants. Some plants may also prefer soils that are more acidic or, conversely, more alkaline.

Soil Amendments

Soil amendments are natural additions to soil that improve both its structure and health, increasing the space between particles, and allowing soils to absorb and retain more moisture and nutrients.

Soil Structure

The spatial relationship of solids materials and porous spaces in the soil. Good soil structure allows water, air, minerals, and nutrients to migrate.

Topsoil

The uppermost layer of the soil, typically with a higher concentration of organic matter and microorganisms compared to subsequent underlayers.

When is This Applicable?

Amending soil is valuable any time you do site work. If your soil and landscaping are not healthy or thriving, or you are having problems with flooding, using soil amendment best practices may provide you with cost-effective benefits like preventing flooding, reducing water costs for irrigation, and maintaining healthy plants.

King County's Clearing and Grading Regulations (King County Code 16.82) require that *soil amendments* be added to any new or significantly redesigned landscaping areas, as well as to any landscaping areas disturbed or compacted during construction. *Soil amendments* should be added once the area is free from compaction or disturbance, or when new soil is installed, and before planting.

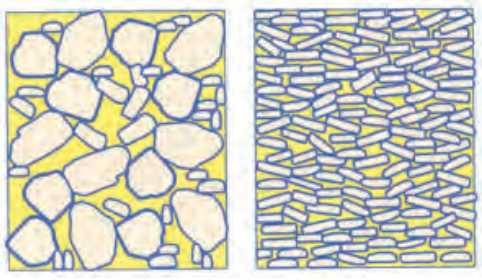
In new lawns and gardens, *soil amendments* are mixed down into the soil, often well before planting time. In established lawns and ornamental plantings, *soil amendments* are applied to the surface and watered in so grasses and other plants are not disturbed. Unlike mulches, which are placed on top of soil and meant to decompose slowly, amendments are meant to get down into the soil more quickly.

Careful protection of native soils save you money, protect the drainage potential of your site, and provide optimal growing conditions for plants. *King County photo*.

What Makes it Green?

Adding organic matter to soils enhances their function and performance on your site in many ways, including:

- Improves *soil structure*, aeration and nutrient balance, helping support the organisms and micro-organisms that enhance soil function and nutrient availability for plants.
- Replaces lost or depleted soil nutrients and can help adjust soil *pH*.
- Improves water absorption, reduces erosion and supports healthier plant growth and disease resistance, making the land more productive and improving its carbon sequestration.
- Landscaped areas are easier to maintain, reducing watering frequency as well as fertilizer and pesticide applications.
- Improves aquatic habitat and protects the health of salmon, trout and other aquatic life.
- Reduces harmful climate change impacts, including the heat that would otherwise be reflected off compacted and dry soils.



These images illustrate the difference between healthy loose soil (left) vs compacted soil (right). The pore space shown in the healthy soil is important for effective drainage and optimal plant growth. *Source: City of Tacoma*

Best Practices

Soils impacted by construction can be improved by tilling in well-composted organic material, or *soil amendments*. Soils with good structure absorb and retain more moisture and nutrients. If you have the time to build your soil, no-till methods combined with continued layering of leaf mulch and garden debris will feed the microbes that do the work of building soil.

Soil amendments are ideally applied in the fall so microbes can break down organic matter and digest minerals; if unable to do this in the fall add them in early spring when soils are typically driest. *Soil amendments* usually available at local nurseries, hardware stores, or home improvement stores are alfalfa meal, bone meal, chicken manure, coconut coir, gypsum, and worm castings. However, products such as alfalfa meal, bone meal, or gypsum should not be applied unless a soil test calls for their addition.

Other sources of *soil amendments* are food and yard waste compost and biosolids.

- Food and Yard Waste compost is made from food scraps, food-soiled paper, and yard waste.
  - Municipal Services: Some municipalities collect these valuable resources curbside and have them composted by companies like Cedar Grove that maintain hot compost piles.
  - Home composting: Slow composting is easy if you have a designated space to pile and occasionally turn a compost pile. Care should be taken to ensure no meat or fats are included as they do not break down without proper heat and can attract rodents.
- Biosolids are the nutrient-rich byproduct of wastewater treatment after sewage is processed through physical, chemical and a biological means that removes physical contaminants and control pathogens. Biosolids can be converted to compost using a bulking agent such as wood chips or co-composted with green materials. Biosolids composting requires a solid waste permit.
  - Class A biosolids are essentially free of pathogens prior to land application.
  - Class B biosolids may have low levels of pathogens which rapidly die-off when applied to soils, essentially becoming pathogen-free within a short period.

Design Guidelines for Amended Soils

(Achieving Post-Construction Soil Standard)

- Define clearing limits and restrict any compaction or disturbance in this zone.
  - Keep vehicles and machinery off of the planned landscape areas.
  - Limit construction impacts to specific areas to reduce the total area compacted. Compacting soil limits water and nutrient availability for plants and soil biology, and may hinder root development. It is extremely difficult, in the short term, to return compacted soils to their original hydrological and biological function.
- Within clearing limits, preserve *topsoil*/duff.
  - Retain the duff layer and native *topsoil* in an undisturbed state if possible.
  - Stockpile any duff layer or *topsoil* removed during grading on-site in a designated. controlled area not adjacent to public resources and critical areas.
- After construction, replace *topsoil*/duff after amending if needed.
  - Ensure areas that have been cleared and graded have the soil moisture holding capacity restored to that of the original undisturbed soil native to the site.
  - Amend soils only between May 1 and October 1, when soils are driest.
  - Replace *topsoil* to a minimum of eight inches thick to ensure conditions equivalent to the soil moisture-holding capacity native to the site.
  - Confirm replaced *topsoil* has organic matter content between 5% and 10% dry weight and a *pH* suitable for the proposed landscape plants.

Buying compost or pre-amended *topsoil*

- Buy compost at your local nurseries, hardware stores, or home improvement stores. Consider buying larger bulk quantities and sharing with your neighbors.
- Ask suppliers for product test results to verify organic matter content and *pH* – you will need these results and receipts during your inspection.
- You can also visit tilth Alliance for more soil health information and multi-lingual tools.

Go Further: Implement an Integrated Pest Management (*IPM*) system for landscaped areas; healthy, biologically active soils help increase *IPM* success – see Resources for more information.

The difference between heavily compacted and healthy amended soil from the same site is very apparent. *Source: Dirt Doctor*

Cost Information / Incentives

Long-Term Economic Benefits: Soil amending is a low-cost solution, but over time it will reduce the utility cost for watering plants and improves plant health, so there will be fewer costs spent on plant replacements.

Soil Amendment	Cost Range (buying in bulk will be cheaper)
Non-GMO alfalfa meal*	$1.39 - $6.05+ per pound
Bone meal*	$1.80 - $4.33+ per pound
Chicken manure*	$1.21 - $7.68+ per pound
Coconut coir	$0.30 - $1.80+ per pound
Gypsum	$1.14 - $3.52+ per pound
Worm castings	$1.40 - $6.00+ per pound
Cedar Grove - Compost	$37.50 per Cubic Yard (CY) (delivery available for fee)
Biosolids (TAGRO Mix)	$10 CY (delivery available for fee)
Biosolids (TAGRO *topsoil*)	$23 CY (delivery available for fee)

*Costs vary with mix ratios

Permit Tips

Per K.C.C. 16.82.100, if your project is located in unincorporated King County, the soil shall be amended to mitigate for lost moisture-holding capacity if any of disturbed soils are compacted or the underlying *topsoil* (duff layer) has been fully or partially removed.

A grading permit is required if you are disturbing vegetation or soil near a critical area, or if disturbing more than 100 cubic yards of soil – unless maintaining an existing area used for lawn, landscaping, or gardening for personal consumption (See K.C.C. 16.82) which will require a completed Soil Management Plan to the Department of Local Services, Permitting Division staff for review during the permit process. Check out the Clearing and Grading Permits reference to determine if a permit is required for your project.

If your project is located outside unincorporated King County, please confirm requirements and resources with the local jurisdiction.

Codes, Standards, & References

King County

Achieving the Post-construction Soil Standard - A reference for how to meet King County's regulations on preserving and restoring healthy soils on developments in King County.

2021 King County Surface Water Design Manual (see especially: 4A – Grading Code Soil Amendment Standard, and 4C – Landscape Management Plan Guidelines).

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Permeable Surfaces, Walkways, & Driveways
- Rain Barrels, Cisterns, & Rain Gardens
- Routine Home & Yard Maintenance

Soils for Salmon - Sponsored by the Washington Organic Recycling Council, this website provides ample information helping to ensure your soils are healthy for salmon habitat.

The City of Bellingham Public Works Department - In partnership with Sustainable Connections this team created an Advanced Methods and Materials document to describe how stormwater infiltration is increased by incorporating amended soils.

Seattle Public Utilities – SPU provides information on integrated pest management as well as information on how to Grow Healthy Soil.

tilth Alliance - This web site provides information on healthy soil management including composting waste & worm bins.

Tree Hugger - This web site provides a step-by-step guide to hot composting.

Permeable Surfaces, Walkways, and Driveways

Overview

In a native forest, most of the rain that falls is intercepted by the trees and allowed to infiltrate into the ground where it is taken up by plants, recharges groundwater or flows slowly downhill to valley bottoms where it surfaces in creeks and rivers. When rain falls on roofs, roads, and parking lots – even compacted lawns and golf courses – it stays on the surface and runs off more quickly into creeks and rivers, often carrying sediment and other pollutants. This rapid runoff results in less *groundwater recharge*, erosion from higher stream flows in winter, and low stream flow from low water tables in the summer.

Permeable surfaces are an example of Low Impact Development (LID). LID is a stormwater management strategy that strives to mimic how the land managed stormwater prior to disturbance caused by development and the increase of *impermeable surfaces*. *Permeable* surfaces are one such strategy and allows precipitation to trickle through, for paved areas and hardscapes such as driveways, patios, parking areas and roads. This *infiltration* method allows some of the harmful effects of development on water quality, erosion, and groundwater levels to be reduced.

Permeable pavements (designed to support vehicles) can be used for low traffic roads, driveways, and parking areas. *Permeable* hardscapes (surfaces used by pedestrians) can be used for sidewalks, patios, plazas, and pathways. *Permeable* pavements and hardscapes use similar materials such as interlocking concrete pavers which allow water to soak into the ground below; Or *permeable* concrete, asphalt, and reinforced grass or gravel that are designed with an open network of spaces that allow water to soak through the material itself yet are still strong enough to support vehicle loads.

Instead of running off, water flows right through pervious concrete. *Source: JJ Harrison*

Definitions

ASTM

American Society for Testing and Materials

Impervious/Impermeable Surface

A hard surface area that either prevents or slows the entry of water into the soil as compared to natural conditions prior to development.

Infiltration

The hydrologic process of water soaking into the ground (commonly referred to as percolation).

Open Graded Ballast Rock / Reservoir Course

Crushed rock with most particles being uniform in size and thus creating voids which can store water below ground where it can infiltrate. This rock is located below a layer of finer crushed rock, and atop the native soil.

Groundwater Recharge

The flow of water from the surface to groundwater via the infiltration of surface and storm water runoff.

NRMCA

The National Ready Mix Concrete Association

Pervious / Permeable Surface

Any surface material that allows stormwater to infiltrate into the ground. Examples include lawn, landscape, pasture, and native vegetation areas.

When is This applicable?

Most projects that install a walkway, driveway, or other hardscape surfaces may be able to integrate a *permeable* material. Depending on the size and scope of your project, you may be required to address stormwater runoff including measures to reduce runoff and improve the permeability of your site. *Permeable* pavements and hardscapes are examples of Low Impact Development (LID) practices which address Stormwater Flow Control requirements. Appendix C of the King County Surface Water Design Manual contains design requirements for many LID applications (including *Permeable* Paving, described in Section C.2.7).

Whether you are using *permeable* surfaces to meet your surface water requirements or not, they can always be used instead of traditional *impermeable surfaces* for many common hardscape applications.

What Makes it Green?

Permeable surfaces can reduce or even eliminate the negative impacts of rapid stormwater runoff, such as flooding, stream bank erosion, water quality degradation from pollution (pesticides, gasoline and heavy metals), elevated stream temperatures, reduced *groundwater recharge*, and low summertime stream flows. All these contribute to loss of aquatic habitat in streams, rivers, and wetlands – and ultimately affect the quality of Puget Sound habitat that supports healthy fish, bird, and mammal populations.

Besides complying with Flow Control requirements, benefits of *permeable* paving include:

- Reduced the rate and volume of stormwater runoff (also called "Flow Control") and reduces the amount of stormwater infrastructure needed downstream (pipes, catch basins, etc.).
- Allows snowmelt to infiltrate and reduces the risk of formation of ice during cold weather.
- Increased *groundwater recharge*.
- Allows air and water to flow naturally through soil, so trees are healthier and tree roots grow deeper rather than shallow, resulting in the buckling of pavement.

Best Practices

Driveways, fire lanes, and parking areas are common places to install *permeable* pavement, as they have lower speeds, lower traffic loads, and less traffic volumes. *Permeable* pavements perform best when installed on nearly flat ground, but some types can be installed up to a 5% grade (porous asphalt & *permeable* interlocking pavers) and in some cases up to about an 8% grade (pervious concrete). However, when installed on slopes greater than about 3-4% the design should be reviewed by an engineer.

Initial Steps as a Homeowner if you want to install a *permeable* surface or pavement:

1. Decide which type of *permeable* surface best matches your budget, needs, and property per the table below.
2. Hire a contractor and designer with experience working with the system you want to use.

Permeable grass pavers are an attractive permeable alternative for parking areas and patios. *Source: Stock photo*

Application Examples

Permeable Pavements	Suitable Applications	Approx Cost (per sf)*	Maintenance	Considerations
Pervious Concrete	Slow-Traffic Roads, Sidewalks, Patios, Walkways, Parking Areas, Emergency Vehicle Access	$14 - $17	Occasional cleaning with leaf blower, vacuum or pressure washer to remove surface debris.	A *NRMCA*- qualified installer needs to be used to install this product and *infiltration* tests conducted to ensure performance. Not appropriate for high-speed traffic. Offered in a variety of colors and finishes.
***Permeable* Interlocking Concrete Pavers**	Roads, Sidewalks, Patios, Walkways, Parking Areas, Emergency Vehicle Access	$18 - $22	Gravel fill may need to be swept back into place. Occasionally gravel will need to be vacuumed out and replaced if it becomes clogged with debris.	Larger areas can be mechanically placed to reduce installation cost. Cost varies based on layout and paver type with many colors and styles available.
Porous Asphalt	Roads, Sidewalks, Patios, Walkways, Parking Areas, Emergency Vehicle Access	$10 - $14	Occasional cleaning with leaf blower, vacuum or pressure washer to remove surface debris. Annual vacuum sweeping with a contracted regenerative air street sweeper or lawn vacuum.	Mix design must use PG 70-22 asphalt in the mix which may have limited availability in winter.
***Permeable* Rubber Surfacing**	Walkways, Patios, Tree Wells, Play and Exercise Areas	$20 - $30	Annual vacuum sweeping with a contracted regenerative air street sweeper or lawn vacuum. Some surfaces require a protective UV coat to be applied every 2 years.	Typically made from recycled rubber products, such as tires. Offered in a variety of colors.
Grass Pavers / Reinforced Grass Pavement	Auxiliary / overflow Parking Areas, turf emergency vehicle access	$10 - $14	Mowing and re-seeding depending on use. Irrigation is typically required to maintain healthy coverage in summer. Maintain adjacent grade as needed to avoid a tripping hazard at the edges.	Available in concrete or plastic systems. Not recommended where regular foot or vehicle traffic is expected, because the grass will wear out. Can only be used in flat areas.
Reinforced Gravel Pavement / Gravel Cwellular confinement	Walkways, Parking Areas, Emergency Vehicle Access	$10 - $14	Weeding gravel for aesthetics and regrade gravel fill that has moved. Maintain adjacent grade by filling as needed to avoid a tripping hazard at the edges.	Available in concrete or plastic systems. Sometimes grade can settle adjacent to grid system and cause a tripping hazard.

* Construction prices are very volatile and subject to many factors unique to each site, material availability, size of the project, and other factors. The prices shown are for a complete pavement system, in place and should be used only for Rough Order of Magnitude and relative comparisons. For reference the cost of traditional *impermeable* asphalt pavement is approximately $8 - $12/sf at the time of publication.

When hiring a contractor, ensure she/he is familiar with the best practices for installing *permeable* pavement including:

- Look for qualified installers through professional certifications, like *NRMCA's* Pervious Concrete Contractor certification or Interlocking Concrete Paver Institute's Certified Concrete Paver Installer certification.
- Ask for addresses of past installation projects that you can visit.
- Protect the subgrade below the pavement from compaction (limit compaction to ~92%) and ensure that no vehicles or equipment be allowed to operate directly on the subgrade and do not allow any wash-out" in these areas.
- Protect the *permeable* pavement, *reservoir course*, and subgrade from contamination with silt to maintain the *infiltration* capacity. Establish "No Heavy Equipment" zones to protect the subsoils under future *permeable* paving from compaction. And ensure that the *permeable* pavement areas are clearly shown in the Temporary Erosion and Sediment Control Plans and runoff is directed away from these areas.
- Provide a base course of *open graded ballast rock* to store water and allow it to soak into the ground between storms and a layer of more finely graded crushed rock (known as choker course) as needed to support the type of pervious pavement selected.

This mockup shows a typical cross section of engineered subsurface that contributes to permeable surfaces. *Source: O'Brien360*

Maintenance Requirements

- A typical *permeable* pavement system has a life expectancy of approximately 25-years, though this varies depending on pavement type; this duration can be protected with proper, regular maintenance. Maintenance needs depend on the pavement type and is described generally in the table above.
- The *infiltration* capacity can be assessed by observing the runoff patterns during rain events or running a test such as *ASTM* C1701 "Standard Test Method for *Infiltration* Rate of In Place Pervious Concrete" or similar.
- Ponding or standing water on the pavement surface is a sign that the system may be clogged and may need to be vacuumed-cleaned or replaced.
- Protect the pervious pavement from runoff from adjacent areas and remove any accumulated silt or debris at least annually.
- For vegetated *pervious surfaces* (such as Grass Pavers), regularly mow and maintain the grassed surface of the pavement in a good condition. Limit foot and vehicle traffic to avoid wearing out grass then replant all bare spots in the spring or fall.

Cost Information / Incentives

The cost to maintain the *pervious* pavement will depend on the size of the pavement, the cleaning method used, and the level of contamination. The average annual maintenance cost for *pervious* pavement is 4% of the original construction cost. If pavements are not maintained, they can become deeply clogged and may need to be rehabilitated or replaced – which can be more costly.

Permit Tips

If your project involves clearing, filling, or grading more than 2,000 square feet of area, then a grading permit is required. The use of *permeable* pavement can help projects comply with Core Requirements #9 (Flow Control) of the King County Surface Water Design Manual.

Codes, Standards, & References

2021 King County Surface Water Design Manual: Appendix C and Section C.2.7, *Permeable* Pavement

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Amended Soils
- Rainwater Harvesting for Outdoor Use
- Roofing Materials
- Routine Home & Yard Maintenance

National Ready Mixed Concrete Association - *NRMCA's* database provides contact information for Certified *Pervious* Concrete Contractors (Choose *Pervious* Concrete Craftsman, Installer, or Technician from the drop-down menu).

Soils for Salmon - This resource shows how to adopt practices that help to preserve and improve the soil on your property.

Rain Barrels, Cisterns, & Rain Gardens

Overview

Water is a valuable resource but can quickly become a problem when there is too little or too much of it. In the Pacific Northwest, the winter usually provides an abundance of rain and in the summer, too little. Stormwater is rainwater that drains off surfaces such as roofs, streets, sidewalks, and lawns. Rainwater catchment systems such as rain barrels & cisterns, as well as rain gardens, are low-tech strategies we can use to manage the volume and quality of stormwater.

As rain falls, it can be captured on a roof and travel from gutters to downspouts into a rainwater catchment system, such as a rain barrel (above ground) or cistern (located above or below ground). These systems hold water that can be used to water plants which then reduces your utility bills because you're not drawing water from the municipal water supply!

From the downspout, that rainwater can instead travel through pipes into a rain garden, also called a bioswale. Rain gardens have a special selection of organic-rich soils and plants that remove toxins and allow the water to be slowly absorbed into the ground. This action prevents toxins from flowing into our sewer systems into waterways and Puget Sound, causing great harm to marine life such as orcas and salmon. Rain gardens also provide beneficial habitat for birds and pollinators and are visually beautiful.

On a roof 1,000 square feet in size, one inch of precipitation in our region will yield over 600 gallons of water – which equates to approximately 24,000 gallons of rainfall per year.

Definitions

Infiltration

The process by which rainwater soaks into the soil.

Non-potable Water

Water that is NOT safe enough to be consumed by humans but may still be useful for other purposes such as watering plants.

Potable Water

Water safe enough to be consumed by humans.

When is This Applicable?

Rainwater catchment systems and rain gardens can be used or integrated into new and existing residential (or commercial) properties that have an adequate roof area for collecting water and space for an appropriately sized catchment system.

Proper sizing and a clear understanding of the intended use of the selected system should be considered before installation. Both systems are approved best management practices (BMPs) that meet King County's surface water management requirements

Rain gardens reduce the amount of run-off in stormdrains and reduces contaminants from entering waterways. *Stock image*

What Makes it Green?

Rainwater catchment systems and rain gardens provide numerous benefits which include:

- Saving money by reducing potable water use and pumping from your well.
- Protecting salmon and water quality by removing contaminants
- Protecting against flooding by reducing your site's stormwater runoff
- Providing an on-site source of non-potable water for irrigation or other outdoor uses
- Rainwater used to irrigate is healthier for plants because it does not have chlorine, an additive that keeps municipal water safe for drinking.

The special selection of a rain garden's plants and soils. *Source: King County RainScapes Program*

Best Practices

To optimize the benefits of harnessing rainwater consider the following best practices:

Rainwater Catchment Systems

Rain barrels provide an easy option for collecting rainwater to use within your landscaping. *Source: King County*

- Design your system based on the size of catchment needed, location of the downspout or collection area, and watering location.
- Make your cistern dark to inhibit algal growth and bug-tight to prevent mosquitoes.
- Install a low-flow valve near the bottom of the cistern to allow for slow drainage of the tank during the rainy season. The valve can be closed in May to store water for summer use.
- Sufficiently filter the water on the way into the cistern to prevent sediment build-up in the cistern.
- Drain the storage device to nearby gardens or the side sewer at the end of the dry season (May 1st - September 30th) in order to provide capacity for future rain events.

Rain Gardens

- The design should be based on *infiltration* testing, collection area, calculated stormwater runoff volume, and proper garden location.
- Project Materials may include perforated pipe to convey water into the rain garden, zonally selected plants, organic-rich soils, and wood chips to suppress weeds and retain moisture.
- After major storm events, verify that the overflow system is working properly, and sedimentation is not occurring at the inlet (Refer to the Routine Home & Yard Maintenance Green Sheet).
- During the first year, provide a supplemental watering program to help establish the garden plants if needed.
- Do not use chemical fertilizers and pesticides.

For system maintenance, check out the Routine Home & Yard Maintenance Green Sheet

Rainwater catchment systems are available in numerous shapes and sizes, including a cube-shaped tank as pictured here. *Source: Batt + Lear*

Roof Materials

- Water quality is an important consideration. Coated metal roofs make the best catchment surfaces and asphalt is least favorable because of the particulates that can wash off
- Based on a Department of Ecology collaborative study with King County and roof manufacturers, it's best to avoid the following materials in the collection area to prevent the release of additional pollutants in runoff:
  - Treated wood panels (copper and arsenic pollutants)
  - PVC panels (arsenic pollutants)
  - Copper panels (high copper concentrations)
  - Zincalume® and EPDM roof (zinc pollutants)

Cost Information / Incentives

Cost of Rain Gardens:

Rain garden cost vary depending on size and who does the construction:

- DIY: $1 to $5 per square foot
- Using a professional: $20 to $40 per square foot

Cost of Rainwater Catchment Systems:

- $100 to $500 for a *non-potable* small system (55 to 140 gallons)
- $1,000 to $2,500 for a *non-potable* large system (300 to 3,000 gallons)

RainWise Program – Provides rebates for the installation of rain gardens and rain catchment systems for properties located in the City of Seattle (only)

RainScapes Program - Funds and installs features such as rain gardens, cisterns, and native plant landscaping for properties in unincorporated King County (only)

Green Stormwater Infrastructure Mini Grants – Provides up to $4,500 for rain gardens, cisterns and other green infrastructure for properties within the King County Wastewater Treatment Division (WTD) service area not eligible for other incentive programs.

Permit Tips

Will you need a permit?

Rain Gardens and cisterns:

Most rain gardens will not require a permit from the Department of Local Services, Permitting Division unless more than 2000 square feet of soil is being disturbed or added. However, a grading permit will be required if you are disturbing more than 100 cubic yards of soil, or for any disturbance near a critical area (See K.C.C. 16.82.050). You will need to submit a Soil Management Plan that shows which soil amendment choice will be used.

Rain barrels:

For small-scale collection systems such as rain barrels, you do not need a permit.

Codes, Standards, & References

2021 King County Surface Water Design Manual, Appendix C: Section C.2.5 Rain Garden and Section C.2.7 Rainwater Harvesting

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email dperwebinquiries@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Amended Soils
- Hiring the Best Professional for Your Project
- Permeable Surfaces, Walkways, & Driveways
- Routine Home & Yard Maintenance

700milliongallons.org – Green Infrastructure Partnership, City Habitats Coalition, 2030 Districts Network, 12,000 Rain Gardens, and the Green Infrastructure Leadership Exchange are working together to naturally manage 700 million gallons of stormwater annually by 2025.

12000raingardens.org – The 12,000 Rain Garden campaign is a cooperative effort with local partners lead by Stewardship Partners and Washington State University Extension. The campaign promotes rain gardens to address significant problems on priority streams and marine shorelines caused by untreated, uncontrolled runoff. We act as a clearinghouse for information and resources, including in-person events and trainings for people interested in learning to build rain gardens.

King County Rain Barrel Information and Sources – This website provides do it yourself instructions, resources for buying barrels, and numerous links to related resources and information.

Seattle Conservation Corps Program - Seattle Parks and Recreation offers rain barrels through this program.

ASTM International – This organization provides standards for various types of roofing systems.

Department of Ecology – This website provides information on rainwater harvesting, including a downloadable, easy to use, calculator to size your system according to your needs.

Saving Water Partnership - An organization offering tips, tools, and rebates to help people preserve our region's water.

The Garden Hotline - free service offering individualized solutions to garden problems that are practical, safe, effective, and natural (managed by TILTH Alliance)

Insulation

Overview

Insulation serves a variety of purposes in a home. Insulation reduces energy consumption, increases comfort, reduces noise, and prevents condensation and moisture issues in building cavities. This guide is intended to help you select the correct type of insulation for your application.

Definitions

AHERA (Asbestos Hazard Emergency Response Act)
A qualified AHERA inspector can help to limit abatement costs and provide a thorough report that will get the project done safely and within all relevant laws and regulation (see AHERA for more information).

Attic Baffles
Designed to provide a channel of air to flow through specific parts of your attic.

Formaldehyde
A chemical used in glues, adhesives, and binders. It is a known carcinogen and will off-gas from building materials for the entire time that material is in your home. Urea-formaldehyde is typically used as a glue for plywood, particle board, and other engineered wood materials. It can also be found in spray foam insulation. When higher levels of formaldehyde are measured in the air, health effects can occur such as watery eyes, coughing, nausea, and skin irritation. Phenol-formaldehyde resins are used for exterior plywood, oriented strand boards (OSB), and engineered high-pressure laminate. Studies have shown that phenol-formaldehyde resins are irritating to eyes, skin and mucosal membranes.

R-value
Resistance to heat flow. A higher R-value means higher resistance to heat loss and therefore conserves more energy.

RESNET (Residential Energy Services Network)
Standards that define an insulation installation grading system. Grade I – Minor Defects, Grade II – Moderate Defects, Grade III – Substantial Defects (see RESNET for more information).

Volatile Organic Compound (VOC)
Toxic chemicals used in the manufacturing of building products and materials. VOC's then off-gas from these products, polluting indoor air, and are harmful to breathe in.

When is This Applicable?

Attics, walls, and floors can be insulated at any time, but it is often easier, less expensive, and more effective during new construction or a renovation. Insulation is required any time you build a new home or addition, and an update to existing insulation may be required by code depending on the extent of remodel or retrofit. The energy code has specific insulation minimums.

Adding or replacing insulation may also be applicable if the original installation was insufficient, installed poorly, or has been disturbed. Common errors in installation include gaps between pieces of insulation, compression, and improper cutting around ductwork, plumbing or electrical wiring. Examples of activities that may disturb insulation include:

- Use of attics for storage;
- Repairs to plumbing or electrical systems;
- Additions of low voltage wiring, like networking, security, video, audio and cable or satellite TV wiring;
- Rodent activity;
- Installation of ducts and vents;
- Effects of gravity on floor or wall insulation; and
- General home maintenance.

Insulation was not required to be installed in Washington homes prior to 1985, so you will need to check your walls, attic, floors, and roof cavities to see if your home has any insulation or not. In older homes, wall insulation may also have sloughed down, leaving gaps around the top of your walls. Attic insulation can also settle over the years or become moist and ineffective. Adding more insulation to your attic and topping off your wall insulation is one of the more cost-effective solutions to increasing energy efficiency in your home.

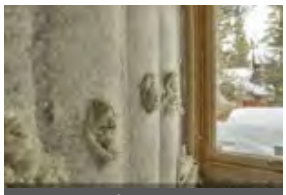
What Makes it Green?

Adequate and properly installed insulation has major benefits to the homeowner, including both financial and comfort improvements. Additionally, maximizing the *R-value* of insulation will improve comfort and reduce utility bills. New technology has changed the way insulation is installed within walls and roofs, and there are many new materials from which insulation is made that are considered more sustainable, such as mineral wool and recycled denim.

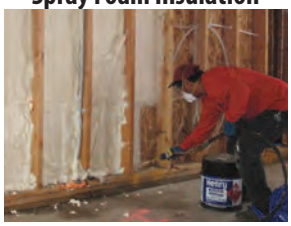
Best Practices

Before choosing standard fiberglass batt insulation, review the pros and cons and other considerations of the following options.

Insulation Type	*R-value* per inch of thickness	✓ Pros and ✗ Cons	Best practices	Where to install
Cellulose  Loose fill  Hard Pack	2.9 to 3.6	✓ Made from 75%-85% of recycled newspaper and borate and/ or ammonium sulfate flame retardants, which are benign in comparison with other common flame retardants. ✓ Can be recycled ✓ Fills cavities more effectively than batts. ✓ Fire resistant ✓ Borates provide mold resistance ✓ Vapor permeable ✓ Can be installed in walls (hard pack) or in attics (loose fill)	Look for low-VOC binders containing no *formaldehyde* Install *attic baffles* to prevent air movement from displacing insulation	Attics New walls Existing walls
Fiberglass Batt 	2.6 to 4.3	✓ Lower first cost ✓ Familiarity among installers ✓ Many options available with 30%-40% recycled glass content ✗ Requires close attention and careful detailing around wiring and pipes, etc. ✗ Requires skin protection to keep fibers from penetrating skin such as long sleeves and gloves	Select high density batts for slightly higher *R-value* and better resilience Select products labeled with No Added Urea *Formaldehyde* (NAUF) Prioritize GreenGuard-labeled products	Floors Attics New walls
Blown-in Fiberglass 	3.6 to 4.4	✓ Fills cavities more effectively than batts ✗ Usually only used in closed cavities ✗ Can release breathable fibers into the air that are respiratory irritants	Select products labeled with No Added Urea *Formaldehyde* (NAUF) Use only if fibers can be prevented from entering the occupied space or ductwork	Attics New walls Existing walls

Insulation Type	*R-value* per inch of thickness	✓ Pros and ✗ Cons	Best practices	Where to install
Mineral Wool  Batts  Rigid	4-4.4 3.7 to 4.2	✓ Insect and fire resistant. ✓ Made from molten slag and/or natural rock (such as basalt and diabase) ✓ Less itchy to install than fiberglass batts ✓ Higher density than fiberglass so provides great sound deadening ✓ Vapor-permeable, fire-retardant, and moisture-resistant	Installs snugly in between framing members and cut around obstructions cleanly and closely Comes in batts or boards. Consider the fastening system when installing siding and furring strips (if using a rain screen) over thick layers of rockwool	Attics Floors New walls Existing walls (if wall covering is removed for renovations) Exterior side of new or existing walls
Sheep's Wool  Batts  Blown In	3.6-4.3	✓ 100% natural product that is renewable and sustainable ✓ Naturally mold, mildew, and fire resistant ✓ Zero VOCs ✓ No protective clothing or equipment is required to handle or install ✓ Biodegradable and compostable at the end of its life ✗ Higher cost and lower availability	Use the blown in product for better coverage and higher *R-value*. Use batts where blown-in is difficult or where you are installing it yourself	Attics Floors New walls Existing walls
Cotton Batts 	3.0 – 4.0	✓ Made from recycled blue jeans ✓ 100% natural materials and bio-degradable ✓ Excellent acoustic properties ✓ Contains borates for fire and pest resistance ✓ Recyclable ✗ Susceptible to water damage and mold	Installs snugly in between framing members and cuts around obstructions cleanly and closely Do not compress the batts as they will be less effective	New walls Existing walls Not advised for horizontal installations

Insulation Type	*R-value* per inch of thickness	✓ Pros and ✗ Cons	Best practices	Where to install
Wood Fiber  Boards  Batts  Blown In	3.4-3.6	✓ Uses a mixture of post-industrial, recycled wood chips, shavings, and milled wood ✓ Carbon negative ✓ Repels water due to wax treatment ✓ Boards can replace sheathing in some scenarios ✓ Wind Resistant and Vapor permeable ✗ Not fire-resistant ✗ Higher cost and lower availability	Use as exterior wall and roof sheathing to create a continuous insulation layer Locate a qualified installer that is familiar with dense-packing cellulose insulation Look for more manufacturing choices in the coming years	Roofs New walls Existing walls
Cork Insulation  Semi-rigid boards	3.6 - 4	✓ 100% natural product that is renewable and sustainable ✓ Carbon negative ✓ Zero VOC ✓ Sound isolating ✗ Higher cost and lower availability ✗ Typically manufactured abroad, so higher carbon impact to transport	Contact local supplier for thickness options and shiplap joints for thicker panels Cork resin is natural binding agent	Roofs New and existing walls
Algae Insulation  Seaweed is a plant that grows in the water along the coast. Excess leaves are discarded and washed ashore, where it is salvaged by local farmers, dried in fields, and then pressed into bales. It can be used as an insulating material due to its low density.	1 - 2	✓ Seaweed naturally contains minerals that make it resistant to attack by animals and molds and act as a flame retardant. This allows the product to remain free of artificial pollutants and chemicals. ✓ Made entirely of renewable raw materials ✓ Can be recycled and reused ✓ Fire proof (due to salts in the plant material) ✓ Biodegradable ✗ Comes from Denmark	Delivered in large round bales that must be pulled apart and hand placed in the wall and roof cavities	Walls Roof/ Ceiling

Insulation Type	*R-value* per inch of thickness	✓ Pros and ✗ Cons	Best practices	Where to install
Spray Foam Insulation 	5 to 6	✓ Best at stopping air flow ✓ High *R-value* per inch ✓ Great for sealing around windows, doors, cracks, and gaps ✗ High embodied energy ✗ Higher first cost than batts ✗ Not recyclable ✗ Highly toxic to install ✗ Not for DIYers ✗ Can pull away from wood framing as the framing shrinks due to drying.	Choose a qualified installer and ensure they completely fill cavities either with spray foam alone or a "flash and batt" technique combined with fiberglass batts Use a minimum of two-pound foam to avoid air bubbles and potential condensation Know the difference between "open cell" and "closed cell" foam – Close cell is not vapor permeable so it acts like a vapor barrier – open cell foam will allow vapor to pass through, which means you will still need to install the plastic sheet VR in your walls Don't be fooled into thinking that soy-based insulation is 100% soy, or even mostly made from soy; as much as 85% of soy-based insulation may be petroleum-based	Walls Underside of roof Rim joists Knee walls Optimal for use in homes with lesser stud depth (i.e. 2x4 in versus 2x6)
Rigid Insulation / Foam Board 	5 to 7	✓ High *R-value* per inch ✓ High durability ✓ Great for foundations ✗ Not recyclable. ✗ Manufactured using several hazardous chemicals, including the brominated flame retardant HBCD	Look for products with recycled content Look for blowing agents with little or no global warming potential	Exterior side of new walls Outside of basement walls

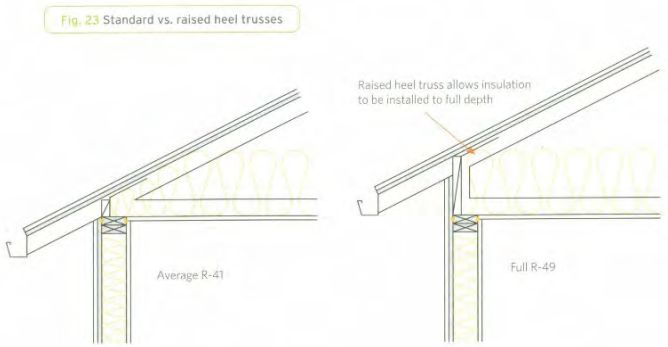
Insulation Type	*R-value* per inch of thickness	✓ Pros and ✗ Cons	Best practices	Where to install
Aluminum Faced Reflective Insulation 	4.9 to 14.1	✓ Serves as a thermal break and vapor barrier ✓ Best for adding a layer to existing insulation ✓ Best for homes with HVAC ducts in the attic ✓ Long lasting ✓ Prevents condensation ✗ *R-value* varies by materials between the foil faces ✗ Most effective in warmer climates to keep attics cool in summer	Look for single bubble or double bubble interior core Seal all edges with reflective tape	Attic floor Crawl Space ceiling

Any attic insulation should be smooth across the entire home. Mounding, lumps, valleys, voids and other problems with uniformity significantly reduce the overall *R-value* of the insulation. *Source: O'Brien360*

Here, loose-fill blown cellulose insulation covers the attic correctly – there is no indication of more or less insulation in any one area. Depth is uniform and smooth, and the code-required insulation ruler is visible near the back left to demonstrate insulation depth. *Source: O'Brien360*

In order to most effectively insulate your home:

- Consider conducting or having professionals conduct air-sealing and duct-sealing of your home. Seal cracks and penetrations with appropriate caulking or spray foam before installing any insulation to ensure full *R-value*.
- Regardless of which type or brand of insulation you select, hire a contractor who will guarantee a "*RESNET* Grade I" installation quality – this will ensure you get the full *R-value* and best possible performance.
- Install a blown-in product rather than batt when possible – a higher quality install and better coverage are more likely.
- In attics where there is more room, add more insulation than required by code.
- Utilize raised heel trusses to enable more insulation around the perimeter of the attic/roof.
- Install *attic baffles* in vented attics to prevent wind-driven air from passing through or behind the exterior wall insulation, causing heat loss, condensation and a reduction in *R-value*.
- Select fiberglass products with high recycled content and no added urea-*formaldehyde*. Look for the GreenGuard label.
- Select cellulose insulation with 100% sodium borate additive and no ammonium sulfate, which can release an ammonia odor if it gets damp or wet.



Cost Information / Incentives

The Washington State Department of Commerce provides information for weatherization programs that include the installation of insulation and other elements for income qualified individuals

Puget Sound Energy - PSE offers for rebates on a variety of items, including insulation.

Insulation costs will vary depending on availability, project size, insulation thickness, and installer. The table below can be used as a guide for comparing insulation costs based on product. It is always best to understand your project size, type, and goals in order to determine the best insulation solution for your home.

Insulation Cost Per Square Foot	
Insulation Type	**Cost of materials per square foot (1" thick unless noted otherwise)**
Cellulous	$0.35 - $0.70 (R-19 - R-38)
Fiberglass Batt	$0.30 - $1.50
Fiberglass Blown	$1.00 - $2.00
Mineral Wool Batt	$0.62 - $1.10
Mineral Wool Board	$1.62 - $2.27
Sheep's Wool Batt	$1.90 - $2.85 (R-13 - R20)
Sheep's Wool Blown	$2.22 - $5.90 (R-15 – R-40)
Cotton Fiber Batt	$1.20 - $1.50
Wood Fiber Board	$1.60 – $2.25
Cork Boards	$1.78 - $3.25
Algae	$1.75 - $2.45
Spray Foam	$0.50 – $2.00
Rigid Foam Board	$0.25 - $2.00
Reflective Sheet	$0.25 - $1.00

Costs based on 20232 information and will vary based on project square footage, location, etc.

Diving Deeper...

Some houses may contain vermiculite insulation; a shiny, brown rock-like material roughly the size of a pea. This insulation potentially contains asbestos and could be a health hazard if disturbed and inhaled. If you find this type of material:

- Do not perform any work that might disturb the material.
- Hire an *AHERA* Building Inspector to evaluate and test vermiculite.
- Conform to local remediation requirements and hire an abatement contractor as necessary.

Vermiculite insulation is often nugget-shaped and silver-gold or gray-brown. ***Source:*** ***Agency for Toxic Substances & Disease Registry***

Permit Tips

If you are adding insulation to an existing home (to the attic, walls, or floor/crawlspace/basement), typically you do not need a permit. However, if you are building a new home, an addition, or embarking on a significant remodel, then insulation is required by the WA State Energy Code. Your local jurisdiction will ensure the insulation *R-value* meets the minimum value required by code and that the insulation has been installed correctly.

Codes, Standards, References

Washington State Energy Code Table R402.1.1. shows the required *R-value* that should be installed in the ceilings, walls, floors, and foundations of your project.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Air Sealing Your Home
- Duct Sealing
- Fresh Air Ventilation
- Green Products and Building Components
- Heat Pumps and Efficient Heating and Cooling Systems
- Hiring the Best Professional for Your Project
- Thermostats
- Passive Solar
- Solar Energy

The EPA recommends several private sector standards/ ecolabels to be considered when purchasing insulation.

Greener Options for Fiber Glass and Cellulose Insulation: This brochure provides a list of products with high recycled content and low emission of *VOCs* that have been third-party tested.

Puget Sound Clean Air Agency - This web link provides information on how to manage asbestos containing materials

Advanced Framing

Overview

The majority of homes in King County are built using lightweight wood framing, often referred to as "stick built." *Advanced framing* is a tried and tested approach to stick framing that allows you to do more with less – more performance with less wood. By using standardized dimensions and optimizing the layout and alignment of the joists, studs and trusses, you can build a structurally-sound, code-compliant building that uses less wood, takes less labor to build it, and leaves more space in the walls for insulation to save energy and keep you comfortable.

Definitions

Advanced Framing

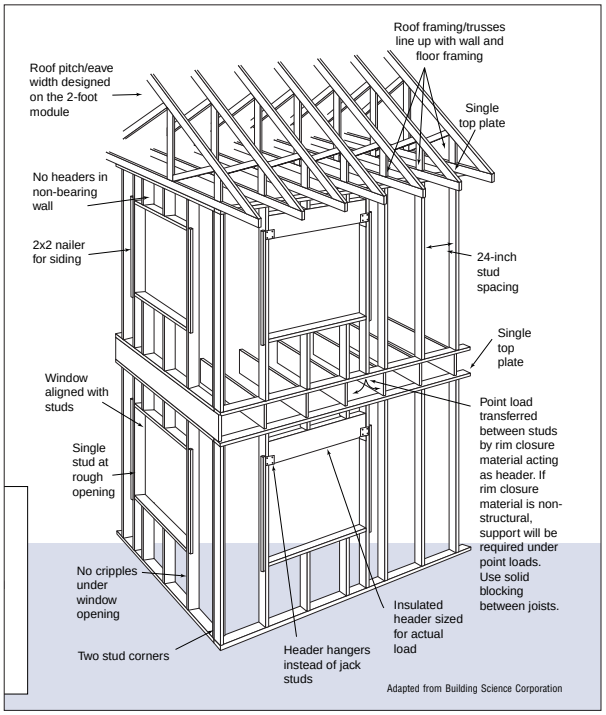
Wall studs, floor joists, and rafters framed 24 inches apart (instead of the typical 16"), both reducing the amount of lumber used and waste generated, as well as creating more space for insulation, which increases a home's energy efficiency.

Thermal Bridging

Heat loss through the wall or roofs where wood studs or other materials cause breaks or reductions in the amount of insulation.

When is This Applicable?

The *advanced framing* technique can be used in most one- and two- story buildings and additions. On taller buildings it may be applicable for the top two stories only, unless a licensed engineer is involved in the framing design. The Washington State Residential Code includes standard, code-approved *advanced framing* options (Chapter 6 and Table R602.3 (5) for walls and Chapter 8 for ceilings and roofs).



This framing detail from the U.S. Department of Energy demonstrates shows the use of advanced framing spacing in a two-story structure.

What Makes it Green?

Advanced framing is a win-win technique. It lowers construction cost, resource consumption, and pollution while contributing to a comfortable, more efficient home. Here are some reasons why:

- *Advanced framing* is environmentally friendly because it reduces the amount of lumber used and waste generated in the construction of a wood-framed house.
- With fewer nails to pound and cuts to make, framers experienced with *advanced framing* find it saves time and money and reduces waste.
- With wider spacing between studs, and different stud layouts at openings, corners and wall intersections, and features like raised heel trusses, *advanced framing* allows for more insulation in the walls and ceiling and reduces *thermal bridging*.
- This increase in insulation and reduced *thermal bridging* means the walls and ceiling have a more even temperature across the surface to help make your house more comfortable and efficient.
- Reduced energy use for heating reduces utility bills, environmental impacts and air pollution from producing power or burning fossil fuels needed to heat and cool your home.

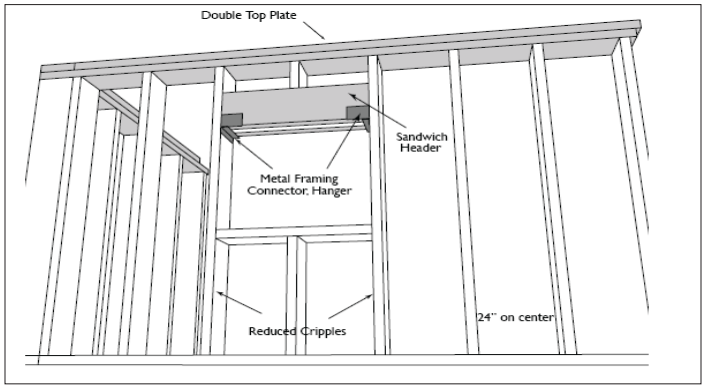
Best Practices

There are many beneficial key elements of *advanced framing*; the more elements you include from the following list, the more benefits you will achieve. *Advanced framing* construction practices can be performed by experienced DIY'ers by educating themselves prior to work. If unfamiliar with this method, consider seeking help from an experienced contractor or input from a licensed engineer for your project.

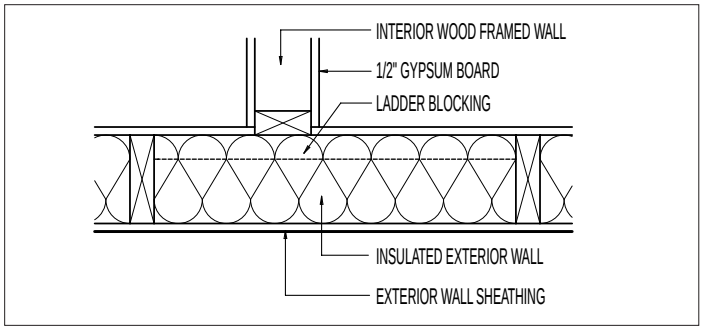
- Increase stud, joist, and rafter spacing from 16" (most commonly used) to 24" on center.
- Keep studs, floor joists, and roof trusses or rafters in line vertically – called stacking.
- Use a single, rather than a double, top plate. This is allowed where framing is stacked so that rafters or joists above are within 1" of the stud below and top plates are properly connected at corners, walls and splices.
- Design wall heights and eaves to accommodate full and even depth of ceiling insulation extending to the outside edge of exterior walls.
- Frame corners using two studs or drywall clips to allow for fully insulated corners.
- Design on 24" or 48" modules to make the best use of standard material sizes which will reduce, cost, waste, and labor.
- Prioritize simple forms and standard dimensions over complex forms and irregular dimensions.
- Align openings with at least one edge of a 24" module.
- Minimize framing around doors and windows by using metal hangers.
- Use flat-stud or ladder-blocked intersections to allow full insulation.
- Create headers by "sandwiching" foam insulation between plywood and small framing members.
- Include raised heel height requirements in your roof truss order.

Be sure to use sheathing and drywall that is rated for a 24" span. Having fewer studs in contact with wall planes actually reduces risk of deflection that can be caused by warped or crowned studs. While some flexible siding materials may bow more over the longer span if not supported by a rigid backer, there are decades of examples of successful advanced framed homes with long-lasting benefits.

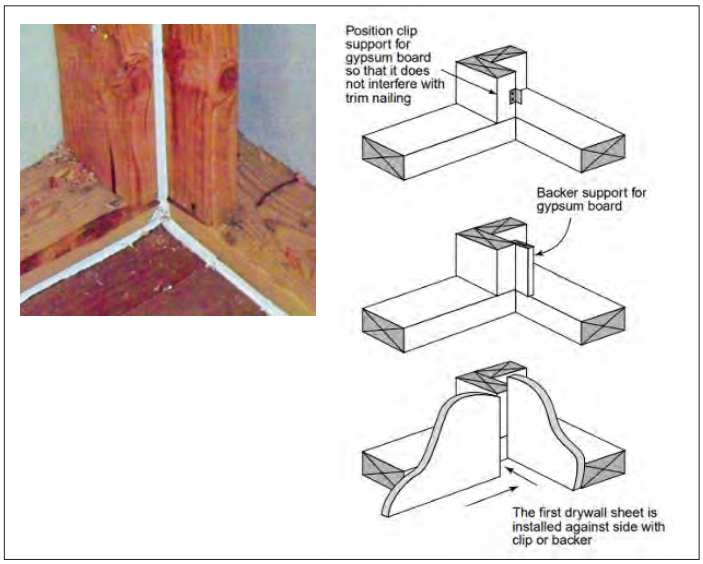
Go Further: *To enhance the green benefits of advanced framing, source sustainably-harvested wood such as wood certified through the Forest Stewardship Council (FSC) – see Resources for more information.*



Suggested approaches to advanced framing. The double top plate is only needed if you are not stacking. *From the Olympia Master Builders Built Green® Field Guide.*



Ladder blocking at wall intersections accommodates insulation of exterior wall. *From Energy.gov.*



These stud arrangements enable insulation to be fit into the full depth of the corner with minimal framing. Photo shows a nailer for drywall, drawings shows clip placements. *Photo source: O'Brien360. Diagram from the Olympia Master Builders Built Green® Field Guide.*

Cost Information / Incentives

The Engineered Wood Association states that by optimizing framing material use, the builder can cut floor and wall framing material costs by up to 30 percent while reducing framing installation labor.

Permit Tips

Be sure to include notes and details on your plans associated with *advanced framing* techniques. The King County Department of Local Services, Permitting Division will inspect the *advanced framing* techniques during an onsite framing inspection. If your project is located outside unincorporated King County, please confirm requirements and resources with the local jurisdiction.

Codes, Standards, & References

Code guidance for how to build using the *advanced framing* technique can be found in chapters 6 and 8 of the 2021 Washington State Residential Code.

The Washington State Energy Code - Residential: Section 402 in particular describes framing and the thermal value of wall assemblies.

Resources

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See these related King County Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Air Sealing Your Home
- Construction & Demolition (C&D) Materials Management
- Hiring the Best Professional for Your Project
- Insulation

Additional fact sheets about *Advanced Framing* include the Department of Energy's Advanced Wall Framing Technology Fact Sheet and Bellingham's Advanced Methods and Materials AMM400.

U.S. Department of Energy – Provides *Advanced Framing* information sheets

Forest Stewardship Council (FSC) -This web site promotes environmentally appropriate, socially beneficial, and economically viable management of the world's forests.

**Note: FSC is important from a social equity perspective. Its 10 Principles of Certification includes Indigenous people's Rights and Workers Rights. Their ethical requirements for harvesting are supportive of other habitat as well including clean water for salmon.*[1]

WSU Energy Program – The WSEC Builder's Field Guide provides helpful *advanced framing* techniques and drawing details.

1 https://www.nnrg.org/our-services/get-certified/fsc/

Roofing Materials

Overview

The roof is the first line of defense against the elements, protecting the people, building exterior, and things you value within your home or structure. Beyond this critical role, roofs can improve your home's performance and comfort. For instance, the slope of the roof, color and material type can help reflect rather than absorb solar heat and reduce *stormwater runoff.*

Additionally, roof materials play a major part in affecting local water quality. Some roofing materials contain harmful ingredients such as arsenic, cadmium, copper, lead, and zinc. *Stormwater runoff* from roofs often deposits water and pollutants directly into the local water table, or into the stormwater system which flows directly into streams, lakes, or Puget Sound. You can help protect your local ecosystems while potentially reducing cooling needs and utility bills through informed and strategic roofing material choices. Below you will find different options, best practices, and important things to consider when upgrading, repairing or building a new roof.

Definitions

Evapotranspiration
The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration, or the release of water vapor from plants.

Stormwater Runoff
Precipitation that flows over impervious surfaces, accumulating debris, chemicals, sediment, and other pollutants as it goes, and does not percolate immediately into the ground.

Vegetated Roof
A roof that is partially or completely covered with vegetation and a growing medium, planted over a waterproof membrane.

When is This Applicable?

Whether you are repairing or replacing your roof or planning to build a new structure, there are opportunities to consider roofing material choices and how your roof water runoff will be handled.

What Makes it Green?

Consumers have many choices when it comes to roofing materials. While initial cost is often a driving force when selecting roofing materials, there are numerous other considerations that factor into the total lifetime costs and benefits of your roof – including many that provide green benefits.

Roofing Materials

Some types of materials and systems deliver more green benefits than others, such as low toxicity, recyclability, recycled content, as well as energy-producing and energy-conserving features. Durable roofing materials require less frequent replacement, saving natural resources and money while adding value to your property.

Roof Stormwater Runoff

You can make roofing choices that minimize pollution transported to our water bodies through roof runoff. For example:

- Choose materials that are not pollution-generating to avoid the need for additional treatment of roof runoff for water quality mitigation. For example, metal roofs are considered pollution-generating impervious surface unless they are treated to prevent leaching of zinc and other water pollutants.
- If your house has a flat roof, consider using a vegetated roof which can reduce or even eliminate water runoff from your roof. Vegetated roofs reduce *stormwater runoff* by retaining water on the roof in the soils and plants, slowing peak flows, and increasing *evapotranspiration*. This in turn decreases the demand on our stormwater systems. *Vegetated roofs* can also help promote clean air and increase wildlife habitat.

For added benefit, consider adding rainwater collection; see the "Rainwater Harvesting for Outdoor Use" Green Sheet for more information on this option.

Rooftop Solar Options

Adding solar photovoltaic (PV) panels or solar thermal collectors to your roof, produces energy or heats water, and will increase your energy independence as well as reduce your carbon footprint. The cost of solar energy systems is falling rapidly – some forecast photovoltaic systems will be cheaper than grid electricity in King County in the near future. (See the "Solar Energy" Green Sheet for more information)

- When doing roof work on an existing home, if you have a roof with good solar access and relatively few obstructions (roof vents, skylights, etc.), consider preparing the roof for the future installation of a solar array - even if it is not an option to install now. If you have a relatively flat roof (roof slope of 2:12 or less), consider installing a capped roof penetration sleeve to allow for future conduit routing. Integrating the pre-wiring or conduit access points into the roof now is a better approach than drilling holes in a good roof later.

Diving Deeper...

If you are striving to achieve Living Building Challenge Certification on your project and you intend to harvest and treat rainwater for potable use, the roofing material you select will need to be National Sanitation Foundation (NSF) certified.

Best Practices

Pay careful attention to the design of your roof – think like water when looking at the design. Is there a free path for the water from the point of impact to the bottom of the downspout? Even the best flashing and materials will fail if water flows are concentrated and constrained by roof lines.

Solid-Surface Roofing

Characteristics to consider

- *Durable:* Use durable materials to reduce the frequency of replacement. Some varieties of shingles have up to 40-year warranties, while some aluminum or steel shingles have 50-year warranties and include a coating that is HUD-approved for rainwater collection suitability.
- *Composite materials:* Consider one of numerous composite roofing material options that can provide lower maintenance along with durability. Because some composite materials may contain zinc, it is important to identify the ingredients of your options before making a decision.
- *Recycled content:* Give preference to shingles with recycled content, preferably at least 25% post-consumer content.
  - Asphalt shingles typically contain recycled "mixed" waste paper or reclaimed mineral slag, some resulting in 20% to 25% recycled content.
  - Roof panels made from recycled plastic resins provide a lightweight roofing alternative.
  - Recycled aluminum shingles may contain up to 100% recycled content.
- *Ingredients:* Based on a Department of Ecology collaborative study with King County and roof manufacturers, it's best to avoid the following materials to prevent the release of additional pollutants in roof runoff:
  - Treated wood panels – contains copper and arsenic
  - PVC panels – contains arsenic
  - Copper panels – contains high copper concentrations
  - Zincalume® and EPDM roof – contains zinc
- *Energy Generation:* Solar shingles and solar panels produce clean energy. Savings in utility bills help to offset installation costs.
- *Solar Reflectance:* Select materials with a high solar reflectance value because lighter color materials are better at reflecting solar heat and keeping your home cool. Look for materials with a high solar reflectance Index (SRI) value of a roofing material. For example, the value of a standard black material is 0, and a standard white value is 100.

Roofing material types:

- **Solar Shingles** – These shingles are similar to traditional shingles but generate electricity. They are made of flexible thin-film solar cells.
- **Metal Roofs** – Durable, fire-resistant, and can last up to 50 years. Treated metal roofs are ideal for funneling rainwater to a rain barrel or cistern; Standing seam models are ideal as the base for thin-film solar panels. Many metal roofing products include recycled material.
- **Forest Stewardship Council (FSC) Certified shakes and shingles** – these are conventional wood shingles that have been certified to have been grown and harvested using sustainable practices. Keep an eye out for local retailers.
- **Slate Tiles** – Slate is one of the most durable shingles and is made from a natural material. It can last hundreds of years, often being warranted for 100 years. However, it is not a locally sourced material, so it travels from a long distance,
- **Clay Tiles** - Clay is also a highly durable roofing material but does not have the same life as slate.
- **Conventional Wood Shingles** – If not FSC Certified, conventional wood shingles are generally milled from old-growth western cedar. However, untreated (with chemical preservatives) wood shingles and shakes can be considered are a greener choice for roofing materials. They are easy to make and dispose of when you need a roof replacement because wood is a natural resource, renewable and biodegradable.
- **Asphalt Shingles** – Made from asphalt-saturated fiberglass that is covered with granules of rock. They typically contain recycled "mixed" waste paper or reclaimed mineral slag, some claiming 20% to 25% recycled content.
- For ***vegetated roofs*** consider the following:
  - The roof structure must be designed to carry the added load of a *vegetated roof* system, therefore design by a Washington State licensed engineer may be needed.
  - A 60- to 80-millimeter thick reinforced PVC membrane must be placed on the roof surface to provide waterproofing and protect against root penetration, or if the roof is asphalt-based, the membrane must be high-density polyethylene (HDPE).
  - If the roof surface is flat or has a pitch flatter than 1 in 12, an underdrain system or layer must be provided to drain excess water away from the root zone of the soil layer.
  - The growing medium must have the capacity to store a minimum depth of 3 inches of water for full Best Management Practices (BMP) credit, partial credit will be given for reduced storage.
  - The soil layer must be adequately contained on the roof with sidewalls or other appropriate means.
  - The composition of the soil layer must be confirmed by a civil engineer as meeting the desired soil storage and the maximum allowable loading specified by the structural engineer.
  - Plant grass or other vegetative cover suitable for shallow soils and harsh roof conditions (e.g., various species of sedum, sempervivum, creeping thyme, allium, phloxes, anntenaria, armeria, and aubrieta).
  - *Vegetated roofs* must not be subject to any use that would significantly compact the soil.
  - Provision must be made for supplemental irrigation during the first dry season to ensure plant survival, along with replacing dead plants, removing weeds and leaves, and clearing drain inlets.

Note: If you are in an area prone to wildfire, near relatively forested or undeveloped natural areas, or in an area classified as wildfire-prone by virtue of it being in the Wildland-Urban Interface, some types of roofing materials or configurations may not be allowed or would be ill-advised due to increased fire risk.

- Most fiberglass asphalt composition shingles have Class A Fire resistance but ask your roofer for a specifications sheet in advance to verify the product has ASTM E108/ UL790 ratings.
- Noncombustible materials are a good alternative, including Iron (ferrous); cement and fiber-cement shingles or sheets; clay or concrete roofing tiles; slate shingles; exposed concrete slab roof; or other exposed masonry or brick features.
- Note that wood shakes and aluminum roofing are not fire-resistant by themselves; wood shakes need to be treated with fire retardants, and aluminum roofs require additional materials, to comply with fire-resistant certifications.

Maintenance

After installation, continued roof maintenance is the most important factor in prolonging the life and performance of your roof:

- Visually inspect your roof for damage or debris (missing or damaged shingles, algae, fungus, moss, leaves, etc.) on a regular basis to identify trouble as soon as possible and avoid cumulative effects of disrepair. Do this by walking around your home and, if accessible, by

climbing a ladder. Also schedule routine professional inspections every few years.

- Check the flashing around all exterior penetrations, such as vents and chimneys, for signs of deterioration.
- Make sure your gutters are clear, continuous, and well attached to your home.
- Remove overhanging tree limbs to avoid pest infestation and potential damage from falling branches.
- If you have an attic, inspect your attic ceiling to identify any issues that may not be visible from the exterior. Look out for streaks or staining from water leakage as well as holes and insulation damage from pests.
- *Vegetated roofs* need to be inspected regularly to check for plant health, weed removal, that soil is not washed out after a heavy rain, etc. (See Appendix A of the Surface Water Design Manual)

Roof Removal / Disposal

You may be able to recycle your old roofing materials. Check King County's "What do I do with...?" interactive website which will show locations near you where materials can be recycled or disposed of. See the "Deconstruction and Reuse" and the "Construction & Demolition (C&D) Materials Management " Green Sheets for additional information.

Cost Information / Incentives

Solar Incentives and Permit Process Guide: Provides information on Federal and State rebates and tax incentives your project may be eligible to receive.

Roof shingles are sold by both the square and by the bundle. A square of shingles covers 100 square feet of roof; there are 3 bundles in a square.

When receiving a quote from a professional installer, roughly 40% of the total will reflect the materials and 60% will be labor to install.

Average Price of Shingles[1]		
Type	**Per Square Foot**	**Per Bundle**
Solar Shingles	$2,200	n/a
Metal Roofs	$300 - $1,800	$100 - $600
Slate Tiles	$800 - $1,800	$270 - $600
Clay Tiles	$800 - $1,800	$270 - $600
Conventional wood shingles	$480	$160
Asphalt Shingles	$100 - $150	$30 - $50

1 https://www.homeadvisor.com/cost/roofing/shingle-roof-estimator/

Vegetated (green) roof. *Source: O'Brien360*

Composite Roofing with solar photovoltaic panels. *Source: O'Brien360*

Permit Tips

Confirm with the local jurisdiction if a building permit is needed for a roof replacement. In unincorporated King County, roof replacements for detached one- and two-family houses do not require a. If you are increasing your existing roof load by more than 4 pounds per square foot you will need a permit. Most roofing contractors will interact directly with the building department to obtain the permit or at least help you navigate the process. Ask the contractors you contact for bids if this step is included.

Codes, Standards, & References

(2021 King County Surface Water Design Manual (In particular, Appendix C)

Requirements for roof coverings can be found in Section 905 of the 2021 Residential Code

Solar Incentives and Permit Process Guide: Provides permitting guidance for projects in unincorporated King County. If located elsewhere, please not located in federal and State rebates and tax incentives any project in King County may be eligible to receive. Please check with your local jurisdiction for permitting guidance if your project is not located in unincorporated King County.

Solar Photovoltaic System, Roof Mounted, Residential Exemption: This handy checklist for projects in unincorporated King County will let you know if a permit is required to install your rooftop system. If your project requires a permit, please check out the Renovations and Remodel Overview.

Resources

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- Amended Soils
- Construction & Demolition (C&D) Materials Management
- Fresh Air Ventilation
- Hiring the Best Professional for Your Project
- Green Products and Building Components
- Insulation
- Permeable Surfaces, Walkways, & Driveways
- Rain Barrels, Cisterns, & Rain Gardens
- Routine Home & Yard Maintenance
- Solar Energy

ASTM International – This organization provides standards for various types of roofing systems.

Copper, Zinc and Urban Runoff (2019) - A document by the Washington Department of Ecology identifying leaching potentials from the various roofing materials.

Salvaged Tile Roof. *Source: O'Brien360*

Efficient Water Heating

Overview

Many homes in King County use one of the following water heating systems:

- Natural gas-fired or propane-fired water heater
- Electric resistance water heater
- Oil-fired water heaters

These systems are familiar and reliable. However, for new construction and home remodels, higher efficiency options such as heat pump water heaters are now available to homeowners. While some high-efficiency water heaters may have a slightly higher up-front cost, they will save resources and money during use, delivering a return on your investment. Your utility company may also offer incentives for replacing older equipment or buying new high-efficiency water heaters.

Definitions

Heat Pumps (general)

A heat pump is an electric appliance that works in a similar way to a refrigerator or air conditioner, but in reverse. The system uses electricity to drive a refrigeration loop that moves heat from a source (air in or outside the home) to a point of use (inside your house or water heater). Heat pumps can be 2-4 times as efficient as electric resistance heating and 3-5 times as efficient as oil or gas water heating.

Rating Systems

There are many rating systems for appliances. Commonly used systems for water heaters are from the Consortium of Energy Efficiency (CEE) and EnergyStar, which is sponsored by the US Government. These rating systems help provide information on efficiency and performance of appliances to allow comparisons between manufacturers and system types.

When is This Applicable?

Highly efficient water or renewable energy water heating systems can provide significant energy and cost savings over fossil fuel and electric resistance system over their operational life. When purchasing a new water heater, compare not only the sticker price, but how much you will save on energy bills over time!

They may also be used to replace an existing water heater appliance upon failure or near the end of its service life. Washington State is phasing out fossil fuels from our energy mix, so shifting away from water heaters that run on fossil fuels is an important step in that direction.

What Makes it Green?

Highly efficient and renewable energy water heating equipment can significantly reduce the energy used and cost of water heating over older, less efficient equipment. Fossil fuel heating decreases local air quality and is significantly less efficient than electric resistance or heat pump water heaters. Examples of high-efficiency and renewable systems include air-source and ground source *heat pumps*, solar thermal collectors and passive solar design.

Additional positive features of high-efficiency appliances include:

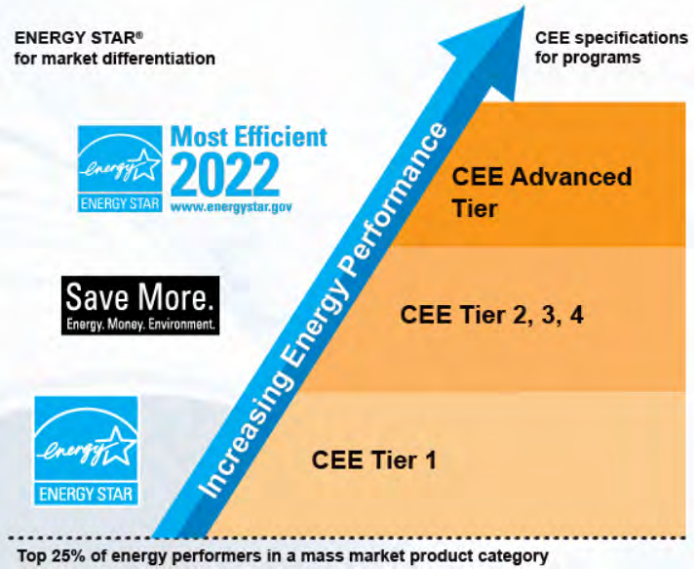
- Lower overall electricity use.
- Less standby heat loss from water heaters.
- The ENERGY STAR Certified Homes Program requires ENERGY STAR labeled appliances and high-efficiency water heaters, and you can earn additional points in Built Green and LEED for Homes for choosing high-efficiency appliances.

Due to the unique mix of electricity production in Washington including large amounts of hydro power, our electricity tends to be less affected by fluctuating fossil fuel price than other states. This means using electricity for water heating with resistance heaters or a heat pump can provide more stable energy bills over time than fossil fuels.

Best Practices

Before considering replacing or upgrading your existing water heater, it's important to look at the ways you use hot water in the home. A quick and easy way to save money and energy is install more efficient and lower flow fixtures like sinks, and showerheads. Washing your clothes on cool or cold cycles is another way to reduce hot water use and save energy. The Resources section at the end of this document provides other places to look for savings in addition to more efficient water heating equipment.

In order to find the most efficient appliances, look for a third-party efficiency label such as ENERGY STAR or Consortium for Energy Efficiency (CEE). The ENERGY STAR label products usually exceed minimum federal standards by a substantial amount, while CEE goes beyond ENERGY STAR and delivers greater savings.

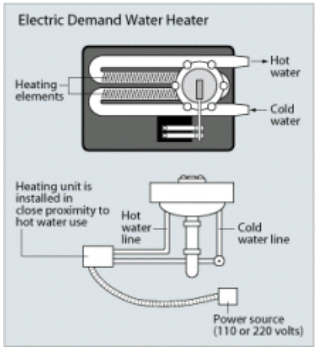
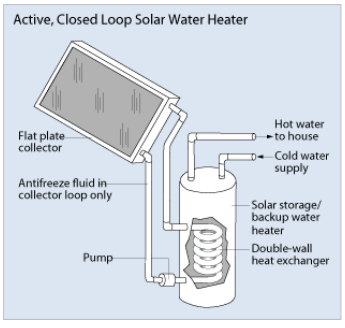


This graph shows the relationship between ENERGY STAR and CEE Tiers. *Source: http://www.cee1.org/content/cee-tiers-and-energy-star*

Image courtesy
Delta Faucet

The following table provides considerations and examples for advanced and alternative water heating systems for your project.

Water Heating System Types		
System Type	**Benefits**	**Considerations**
Heat Pump Water Heater  *Photo Credit: Rheem Inc.*	• Heat pump water heaters are two to three times more efficient than electric resistance water heaters, sourcing heat from the surrounding air. • Although they have a higher upfront cost than electric water heaters, they are comparable to high-efficiency gas water heaters with lower operating costs than gas. • The average home can save $300 per year in utility bills which usually pays for the higher install cost in less than 5 years. • The water heater provides some cooling to the room it is in which can be helpful in the summer. • Most are equipped with WiFi controls, making it easier to lower temperatures and costs during vacations or low-usage times.	• CEE and ENERGY STAR Rated models are available. • Many units require the water heater to be in a room of about 10 feet by 10 feet (100 square feet). The energy used to heat the water is drawn from the air around the water heater and to operate efficiently, must have some volume around it. • A large closet or garage could be a good choice. The room you locate the water heater in will tend to be cooler, so using an unheated room, like a garage, is preferable to avoid increased heating load. • If you don't have sufficient space, the unit may need a duct or vent grille on a nearby door. If you have an existing gas water heater, the exhaust duct might be adapted for this use. • Heat pump water heaters emit noise similar to a modern refrigerator (approximately 50 decibels), so they may not be appropriate near bedrooms or office spaces. • Most models require 15-30 amps from your electric panel. If you don't have an electric water heater or your home has 100-amp electrical service, or has no 240-volt connection, ask your installer whether an electrical service upgrade is required.

Water Heating System Types		
System Type	**Benefits**	**Considerations**
"Tankless," "Instant" or "On-Demand" water heaters (Point of Use Electric Resistance Heating)  *Photo credit: energy.gov/energysaver/ tankless-or-demand-type-water-heaters*	• Can be more efficient due to lower thermal losses because there is no storage tank from which to lose heat. • Water is only heated when needed. • Smaller physical size, so the devices can typically fit under a sink or in a small closet. • For homes that use 41 gallons or less of hot water daily, demand water heaters can be 24%–34% more energy efficient than conventional storage tank water heaters. They can be 8% –14% more energy efficient for homes that use a lot of hot water -- around 86 gallons per day.	• Units are classified by flow rate. Exceeding the rated flow will result in cooler water. • The higher flow required, the larger the electrical power needs. Check your electrical panel or consult an electrician before purchasing to ensure your panel can accommodate the additional load. • Some point of use (instant) hot water heaters may be coupled with a small storage tank to provide a balance between features.
Electric Resistance – Tank  *Photo Credit: Ferguson Inc.*	• Electric resistance water heaters have a maximum energy efficiency of about 95%. • More storage capacity than tankless units for higher flowrates; this can accommodate more appliances/fixtures running at once. • May have a lower peak power use, so a smaller breaker can be used. This can make a retrofit easier in older homes with reduced electrical service panel capacity.	• Some energy is lost to the air through the insulation, though energy loss is very low with modern designs. • Size depends on the demand in the home. Most units will take up a closet, or the corner of the garage. Smaller units may fit in a cabinet. • The tank requires some time to reheat after high demand. Look at the information label for details on particular models.
Solar water heating  *Photo Credit: energy.gov/ energysaver/ solar-water-heaters*	• After installation, these units cost little to operate and require no energy. • Systems last 20 years or more • They may have electric resistance heaters as backup during cloudy periods of year.	• Just like electricity-producing solar panels, these systems need unshaded roof space facing south. • Systems in King County will typically require a separate heating loop with a small pump to circulate treated water to prevent freezing in winter. • An experienced contractor is required to help identify if your home is suitable for this type of system, and because they are less common may be more challenging to install.

Maintenance

Keep your appliances running as efficiently as possible and prolong their life by following these best practices:

If you have a tank water heater, check the outside for corrosion, which can lead to cracks and leaks.

Ensure the water heater is raised off the floor with a pan or other support recommended by the manufacturer. This can avoid water buildup and corrosion.

Consider having one of our local salvage retailers sell an unwanted appliance so it can be used by someone else.

Cost Information / Incentives

A typical heat pump water heater costs about $1,100 new, and an additional $400 if you hire a contractor to install it. A similar sized electric resistance heater with tank is about $600 installed. The energy costs of a heat pump water heater are nearly always about one third of the costs from a typical electric resistance tank-style heater or gas water heater.

Electric tankless water heaters cost from between $300 and $1,200 dollars. Smaller units for a single sink are lower cost, while larger units for a whole home, or larger appliances cost more. Installation costs for tankless units are similar to those for tank water heaters.

Solar hot water option: A family of 3 or 4 would typically use an 80-gallon tank which costs about $5,000 for the equipment and $2,000 for installation. The cost may be less if you opt for 60-gallon tank, which is more typical for 2- and 3-person households. Green loan options may help finance the install.

Electrical panel upgrades or changes to accommodate new electric water heaters can be expensive, but are not often required. Consult an electrician to identify any needs for your particular installation.

Note that the average heat pump water heater lasts longer than tank systems (12-15 years for *heat pumps* versus the 10-13 years of either a natural gas or electric tank systems), though both tankless hot water heaters and solar heating last up to 20 years or more. Solar hot water and heat pump water systems will provide an excellent return on your investment; both systems pay for themselves in operational savings in 5 years or less (including the current 30% federal tax credit for the solar thermal system).

Solar water heating: Can cut up to 80 percent off water heating bills with a relatively quick payback. Note that Solar water heating systems may require back-up systems, or alternatively can supplement conventional water heating equipment rather than replacing it.

Check out the rebates offered through Seattle City Light and Puget Sound Energy.

Federal tax credits for energy efficiency have mostly been extended through 2032 thanks to the Inflation Reduction Act of 2022.

Note that if you are converting to natural gas for your currently electric water heater, running a new gas line and installing venting can add between $1,500 to $2,500 in installation costs. Alternatively, converting from gas to electric will require capping the existing gas line (can be performed by a plumber), typically costing around $200; it may also require upgrading your electrical panel if you have a 100 amp system.

New Construction Water Heater Comparison

Water Heater Type	Heat Pump	Tankless Gas	Tank Electric	Tank Gas
Efficiency	310%	82%	92%	60%
Annual Operational Cost	$120	$248	$405	$339
Installed Cost	$1,250	$2,300	$500	$1,400
First Year Cost	$1,370	$2,548	$905	$1,739
5 Year Cost	$1,851	$3,540	$2,524	$3,094
10 Year Cost	$2,451	$4,780	$4,547	$4,789

A helpful table comparing install costs versus billing costs over time is provided by Bob Price Jr.

Permit Tips

Water heater installation projects may be required to obtain a plumbing permit. If your project is in unincorporated King County, replacing a water heater connected to the same type of fuel source (gas to gas, electric to electric), a plumbing permit is not required – but this may vary between jurisdictions so it's wise to check. Electrical permits through local governments and Labor and Industries will be required for installing new electrical equipment.

Washington State Labor and Industries Electrical Permitting Page: Provides information about required permits, obtaining permits, and required inspections for electrical work in the home.

Some cities have their own Local electrical permitting jurisdictions. Those can be found at the link provided.

King County Department of Health Division's Permitting Information page: General information and forms about plumbing and gas piping permits for City of Seattle and unincorporated King County.

Codes, Standards, & References

Some safety measures while installing a water heater are listed below.

- Install in an accessible area with 24-inch continuous width for access.
- Protect the water heater from earthquakes by placing seismic bracing on the tank.
- An expansion tank or thermal expansion device must be installed if your water is on a closed system.
- Temperature or pressure relief valves must be installed according to the manufacturer's instructions.
- Use 20-gauge sheet metal straps to protect your water heater in case of an earthquake.
- See "Considerations" in the Water Heating System Types table to review installation needs for Heat Pump Water Heaters.
- To install or change the gas piping on a gas water heater, a separate gas-piping permit must be obtained. See the costs section for cost impacts of converting to gas or to electricity from other sources.

King County Department of Public Health has tips for installing a water heater.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

Also see these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces
- *Heat Pumps* and Efficient Heating and Cooling Systems
- Rainwater Harvesting for Outdoor Use
- Toilets, Showers and Faucets

ENERGY.gov Energy Saver articles - These pages provide extensive information about all types of water heating technology.

Rewiring America - Is an American non-profit dedicated to removing combustion equipment from homes and helping consumers purchase electric equipment instead, including heat pump water heaters. They have extensive rebate and cost savings information.

Keeping Energy Bills out of Hot Water: This DOE graphic helps you quickly compare the pros and cons of selecting different types of water heaters.

Heat Pump Water Heater (HPWH) Buying Guide - ENERGY STAR guidance on buying and installing heat pump water heaters affordably.

King County Appliance Disposal Information - This database provides information on how to properly dispose of different appliances in King County, in addition to other materials.

Comfort Ready Homes: Offers a list of certified contractors for weatherization, water heating and HVAC professionals.

Toilets, Showers, & Faucets

Overview

You can get big savings through easy, small improvements to your home's water *fixtures*. Whether you are dealing with a constantly running toilet, a barely-there leak in the background, or an older showerhead – you might be surprised at how much water these seemingly small culprits consume. Simple water conservation measures incorporated into individual projects are easy to do, have little to no cost premium, and can save you money on your energy bill while also stretching our region's water resources. Many local utilities have incentives for replacing shower heads, toilets, and faucets. Be sure to check what incentives are offered when you replace these *fixtures*.

Definitions

Gallons per Minute (gpm), Gallons per Flush (gpf)
The unit for measurement of water use by different fixture types. Faucets and showers are measured in gallons per minute, toilets, and urinals in gallons per flush.

Potable Water
Water safe enough to be consumed by humans.

Aerator
A flow restrictor device that can be screwed into the tip of modern indoor water faucets, delivering a mixture of water and air to reduce water use but maintain performance.

Greywater
Waste water saved from sinks, showers, and laundry equipment that can be used to flush toilets and water gardens for a significant savings in water use.

Fixture
Plumbing we interact with most in our homes, such as showers, sinks, faucets, and toilets.

When is This Applicable?

You can make water-smart choices on new plumbing fixtures when replacing individual fixtures, or when tackling a home remodel or building a new addition or home. The Plumbing Code sets maximum flow rates, but there are many cost-effective lower-flow choices that are even more efficient and effective. Out-of-date water fixtures are usually relatively easy to replace with new and more efficient options, so any chance you have to update fixtures is a great opportunity for both water and septic savings. Most fixtures which comply with code do not cost more and do not require costly design considerations. It's easy!

What Makes it Green?

The average household in the U.S. spends $1,100 per year in water costs but can save $350 from retrofitting with WaterSense labeled plumbing fixtures and ENERGY STAR® qualified appliances. Saving water also saves a significant amount of energy used for pumping (whether on wells or municipal water) and energy used on treating water (municipal water). The following additional benefits make the case for choosing high efficiency water fixtures:

- Water-efficient fixtures, as well as the use of faucet aerators, help lower household energy use. It takes a lot of energy to heat water, so using less of it through efficient fixtures can save a lot of energy and money!
- Reducing water use reduces wastewater and thus prolongs the life of septic fields and tanks, and your city's sewer system.

Digging Deeper...

Worldwide, only 3% of all water is freshwater—but most of it is frozen or underground and difficult to harvest. In fact, only about 0.3% of the water on the planet is freshwater that we can actually access and use. Researchers have found that, since 1900, US water use has increased six times while the population has only doubled. Our limited water reserves are an important resource to protect, and here are ways your project help:

- Efficient water fixtures can significantly reduce the amount of potable water used and lessen the stress on the local water table.
- More efficient toilets have a big impact: toilet flushing is the largest single use of water (consuming up to 40% of residential water use).

Best Practices

Consider using *non-potable* water, such as rainwater or *greywater* for toilet flushing. About 40% of the home's water use ends up as *greywater*, so this can provide a significant savings!

Prioritize fixtures with the WaterSense logo to help save water, energy, and money without sacrificing performance.

Water Fixtures *Look for the WaterSense Logo*		Maximum Flow Rate to meet WA's Plumbing Code	Other Considerations
Toilets	 	1.28 *gpf*	Toilets constitute at least 30% of daily household water use, making toilets the main source of water use. Dual flush toilets can significantly reduce water use by providing a low-flush option for liquid waste (between 0.8 *gpf* and 1.1 *gpf*), and a full flush option for solid waste (between 1.28 *gpf* and 1.6 *gpf*). Use the MaP Test to find an effective and efficient toilet. If interested in using *non-potable water*, such as rainwater or *greywater*, for toilets, contact the Department of Public Health.
Showerheads		1.8 gpm	There are showerheads that are effective at even lower flow rates (1.25 to 1.5 gpm). Reducing shower times also effectively saves a lot of water and energy costs.
Faucets	 	Bathroom faucet: 0.8 - 1.2 *gpm* Kitchen faucet: 1.8 *gpm*	Consider retrofitting existing faucet fixtures with *aerators*. Choose *aerators* for bathroom faucets (< 1.0 *gpm*) and kitchen faucets (< 1.75 *gpm*) to provide a steady stream of water pressure while reducing water flow.

Cost Information / Incentives

Seattle.Gov Rebates/Incentives: There are several incentives and cost saving programs available for Seattle residents to increase their home's water efficiency.

Saving Water Partnership – This web site provides information on toilet replacement rebates of up to $100 for single family, duplex, triplex, and single condo units in eligible locations across King and Snohomish Counties.

Permit Tips

Replacing existing shower, faucet and lavatory *fixtures* in the home with more efficient models doesn't require a permit. Replacing an existing toilet with one of similar style will not require a plumbing permit. However, if a floor-mounted toilet is being replaced with a wall-mounted toilet (or visa-versa), then a plumbing permit would be required if the project is located in unincorporated King County (otherwise confirm with your local jurisdiction). Most *fixture* replacements are not that extensive, and for such cases, all the needed parts and helpful tips can be found at your local hardware stores!

Codes, Standards, & References

Uniform Plumbing Code

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheet:

- Construction & Demolition (C&D) Materials Management
- Rain Barrels, Cisterns, & Rain Gardens
- Routine Home & Yard Maintenance

WaterSense - This U.S. EPA web site provides extensive information on WaterSense Certified *fixtures* and products and water use reduction approaches.

U.S. EPA: This web site explores statistics and information on water use in the home.

Air Sealing Your Home

Overview

Air sealing is a strategy used in a home to seal possible air leaks between the outside environment and the indoors. Spaces such as crawlspaces, garages and attics are considered 'outdoor' and may have cracks, holes, or gaps in materials, which allow outside air to leak into the home. Some new homes, but especially older homes, often have major air leakage problems. This leakage may not be readily visible to you but the impacts are substantial on the comfort, air quality, and durability of a home. Fixing gaps, cracks, and leaks in your home's *envelope* is usually the most cost-effective upgrade to perform.

Definitions

Air Changes per Hour (ACH)

Describes how often the all the air in your home is replaced with outside air through leakage or ventilation. The number is either presented as "normal" (ACH_n) to estimate leakage under normal conditions, or with a subscript number, such as 50 (ACH_{50}). The 50 indicates 50 pascals of pressure – a standard pressure for air leakage measurement.

Blower Door Test

A specialized procedure that measures and quantifies the total air leakage in a home. The test can calculate the air leakage under natural conditions (ACH_n) or at a standard pressure (ACH_{50}). Either number can help you estimate the leakage and potential for improvement, comply with code or third-party rating systems, and compare a home's leakage to other similar homes.

Envelope

A building's envelope marks the transition between interior spaces that are heated and cooled, and the outside. The envelope typically includes windows, doors, walls, ceilings, roofs, and floors. For example: If you have an unheated attic, the envelope boundary will be the ceiling in the upper floor, but if your attic is heated, the boundary will be the roof.

Weatherizing

When insulation is added, cracks are sealed, and other changes are made to a building, resulting in the reduction of heat loss. Weatherizing your home will save you money on heating bills and make your home healthier. The federal government and Washington State offer weatherization programs for qualified low-income households in order to provide updates to existing homes. See the resources section for helpful links.

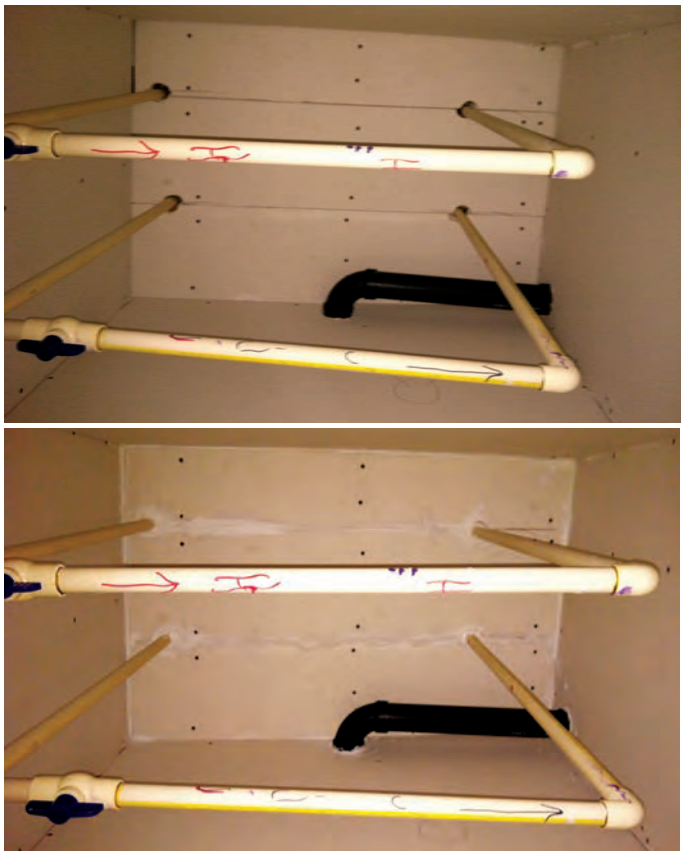
When is This Applicable?

For existing homes

Air sealing can be done when building an addition, performing a substantial renovation, or just making minor improvements. For best results and safety, it is highly suggested to work with a general contractor or home performance contractor. However, a handy homeowner can do much of this work.

For new construction

Section R402.4.1.3.1 of the 2021 Washington State Energy Code (WSEC) requires new homes to test at less than or equal to 4.0 ACH_{50}.



These pictures show before and after air sealing efforts at plumbing penetrations. *Source: O'Brien360.*

What Makes it Green?

Air sealing is a fundamental part of making your home more efficient, comfortable, and durable.

- Energy and cost savings from reduced operation of heating and cooling systems.
- Reduced energy use for heating and cooling reduces environmental impacts and air pollution from producing power or burning fossil fuels needed to heat and cool your home.
- Increased comfort by reducing cold air drafts and loss of conditioned air.
- Improves indoor air quality by keeping out dust, pollen and vapors from outside, garages, crawlspaces and attics.
- Enhances durability by preventing moisture-laden air from condensing on cold surfaces, creating opportunities for mold.
- Closes openings that can invite insects or rodents into your home.

Best Practices

When air sealing your home, consider the following guidance.

- Minimize air leakage and control air changes through ventilation.
- If you are inclined to do the work yourself, begin by learning more about air sealing and how to do the work safely with the Seal and Insulate with Energy Star website and the DIY Guide.
- Consult with a general contractor or home performance contractor for increased safety and effectiveness.
- Wear personal protective equipment, including eye protection, respiratory protection, and body & clothing protection, like gloves and coveralls.
- Seal gaps between exterior sheathing panels using a high-quality acrylic based air sealing tape such as 3M 8067, SIGA Wigluv, Pro Clima Tescon Vana, or Zip System Sealing Tape.
- When air sealing is completed, it is important to ensure the home has adequate mechanical ventilation. Consider installing an Energy Star ventilation fan with automatic controls.
- After air sealing is complete, ensure all combustion appliances are operating properly and that the home is equipped with carbon monoxide alarms.
- Target the largest leaks first – the most common large air leaks are:
    - Plumbing penetrations, like around tub, toilet and sink drains and where plumbing supply lines come into cabinets in kitchens and bathrooms.

In a kitchen or bathroom remodel, or new construction, sealing plumbing penetrations is easy and effective. *Source: O'Brien360*

- Electrical penetrations, like where wires run through top plates, bottom plates or other wood materials

In an addition, new construction or a gut remodel, there are many opportunities to seal electrical penetrations and top and bottom plates. *Source: O'Brien360*

- Around chimneys and flues (be sure to use non-combustible sealing materials in these areas)
- Around bathroom fans and kitchen range exhaust
- Around doors (and sometimes windows)
- Between an attic access hatch and drywall
- Behind attic knee walls
- Rim, or band, joists although these are often hard to access in existing homes

Air sealing with expanding foam or caulk at a rim joist is an effective means of sealing leaks. *Source: O'Brien360*

- Use the right sealing material for the size of the leak; for gaps smaller than 3/8" use caulk, for 3/8" to 1" use 1-part expanding foam, and for leaks larger than 1" begin by adding a solid backing like foam board insulation or plywood before sealing with caulk or expanding foam.
- Seek out no- or low-VOC (volatile organic compound) emitting products to reduce off-gassing of vapors while working and when products dry/cure.
- Ensure the sealant you use is compatible with what you're sealing.

This picture shows the "flash" portion of a "flash and batt" installation. The flash coat of spray-in-place foam insulation creates a tight air seal. *Source: O'Brien360*

Cost Information / Incentives

Puget Sound Energy: Energy efficiency rebates and offers: PSE offers rebates on a variety of items, including air sealing. PSE also provides Home Energy Assessments on existing homes.

Seattle City Light (SCL): SCL provides information on how to conduct a do-it-yourself home energy audit.

Washington State Weatherization Assistance Program: Through the King County Housing Authority and Seattle Office of Housing – HomeWise, federal and state funds are available to assist low-income residents in *weatherizing* their homes.

Codes, Standards, & References

2021 Washington State Energy Code (WSEC) - Section R402 covers insulation and the thermal *envelope* of buildings. This section provides clear requirements for achieving code compliance if desired during retrofits to the home.

Washington State University Energy Program - WSU provides many valuable resources for achieving compliance including forms, guides, and training.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related King County Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Duct Sealing
- Fresh Air Ventilation
- Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces
- Heat Pumps and Efficient Heating and Cooling Systems
- Insulation
- Passive Solar
- Routine Home & Yard Maintenance

EcoBuilding Guild Technical Flash Cards - These are easy-to-use flash cards on specific topics. This link takes you directly to Air Sealing where you can choose topics such as "Air Seal Cove Ceiling" and "Seal Soffit at Ceiling Plane."

Air Sealing Video - This WSU Extension Energy Program video walks through air sealing details of an old home.

Department of Energy - This web page on Air Sealing Your Home provides many tips and links to additional information.

Duct Sealing

Overview

Duct systems carry cooled or heated air from your furnace or heat pump to rooms throughout your home. The Washington State Energy Code requires that new duct systems are sealed, but older systems may have been poorly sealed, not sealed at all, or developed gaps overtime. Tightly sealing the joints and seams in ducts and air handlers ensures that all the *conditioned air* reaches the rooms rather than escaping into attics, crawlspaces and garages. It also reduces dust and other particulates from being transported into these spaces, thereby improving indoor air quality and reducing asthma and allergies. Save money and keep your home clean and healthy by sealing or resealing your ducts!

Definitions

Asbestos Tape
Fibrous tape, typically white, wrapped around joints on a metal duct system. Asbestos tape should NOT be disturbed – instead, in can be safely encapsulated in duct mastic or removed by a professional.

Conditioned Air
Air that has been heated, cooled or dehumidified by a mechanical system.

Duct Leakage Test
Duct leakage can be tested using a calibrated fan and digital pressure gauge.

Duct Mastic
A low-cost, highly durable paste-like sealant used to seal leaks in a duct system.

Pascal
A unit of pressure in the meter-kilogram-second system equivalent to one newton per square meter.

Duct leakage testing in a new home. Non-toxic smoke can be used to locate leakage areas, especially during framing in new construction. *Source: O'Brien360*

When is This Applicable?

If you are building a new home, duct leakage compliance is required by code and confirmed through testing. When a central forced air system is altered by the installation or replacement of a furnace, heat pump, air handler, coil or heat exchanger, the duct system that is connected to the new system must be tested. The *duct leakage test* results must be provided to the building official and the homeowner. If the results fall short of the code target (see "Best Practices"), you may consider sealing your ducts to reap some of the numerous benefits listed below. It's a good practice to always ask for copies of the permits and test results from your contractor to ensure they are following code requirements that help keep you and your family safe and comfortable.

Duct systems in homes built before 2009 are generally not well sealed, unless the home was certified under Energy Star Certified Homes, LEED for Homes or Built Green Programs. If you have ducts that run through an unconditioned attic or crawl space, and don't have a good mastic seal on every joint and seam, there's a good chance you could benefit from sealing your ducts.

Digging Deeper

Duct leakage targets are expressed as a flow rate (cubic feet per minute, or CFM) at a pressure of either 25 or 50 *Pascals* and are based on the square feet of area served by the system. The target for new construction is 0.06 x floor area served (in square feet), with the air handler installed (0.04CFM25 x floor area, without the air handler).

What Makes it Green?

Sealing ducts, particularly those in attics and crawl spaces, is one of the most cost-effective ways to save energy and improve indoor air quality and thermal comfort. Here are some reasons why:

- Air you've paid to heat (or cool) is delivered to your rooms, rather than heating the attic or crawl space;
- The right amount of air is supplied to each space, maintaining comfort;
- Warm air leaking into cold spaces can lead to humidity and mold problems; and
- Leaky return ducts can draw in poor-quality air from the attic, crawl space, or garage.

Best Practices

In order to seal your ducts most effectively:

- Use water-based duct mastic for sheet metal ducts
- For flex duct, use appropriate duct straps (like big cable ties) – one to secure the inner liner to the duct terminal; another to secure insulation and outer cover over the inner liner
- Focus particularly on all joints at right angles and:
  - Where the filter rack sits in the plenum or trunk
  - Between trunks and branches
  - At elbows and "Y"s
  - Between a duct and the boot that connects to the room register

This metal duct elbow seam with properly sealed with duct mastic. If the ducts are in the crawl space, attic, or garage, they should be insulated after being well sealed. *Source: O'Brien360*

- Seal the boots to the floor, wall or ceiling
- Temporarily remove any insulation from these fittings to expose the metal or flex duct liner
- Wear proper protective equipment such as a dust mask and gloves. If you suspect *asbestos tape*, contact a certified asbestos abatement contractor immediately
- Replace and re-secure insulation.

Go Further: While checking ducts, be sure to check for water pipe insulation as well. You can save water, energy, and money by insulating your water pipes (don't forget the corners where the pipe bends).

Cost Information / Incentives

Puget Sound Energy: Suite of rebates duct sealing and duct insulation.

Digging Deeper

While most duct systems are located in attics, garages, and crawlspaces, bringing ducts inside your home – by placing them in floor cavities or interior soffits - has many benefits including:

- Reducing the size and cost of furnace and ducts
- Reducing air leaks to the outside, which improves comfort and savings
- Improving indoor air quality

Note: if all your ducts are within the conditioned space, you are not required to test your ducts.

Codes, Standards & References

Department of Local Services, Permitting residential mechanical permit information sheet: Provides guidance associated mechanical systems and when to get a mechanical permit if your project is located in unincorporated King County.

Residential Mechanical Permit Application: If applying for a mechanical permit, the Department of Local Services, Permitting web site provides a link to the MyBuildingPermit portal where a mechanical permit application can be submitted.

If your project is located outside unincorporated King County, please confirm requirements and resources with the local jurisdiction.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email dperwebinquiries@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Green Building Handbook Green Sheets:

- Air Sealing Your Home
- Fresh Air Ventilation
- Heat Pumps and Efficient Heating and Cooling Systems
- Routine Maintenance

Energy Code Related Documents: This WSU Extension Energy Program website provides numerous links to related documents, including Duct Testing Standard and presentations.

Puget Sound Clean Air Agency's Asbestos Resources: This site provides resources related to asbestos. Anyone who works or has the potential of working with materials containing asbestos must fully comply with all regulatory requirements.

Fresh Air Ventilation

Overview

Fresh air can do wonders for a home and there are a number of ways to provide an appropriate supply of outside air. By installing design features such as operable windows, skylights and through-wall vents, as well as mechanical equipment such as exhaust fans and ventilators, you can ensure adequate fresh air will be brought into a home to dilute and remove contaminants, such as *off-gassing* and emissions from furniture, cleaning products, pollution and wildfire smoke. These measures can also help combat mold and mildew in the home by mitigating and avoiding the effects of excessive moisture inadvertently introduced through daily activities such as cooking and showering.

An example of a heat recovery ventilator located within a conditioned space.
Source: O'Brien360

Definitions

Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV)

Ventilation equipment units take air from outside the house and exchange the heat and moisture with air from inside the house. This saves heating and cooling energy while providing fresh air to the home. Many ERV units have filters included so outside air is cleaned before being brought into the home; it is recommended these filters are changed every 3-6 months. Compared to ERVs, heat recovery ventilators do not transfer moisture which can lower their efficiency compared to ERVs. There are a variety of model options for this type of appliance including ducted, non-ducted, furnace attachments, and in-ceiling versions to fit almost any home.

Cubic Feet per Minute (CFM)

English unit for measuring air flow, calculating the amount of air contained in a one-foot cube passing by a point every minute. The EPA suggests having at least 15 CFM per person of fresh air in every home. A typical small exhaust fan in a bathroom can move 50 CFM, which may be sufficient for 3 people in a home.

Off-Gassing

When materials or products release vapors or gasses, typically from new products and commonly involving Volatile Organic Compounds (VOC) from plastics, rubbers, and adhesives. A chemical smell from a new couch can indicate off-gassing and usually fades over time.

Air Changes per Hour (ACH)

Describes how often the all the air in your home is replaced with outside air through leakage or ventilation. The number is either presented as "normal" (ACHn) to estimate leakage under normal conditions, or with a subscript number, such as 50 (ACH_{50}). The 50 indicates 50 pascals of pressure – a standard pressure for air leakage measurement.

Plenum

A plenum in an HVAC system is a box, typically sheet metal, that connects HVAC equipment to ducts. There are usually both a supply and return plenum, which provides more balanced flows to and from the ducts in your home. For smaller homes with simpler HVAC systems, the plenums may be small or not required.

Damper

A damper is a valve in an HVAC system. Like your sink, faucet valves control the flow of water. In HVAC system, dampers control the flow of air. They can be used to balance flows of air through the home so each space is getting enough air flow, but no single room is getting too much.

When is This Applicable?

A mechanical ventilation system is required to meet code in all new construction projects and is highly recommended in all projects where you are adding additional insulation, air-sealing, and when renovating a kitchen or bathroom. Even if a home has mechanical ventilation, it is worth testing its efficiency and effectiveness if you are planning a remodel, so an upgrade can be included in the scope if needed. Homeowners can also introduce new or better performing air filters for improved air quality. This will help in a high-efficiency *ERV* or even standard HVAC equipment but may not be possible in all models.

Improving insulation and air sealing of your home (which sometimes includes window replacement) reduces the amount of heat that escapes during the winter, thereby reducing your energy bills. However, these efforts also reduce the amount of air moving in and out of your house, so it is important to improve your ventilation system at the same time to maintain adequate fresh air supply.

What Makes it Green?

Indoor air quality is affected by emissions from things such as paints, glues, furnishings and cleaning products, pesticides, engine oil and gasoline brought in on shoe soles, as well as pet hair and other allergens. Moisture from cooking, cleaning, bathing and breathing may also raise the relative humidity of indoor air to the point where the house feels uncomfortable and mold may grow on cool surfaces, introducing more contaminants. Proper ventilation helps reduce or prevent some of these issues.

Best Practices

Operable windows are a great source of fresh air ventilation but only work when open. A mechanical ventilation system helps to ensure you have sufficient fresh air, especially during the heating season when windows tend to stay closed for extended periods. There are three typical approaches to mechanical ventilation in homes provided in order of air quality benefits:

Balanced Ventilation – This approach uses both a supply fan and an exhaust fan with connected controls to ensure they operate at the same time and to provide balanced air flow. Exhaust and make-up air are ducted from and to occupied spaces, either through a duct system solely for that ventilation system, or through integration with an existing central forced air system. *Energy recovery ventilation* (*ERV*) is a specific system type that provides balanced ventilation, improved thermal comfort and energy efficiency. Existing ductwork may not be required to add an *ERV* to your home. This approach is more expensive than the other systems, but it is highly recommended as it is the most effective. Energy recovery typically offsets the energy cost of added ventilation and fan operation and generally saves money in the long run**,** by recovering the heat from the exhaust air and transferring the heat back into the ventilation air. A balanced system also can provide opportunities for better filtration than the other systems. If your home's air tightness is below 3.0 ACH_{50}, then you must install a balanced ventilation system because there will not be enough air leakage to make supply or exhaust-only ventilation effective.

Supply ventilation – In homes with a ducted forced air system, a fresh air duct from outside the house is connected to the return *plenum* of the duct system, with a mechanical *damper* which opens and closes to control the fresh air flow. The *damper* is controlled by a "smart cycler" which monitors heating system runtime to ensure you get sufficient ventilation, but not allowing in excess outside air that requires additional heating or cooling (thus increasing energy use). Ducts provide make-up air to all regularly occupied spaces. This option is moderate in cost, and moderately effective, though it may increase your heating and electricity bills if your furnace has a single speed fan. This system is better than exhaust-only as it creates positive pressure inside your home to keep outdoor pollutants out. As the air is pulled from outside, it gets filtered before being distributed through your home.

Exhaust ventilation – This is the most common approach in older homes, using an exhaust fan that runs continuously to pull air out of the house. Fresh "make-up" air is pulled in through leaks in the building shell or through small "trickle" air vents in window frames. The code requires that make-up air is provided direct to living spaces, kitchen, sleeping rooms and other regularly occupied spaces. This approach is typically the lowest installation cost option and is moderately effective. It also results in unfiltered air being pulled into your home from dusty and dirty spaces such as your attic and crawlspace. Additionally, during wildfire season, this system will pull smoke-laden air into your home. Although this is the least desirable option, if pursued choose ENERGY STAR-labeled fans to reduce energy consumption of this ventilation option.

The following table includes considerations applicable when choosing a ventilation strategy and equipment.

Phase/ Component	Considerations	More Information
Design / Planning	• Hire a contractor, or a designer/architect who is familiar with all the ventilation options. • Ensure that they will perform the necessary calculations and design the system accordingly. • Understand which ventilation approach suits the systems in your home.	• Ask these professionals which ventilation system they recommend and confirm that calculations and system sizing are included in their scope of work. • Check the state code ventilation requirements for the size and occupancy of your home.
Equipment	• Ask for ENERGY STAR fans rated for continuous operation. Variable speed fans with DC motors are the quietest and most energy efficient and can be adjusted if you need more ventilation. • If installing a supply ventilation system, ensure that your contractor includes a smart cycler in your system specification. • Ensure the contractor tests the system as part of the installation scope to be sure it is functioning properly. • Request clear instructions for use and maintenance from the contractor / installer.	• A variable speed fan with a DC motor may use as much as 80% less energy than a single speed fan with an AC motor. • A supply ventilation system integrated into your central forced air system without a smart cycler will significantly increase your heating costs in winter and will not give you adequate ventilation in summer.
Ducting	• Sheet metal duct is preferred. • All ducts should be sealed with appropriate sealant to the fan box, at joints and where they penetrate the building envelope. • The fan box must be sealed to the ceiling.	• If installing an *ERV* or *HRV* with existing ducting, request or procure air-sealing as part of your project to ensure the system operates with optimum efficiency.
Testing / Maintenance	• Testing after installation • Have the fan flow tested once it is installed to ensure it is delivering the required flow – an energy rater can do this, or ask the contractor to provide a testing certificate.	Maintenance • Clean fans and any filters every 6 months or more frequently according to manufacturer guidance. • Periodically (twice per year) ensure the exterior duct "flappers" are functioning properly, and air is flowing in or out during operation. This can be done by turning the fans on and watching to see if the flaps open to allow air flow. If jammed, they can often be fixed by cleaning or tapping to dislodge any debris.

Digging Deeper...
Energy (or Heat) Recovery Ventilator (ERV or HRV)

If you have a very air-tight home (significantly below the code minimum air leakage), balanced ventilation with energy recovery will provide the most effective ventilation and make sure you get the best from your energy-efficient home. An energy recovery ventilator uses heat from stale exhaust air to pre-warm the incoming fresh air, without mixing the two streams. If you or your family have allergies or chemical sensitivities, an ***ERV*** with a high-efficiency filter will also allow you to increase ventilation rates to improve your indoor air quality without spending a lot more on heating. ***ERV****s* are not certified by ENERGY STAR; look for a Home Ventilation Institute (HVI) rating with a Sensible Recovery Efficiency of 75% or higher and fan efficacy of 0.8 ***CFM***/Watt or higher.

Cost Information/ Incentives

King County Indoor Air Technical Assistance: After completing an online form, technical assistance in improving your indoor air quality can be provided. Interpreters are available to help with the form and in obtaining the assistance.

On the low end of cost, simply replacing an old existing exhaust fan can be as inexpensive as $100. An *ERV* for a single room in the home is about $1,000 when installed by a contractor but can be cheaper as a DIY project. Single room *ERV* systems can be great choices for older homes since they can be ductless but still provide the benefits of an *ERV*. The average price for installing a whole home ventilation system is $4,000.

Testing of your home's HVAC system function can typically be done for less than $500; testing your home's air quality is expected to cost around $300.

Permit Tips

In unincorporated King County, permits are required to modify or install new mechanical ventilation systems and may require an electrical permit too. Since there are many options for ventilation, research your options and identify your preferences before filing a permit application. Making an informed decision may provide you with additional energy, comfort, health, and durability benefits. If your project is located outside unincorporated King County, please confirm requirements and resources with the local jurisdiction.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

Also see these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Duct Sealing
- Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces
- Heat Pumps and Efficient Heating and Cooling Systems
- Insulation
- Passive Solar
- Routine Home & Yard Maintenance
- Thermostats

Energy Saver – Ventilation - This Department of Energy guide reviews ventilation options and strategies.

Designing a Good Ventilation System – This Green Building Advisor article discusses standards, choices, pros and cons of ventilation system types.

Heat Pumps and Efficient Heating and Cooling Systems

Overview

Replacing an older furnace and central fan system with a new, energy efficient *heat pump* or electric furnace is a great way to reduce costs and save energy. An inefficient furnace can seriously affect the comfort of your home while emptying your pocketbook through higher utility bills. An older furnace may also sometimes emit toxic gases that can impact the health of your family.

Installing a new *heat pump* or electric furnace can help reduce the amount of energy needed to heat your home but may be a higher first cost than other intermediate steps such as air sealing and duct sealing. That said, rising utility costs can accumulate quickly with an old and/or inefficient system; replacing such systems now may comparatively increase your annual savings through higher efficiency, and shortens the time to see a return on your new system investment. A huge advantage of *heat pumps* is not only the more efficient heating, but that they provide air conditioning during the summer too!

Definitions

Air Handler Unit (AHU)

Typically refers to both the furnace which heats the air and the fan that moves it around your home. All heat pumps also have air handlers; with ductless heat pumps, the air handler or the "heat pump head" refers to the indoor unit that releases conditioned air inside your home.

Annual Fuel Utilization Efficiency (AFUE)

This value identifies the thermal efficiency of combustion equipment like furnaces, boilers, and water heaters.

Flue Gases

The gases generated from the burning of fuel, which includes water vapor, carbon monoxide and unburned hydrocarbons. Natural Gas burns cleaner than oil, but still generates toxic gasses that must be sent out of the home, increasing your local air pollution levels.

Condensing Furnace

In a conventional furnace, only about 80% of the heat energy in the fuel is transferred to the air in your home. The other 20% goes "up the chimney" in the water vapor and other gases. A high efficiency furnace captures half to three quarters of that 20% by condensing the water vapor in the flue and recycling the heat to the heat exchange, resulting in a higher efficiency level of 85-95% when installed and operated as recommended.

Heat Pump Source: Indiana Public Media

Heat Pump

A heat pump is an appliance that works in a similar way to a refrigerator or air conditioner, but in reverse. The system uses electricity to drive a refrigeration loop that moves heat from a source (air in or outside the home) to a point of use (inside your house or water heater). Heat pumps can be 2-4 times as efficient as electric resistance heating and 3-5 times as efficient as oil or gas heating. There are natural gas and electric heat pumps; electric units do not produce toxic gasses and use no combustion.

Ductless Heat Pump (Mini-Split)

This is a specific type of heat pump that can be easier to install in homes without existing duct systems. These have two (or split) components, namely an indoor unit that moves air in a room, and an outdoor unit providing the heating or cooling to the indoor unit through hoses.

Heating Seasonal Performance Factor (HSPF)

HSPF is a common efficiency rating used with heat pumps that specifically measures the efficiency of air source heat pumps, and is typically a better efficiency rating to consider in colder climates (including Washington state).

Modulating or Multi-stage/2-Stage burner

Single stage burners only operate at full power so they adjust heat delivery by turning off and on. A modulating or multi-stage burner adjusts the size of the flame according to how much heat is needed, which allows the furnace to run more consistently and give more even heat, while conserving fuel.

Stands for Seasonal Energy Efficiency Factor (SEER)

SEER is a common efficiency rating used with heat pumps that measures the efficiency of air conditioners, and sometimes heat pumps, and is typically a better efficiency rating to consider in warmer climates (such as the southwestern U.S.).

Variable Speed Motor

Single speed motors only allow for one fan speed, whereas variable speed motors enable a variable speed of air flow across a burner within a furnace or from a heat pump. For furnaces, variable speed motors coupled with modulating burners can improve the efficiency of your system, improve comfort, and potentially increase the equipment lifespan by reducing its on-off cycles. Common types of variable speed motors are Electrically Commutated Motors (ECMs) and normal AC motors with Variable Frequency Drives (VFDs). Both motor types are effective, and your equipment's technical information should tell you whether a variable speed motor is included or optional.

When is This Applicable?

It is highly recommended that you consider replacing your existing furnace heating system with a *heat pump* if any of these apply:

Your furnace is:

- more than 15 years old
- noisy
- in need of frequent repair

Or you(r)…

- carbon monoxide detector goes off periodically
- heating bills are going up
- current heating system is oil heat or electric baseboard heat
- want your heating system to be carbon neutral*

**By state law, utility-supplied electricity must be carbon neutral by 2030.*

If you're not ready to replace your heating system but have an area or "zone" of the home that is particularly cold, you may consider adding a single *ductless heat pump* to provide supplemental heat for that one zone – and you'll be able to use its cooling benefits in the summer to help reduce the impact of summertime heat waves.

Homes that convert from oil to an electric *heat pump* will see bill reductions overall. Homes that convert off natural gas (methane) heating to electric *heat pump* systems may see a bill impact primarily due to the added use of the system during summertime for cooling – though *heat pumps* are more energy-efficient (and will impact your pocketbook less with utility bills) than adding an independent air conditioner unit. Whether converting from oil or natural gas, you will maximize your bill savings by pairing your *heat pump* installation with:

- Air sealing
- Duct sealing, which is recommended every 5 years.
- Insulation improvements, especially if your home was constructed before 1978 when Washington State did not require homes to be insulated. Also consider insulation improvements If your home was constructed before 2005 – home insulation that is 15 to 20 years old may be failing, depending on the insulation type.

If you are converting from natural gas to electric, also check out the Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces Green Sheet for additional information.

What Makes it Green?

Benefits of a new *heat pump* or more efficient furnace include:

- **Potential for cooling** – *heat pumps* provide cooling during the hot summer months.
- Reduced energy costs:
  - Efficiency – a new furnace may use 15% – 20% less fuel than a 15-year-old furnace.
  - Fuel-switching – Propane and oil can be replaced with a *heat pump* to obtain bill savings. Switching to an electric *heat pump* from natural gas may not result in significant bill savings as gas is fairly inexpensive – but other benefits of these systems (i.e., cooling) still apply.
- **Improved comfort and quietness of system** – *heat pumps* are a fairly quiet operating system that provides consistent home heating. Similarly, new furnaces can have multi-stage burners and variable speed fans (ECMs) for more consistent temperatures and quieter operation. To improve system quietness, ask installers to review both efficiency and decibel ratings with you. For *heat pumps*, consider a rear-yard installation, as side yards have less space and can amplify sound. Air louvers and wind baffles can also reduce sound without impacting performance better than compressor blankets (which can slightly reduce system life) – ask your contractor for options. Once installed, consider screening the unit with vegetation like a laurel hedge; vegetation improves aesthetics, and its softer surfaces will help muffle sound, whereas hard surface screening such as brick walls may amplify sound.
- **Improved health / air quality** – electric *heat pumps* result in no local air pollution or emissions. Older furnaces can leak *flue gases* into your home from the flue or through failing heat exchangers. New furnaces emit those *flue gases* into your neighborhood's air through a roof vent.

Best Practices

- Invest in envelope air sealing, duct sealing and insulation BEFORE spending money on a heating system upgrade. This will save money on bills, and may help you install a smaller, less costly system. Some contractors may offer combined services of duct sealing, insulation and heating system installations. *Heat pumps* work best in homes that are well-insulated.
- Consider hiring an energy analyst, conducting a home energy assessment/audit, or working with a local energy efficiency program. This could help determine if your current heating system needs replacing and what system size is appropriate. They may also professionally evaluate your insulation levels and level of air-sealing. Note that some utilities may not include options that evaluate switching off of gas or electric heating systems in their rebates or home evaluations, so you may need to independently research the best option for your home.
- Not all contractors are comfortable with *heat pumps*, and some may try to dissuade you from them due to lack of familiarity with this technology. Select a reputable contractor that is familiar with *heat pumps* to provide a balanced evaluation for your home. Please see the "Hiring the Best Professional for Your Project" Green Sheet to navigate the contractor selection process and to secure multiple bids before committing your money towards a long-term home alteration.
- Ensure the system is sized properly, rather than installing a same-sized unit:
  - Ask how your contractor is evaluating your needed system size. For converting to *heat pump* heating, the contractor will ideally cite that they size according to the Air Conditioning Contractors of America (ACCA) Manual J or Manual S calculations. There are many "rule of thumb" principles contractors sometimes use, but this approach could result in an installation that is too big (inefficient) or too small (will not heat/cool adequately) for your needs – costing you more up-front, or on your energy bills later on.
  - Check that they account for added or planned insulation, new windows, envelope and duct sealing, additional rooms, etc. in the load calculation and sizing selection.
  - Check that the duct system can handle the airflow being moved around by the new furnace and air handler unit. Some central *heat pumps* will require duct modification.
- If purchasing a new *heat pump*, consider the following:
  - If insulation evaluation is not an option, a cold-climate *heat pump* (CCHP) might be preferable, as a CCHP will ensure your system produces more heat on the rare days when the temperature is below 20 degrees. Note that these systems may be less efficient overall or cost more throughout the year; you may be able to supplement with local radiant heaters on those days too.
  - Look at utility rebates in advance – many of these have efficiency criteria that can save you money on your installation! When getting bids from contractors, either tell them the minimum *SEER* and

HSPF/HSPF 2 ratings you want for your system, or ask for efficiency specifications in their quotes; this will help avoid the mistake of going with a cheaper bid that may yield less efficient equipment. It will also help you get more consistent bids from multiple contractors. Ask for the equipment specification sheet to confirm and evaluate online reviews of the equipment.

- Consider what type of system you want in advance. There are:
  - Air-source and ground-source *heat pumps* (the latter of which run refrigerant coils underground). Ground source *heat pumps* are typically more efficient but higher cost. Air-source *heat pumps* (ASHPs) still provide great efficiency, and typically cost less to install; the above efficiency criteria are for ASHPs.
  - *Ductless heat pumps* (*DHPs*) and central *heat pumps*. *DHPs*, also called mini-splits, tend to provide heat in concentrated zones, and are more commonly installed in homes without existing ducting. Sometimes more than one *DHP* is needed to adequately heat a whole home. Homes with existing ducting may install a central *heat pump* that uses and/or modifies the existing ductwork to provide heat throughout the house; homes with adequate room can also choose to install ducts with a central system, though installing ducts will increase project costs.
- If purchasing a furnace, buy an ENERGY STAR direct vent *condensing furnace* with modulating burner and VFD air handler with an *AFUE* greater than or equal to 95%. The first cost is higher, but the benefits include fuel savings, improved comfort, and quiet operations – and there is likely a PSE rebate for the upgrade.
- Review heating system maintenance requirements with this ENERGY STAR checklist.

Certified gas furnaces labeled with the standard ENERGY STAR logo will be up to 15% more energy efficient than baseline models and can save an average of $80 in energy costs per year.
Source: ENERGY STAR

Digging Deeper... What About My Ducts?

The efficiency (tightness vs. leakiness) of your duct system has a huge impact on energy use, comfort, and even durability of your home. When installing a new system in new construction, be sure to test and seal the ducts during framing for optimum results. For furnace and system replacements, consult with your system installer to determine if existing ducts should be sealed based on their location in the home. When possible, bring any ducts located outside back into the conditioned space of your home (i.e. in your attic, garage, or crawlspace) because ducts greatly impact the system efficiency and indoor air quality. If all your ducts are "inside," duct testing is not required by code because duct leakage is less of a concern. See the "Duct Sealing" Green Sheet for additional information.

Cost Information / Incentives

Incentives

Based on a household's Area Median Income (AMI), the federal Inflation Reduction Act (IRA) will offer *heat pump* incentives for multiple households; baseline AMI can be looked up here.

- Moderate income households, with 81% to 150% AMI, will qualify for point-of-sale rebates that will cover 50% of the cost for a *heat pump* and electrical panel upgrade, up to a total of $8,000 for *heat pumps* and up to $1,500 for electrical panel upgrades.
- Low-income households (80% AMI & under) will qualify for point-of-sale rebates that will cover 100% of the cost for of up to $8,000 for *heat pumps*, and $1,500 for electrical panel upgrades.

IRA rebates are anticipated to be available in in 2024, depending on state action. Currently available is a 30% tax credit for *heat pumps* and *heat pump* water heaters, capped at $2,000 per year. The credit resets each tax year and may be helpful if you have tax burden (i.e., you pay taxes at year-end rather than receiving a tax refund).

Both PSE and Seattle City Light offer rebates and discounts that may help lower your installation costs.

Some local governments provide additional *heat pump* incentives. Depending on your current fuel type, additional utility incentives may be available as well.

Costs

New *heat pump* installation costs vary depending on the equipment type, home size, internal layout, envelope efficiency, and whether electrical panel upgrades are required. The below costs do not incorporate the above potential federal rebates, tax credits, or utility rebates – all of these could help reduce installation costs!

- A single, new *ductless heat pump (DHP)* typically has starting costs between $3,000 to $7,000. *DHPs* are a good alternative if you don't have existing ductwork, as adding ducts can cost $2,000 to $7,000, and not all homes have space. A single *DHP* can also be ideal for well-insulated homes smaller than the region average, up to 1,350 square feet, with a relatively open floor layout (i.e., not a lot of rooms closed off by doors).
- Small homes with an open layout, but with one basement room, may struggle to get heat to the basement or to distant bedrooms. Consider adding a *DHP* for the main living air and supplementing with radiant heat panels for the basement or bedrooms.
- For whole-home heating with *DHPs*, multiple *DHPs* may be needed. If so, costs may increase to $12,000 to $15,000 or more.
- A new central *heat pump* system typically has starting costs up to $15,000, though sometimes cost $20,000 or more.
- Some older homes may need a new breaker ($600) or an electrical panel upgrade of up to 200 amps ($1,500) to support a new *heat pump*. Some very large homes may need a 400 amp panel ($4,000). If your house is not that large and an electrician is pressing for a 400 amp panel, get multiple quotes or evaluations to confirm whether the larger service is necessary.
- Decommissioning an existing oil heat system (if present) will add between $500 – $1,000 in costs.

Even if you are not ready to install a *heat pump* now, consider getting quotes – this will help provide useful information if your current heating system unexpectedly reaches its end of life.

Electric Furnaces - A new electric furnace can cost between $1,000 to $2,500; the total cost to buy and install an electric furnace is between $2,000 to $4,000 in a 2,000 ft^2 home.

Gas Furnace - A new gas furnace will cost between $3,000 to $4,000, or $4,500 to $6,000 after installation in a 2,000 ft^2 home.

Permit Tips

In unincorporated King County, installing a new *heat pump* will typically require both a mechanical and electrical permit. If your project is located outside unincorporated King County, please confirm requirements and resources with the local jurisdiction.

For furnace/*heat pump* replacements, the permit is "over the counter" with no plan review required. The Department of Local Services, Permitting Division will conduct an onsite inspection once a furnace is installed, so keep the equipment and installation documentation attached to the furnace.

If a new or replaced heating system is part of a building permit, the sizing calculations (Heating System Sizing Worksheet) are reviewed by Department of Local Services, Permitting Division staff. To ensure success, consider consulting a mechanical contractor to help with the requirements by providing a Manual S calculation.

Decommissioning an oil tank may also require a fire permit. Your contractor will likely offer to obtain the permits on your behalf – ask for copies of the permits prior to installation to ensure they have been obtained.

Codes, Standards, & References

This Residential Mechanical Permit FAQ will help when permitting your project in unincorporated King County.

Heating System Sizing Worksheet - This required form includes guidance for the heat loss calculations that determine system sizing.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheet:

- Air Sealing Your Home
- Duct Sealing
- Fresh Air Ventilation
- Hiring the Best Professional for Your Project
- Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces
- Insulation
- Routine Home & Yard Maintenance
- Thermostats

Washington State University (WSU) Energy Program - WSU provides many valuable resources for achieving compliance including forms, guides, and training.

Energy Saver 101 - This infographic provides great information about home heating.

Heating & Air Conditioning Installation Bid Comparison Checklist - Use this when hiring an HVAC contractor.

Thermostats

Overview

A thermostat allows you to control the heating and/or cooling system in your home. There are many different types of thermostats that vary from those that can be programmed with a customized schedule, to "smart" thermostats that connect to your Wi-Fi and include occupancy sensors, remote control, learning algorithms, and even voice control!

Regardless of a thermostat's bells and whistles, most thermostats and heating/cooling systems are truly capable of only two modes: on or off. Because some heating/cooling systems, such as gas furnaces and heat pumps, may be capable of a low and a high stage, when purchasing a thermostat ensure that it is compatible with your system's capabilities.

Definitions

Set point
The preferred target temperature on a heating and cooling system's thermostat.

Setback
A strategy where the temperature set point is temporarily expanded outside the typical temperature setting, for example, at night or during the workday.

Electric heat lockout
A heat pump thermostat feature where electric heat (also called strip heat, auxiliary heat, or emergency heat) is temporarily locked out to allow the compressor to run longer in very cold weather.

Deadband
A programmed temperature buffer that prevents inefficient or overlapping system operation between heating and cooling needs.

When is This Applicable?

Installing a thermostat is a simple and inexpensive change that can save you money. For new construction and mechanical system replacements, the Washington State Energy Code requires that any forced-air furnace have at least one ENERGY STAR-labeled programmable thermostat capable of a weekday program and a weekend program. It also requires a *deadband* between heating and cooling set points, a *setback* mode, and heat pump *electric heat lockout* capabilities. For existing systems, now is the time to determine if your system is operating optimally, or if a new thermostat will be more beneficial.

What Makes it Green?

Learning to optimally use your existing thermostat or purchasing a new thermostat may improve the energy efficiency of your home and help reduce utility costs. For example, smart thermostats have shown to save approximately $100 per year in energy costs. Those in your home will gain the extra benefit of occupying spaces that are regulated at comfortable temperatures.

Best Practices

Whether you keep your existing thermostat or are shopping for new thermostat, consider the following best practices:

Using the thermostat you have now

- First, ensure your thermostat is the best match for your heating system. Consult your user's manual to determine if you have a single-stage or dual-stage furnace or heating system as this will determine how much functionality the thermostat must have. If you have questions, call a qualified, licensed mechanical contractor.
- Next, ensure you are using your thermostat optimally.
  - For manual thermostats, only turn the system to your desired set point when you are present; otherwise, adjust the set point to save energy while you are away.

  - For programmable thermostats – confirm the programmed schedule matches your current lifestyle.
  - If you have a multi-story home its best to have thermostats on each floor. Because heat rises, the upper floors of a home tend to be warmer so those thermostats could be set at different temperatures to maximize efficiency.
- Learn to use the features of your thermostat in conjunction with the heating and/or cooling system, especially the temperature *setback* mode. Many thermostat user manuals can easily be found online by searching for the make/model.
  - Programmable thermostats do not necessarily save energy automatically. In a recent study, only 50% of homes used their programmable thermostat correctly or optimally. To improve efficiency, ensure you program yours according to your household schedule.
- If using a heat pump, make sure it has an outdoor thermostat as well – this ensures the system does not run in the less efficient auxiliary or emergency heat mode. This feature is also called electric heat lock out.

Choosing a new thermostat

When replacing or buying a new thermostat that works with your heating/cooling system, use the following tips as guides:

- If replacing an old thermostat that contains mercury (these will typically have a glass tube containing silver liquid), the thermostat must be treated as hazardous waste and disposed of properly (see the Resources section).
- Consider using a smart or learning thermostat, one that gathers information about your temperature preferences and automatically adjusts hourly and weekly programming to fit. There is rapid development in this industry. Some smart thermostats even alert you of problems and can provide troubleshooting data about your heating and cooling system.
- Pick the thermostat that best fits your desired level of interaction with it.

The following table helps describe the features, pros/cons, and considerations for various types of thermostats.

Manual Thermostats are the simplest type of thermostat. Some only have the current *set point* while others may display the current temperature, the current *set point*, and have buttons for higher or lower temperature. These may be digital or simple dials. Because manual thermostats do not reduce energy use nor save money, they are no longer allowed by code and should be replaced with programmable or smart thermostats when possible.	 *Photo source: O'Brien360*
Programmable thermostats provide added features for occupants who want to have heating and cooling based upon a regular schedule. These allow for multiple, pre-determined *set-back* periods and temperature *set points*. Most allow for 2-4 programs per day of the week. These programs can be changed and also have manual override features. Many programmable thermostats may connect to Wi-Fi for remote access and additional features.	 *Photo source: O'Brien360*
Smart, or Learning thermostats have all the same functionality of a programmable thermostat with the added ability to track manual changes to programming and adjust accordingly. Since this type of thermostat adjusts to occupant patterns, it minimizes the need to manually refine programming over time, as it is done automatically. Most smart thermostats can connect to Wi-Fi for remote access. Smart thermostats that are integrated with your phone or computer typically send your information, system control patterns and *set points* to an information gathering database. This information is used in aggregate for customer research and product improvement, so for some may be a privacy issue.	 *Photo source: Google Store*

Cost Information / Incentives

Programmable thermostats

Average cost of a programmable thermostat = $20 to $100
Average cost to install a thermostat = $80 to $200

Smart thermostats

Average cost of a smart thermostat = $100 to $400
Average cost to install a thermostat = $80 to $200.

Permit Tips

If submitting a permit for new construction, include a note on your plans to indicate the type of thermostat that will be installed.

Codes, Standards, & References

King County's "What Do I Do With…?" website and the Thermostat Recycling Corporation website both provide databases for where you can take your mercury-containing thermostats.

The Washington State Energy Code (Section 403 in particular) describes thermostats if you want to dig into the specifics.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Air Sealing Your Home
- Duct Sealing
- Fresh Air Ventilation
- Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces
- Heat Pumps and Efficient Heating and Cooling Systems
- High Efficiency Appliances
- Routine Home & Yard Maintenance

Thermostat Center - This web site is a helpful resource when selecting the right thermostat for your system and heating-cooling needs.

Washington State University Extensions; Electric Heat Lock Out on Heat Pumps - This document provides guidance on electric heat pump lockouts for new and existing systems.

Passive Solar

Overview

A passive solar house uses the sun and wind to heat and cool interior spaces, taking advantage of solar angles and the direction from which sunlight reaches the property. For example, placing daytime living areas with south facing windows will maximize southern sun angles in winter, passively heating the space. Wide roof overhangs on the south side then block high summer sun, keeping those same spaces cool in the summer. Appropriate building materials can further enhance the benefits of these strategies. A well-designed passive solar house can also reduce your interior lighting.

Active solar strategies use hardware such as solar panels along with associated systems to collect sun radiation and turn it into power for heating and cooling.

The Passive House Institute has well-researched and documented standards and solutions for passive design. They estimate an additional upfront investment (that includes mechanical equipment) of at least 10% of the construction budget to achieve their passive house standards, as compared to regular construction methods. However, passive solar techniques can reduce a home's energy consumption by 25%1 or more. Passive solar design can be applied in new home construction and additions, and its principles can be incorporated into some retrofit applications. We encourage you to revisit the Green Sheets from time to time for updates to incentives that you may be able to take advantage of for your project.

1 solarreviews.com/blog/dont-pass-on-passive-solar-heating

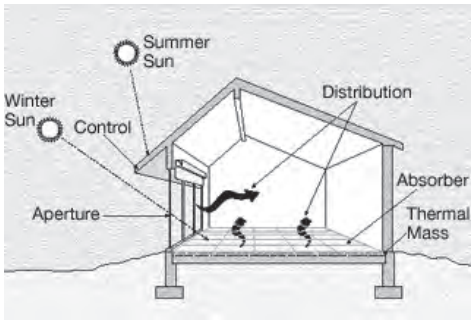
Definitions

Thermal Mass

Dense material such as concrete, concrete blocks, clay tile, brick, ceramic tile, stone, etc. (When the sun shines directly on these materials, they absorb heat from the radiation; When the sun goes down, they release that heat once the radiation supply ceases.)

Trombe Wall

A thick *thermal mass* wall set a few inches behind a glass wall or windows. The *thermal mass* wall absorbs heat through the glass during the day and releases it into the room at night.



Trombe wall. *Source:* Dept of Energy

When is This Applicable?

Because location and orientation are key considerations in a passive solar building, it is easiest to apply these strategies to the design and construction of a new building.

However, additions and renovations can also take advantage of passive solar strategies. Due to the wide variety of existing conditions, it will be most beneficial to have a professional designer evaluate your home and property, along with your design goals, to see if passive design is a good approach for your project.

What Makes It Green?

Passive solar homes have been built for centuries around the world. Passive solar solutions are timeless and will not need to be replaced as the house ages. Well-designed passive solar homes:

- Reduce your utility bills normally expended toward lighting, ventilating, heating, and cooling your home.
- Are quiet and easy to maintain.
- Have lower carbon emissions compared to homes that rely on mechanical equipment.
- Reduce the need for and costs of a furnace or a boiler (you will have to install a back-up heating system but its size may be reduced).
- Allows you to understand how your home reacts within the micro-climate around you, and how you can regulate natural systems to provide a comfortable indoor environment.
- Are considered very green by all residential home accreditation organizations.

Best Practices

Passive solar design involves knowledge of your local climate, a lot with good access to the sun, and some intuition. If you are starting from scratch with new construction, you have more options for maximizing these strategies. This includes locating the building on the site in the right orientation, using appropriate materials, designing the roof to use summer and winter sun angles correctly, placing windows to block cold winter winds while permitting cool summer breezes, and laying out the rooms for the best placement within the home. If you are remodeling or putting on an addition, review the strategies below compared to your existing building and site, and evaluate the options that might work for your home.

Site: In the pacific northwest we have more need for heating than cooling. A site with the long dimension running east-west will maximize south-facing building orientation. The building should be designed with a long, narrow rectangular plan, and larger rooms on the south side to maximize the heating that can be derived from longer solar exposure. Rotating the building slightly west of south will enhance use of low angle western sun in the winter.

Roof: The roof should be designed with deeper (than typical) overhangs on the south side. The overhang should be deep enough to block high summer sun (June, July, August) from entering the windows, while allowing the lower angle sun (September through May) to pass through those windows. Insulating the roof is also very important. Consider using more than code minimum (R60) insulation in your attic to hold the heat in the building.

Windows: Large, expansive windows should be maximized on the south side on the building, while narrow, high, preferably operable windows should be placed on the north side. While laying out your room plan, keep in mind that direct sunlight passing through west-facing windows is very difficult to control. If you have a remodel with a lot of west-facing windows, consider a *Trombe wall* to collect that valuable heat throughout the winter months.

Operable windows are needed for natural ventilation and cooling in summer. Windows with a bottom hinge that open inward (typically called hopper windows) and are located near the floor will collect cooler air and bring it into the home. Windows located high on the wall with a top hinge that open outward (typically called awning windows) will let out heat near the ceiling or top of your house. Placing these window types on opposite sides of the home can create convection and move heat from one side of the house to the other.

Triple pane windows may seem attractive for a passive home, but here in our mild pacific northwest climate, the payback is usually not worth the additional cost. It is more beneficial to spend money on improved wall insulation and higher quality double pane windows, which will provide years of service for your passive solar system.

Sealing around all the openings in your passive home is also very important. You want to have full control of the air movement in your home. Gaps around windows and doors can completely throw off your passive system operation.

Walls: Well-insulated walls are an important part of your passive solar home. Keeping the heat you collect inside your home is easier if your walls are better insulated. For a remodel, you can consider adding a layer of rigid insulation on the outside of your walls and installing new siding over that, for less disruption to the interior - adding spray foam within existing wall cavities is also an option. Consider using wall insulation with a higher R-value than the Energy Code requires (and don't forget the vapor retarder on the warm side of your exterior walls to stop condensation from accumulating).

Materials: You will want a solid *thermal mass* floor in the rooms that are used to collect heat from the sun passing through the windows. A concrete floor slab is one of the best low-cost, low-maintenance materials for this. Consider using a stain and or clear protective coating to give your concrete a more finished look (See the "Green Products and Building Components" Green Sheet). If your floor is constructed of wood, you can overlay it with cement board, a thickset mortar and ceramic tile or stone. If the sun will reach an interior wall, build that wall with grouted concrete blocks, solid concrete, stone, or brick veneer, or ceramic tile. The thicker the material, the more heat it will hold, and the longer into the night it will release heat.

Cost Information / Incentives

Costs for passive strategies can be minimal. You can choose more expensive, high-end finishes like tile and stone, but it is not necessary since a concrete slab works just as well for thermal gain. Your biggest increase in cost will be for added insulation, but this is a great investment as it will lower your utility bills, and improve you sense of warmth and comfort in the home.

Spending money on your building envelope will always be a good investment overall, as the walls, roof, windows and doors are the most critical and costly things in your home to fix if not built well.

ENERGY STAR offers tax credits that may be available to you for using energy efficient windows and other energy upgrades on your project.

Permit Tips

There are no special considerations for permitting passive solar strategies, as these are standard building practices, used in a more thoughtful and deliberate manner, to provide energy savings to the homeowner. Many passive solar strategies, such as highly insulated walls, roofs, and windows, count toward the energy credit options in the Energy Compliance Form for your plans, if applicable.

Codes, Standards, & References

Section R407 of the 2021 Washington State Energy Code recognizes Passive House as a compliance pathway.

Resources

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- Fresh Air Ventilation
- Hiring the Best Professional for Your Project
- Green Products and Building Components
- Insulation
- Roofing Materials

Energy Saver Guide - The Department of Energy provides information on passive solar home design and other efficiency tactics

EPA Passive Solar Home Design – An overview of basic passive solar strategies.

Passive House Institute: A research institute that has played a crucial role in the development of the Passive House concept, a performance-based energy standard used in construction. Buildings can be certified if using proper Passive House design Criteria for Buildings.

Solar Energy

Overview

The sun is the primary source of energy on planet Earth. You already use it to provide light and warmth directly into your home. You can increase your use of this clean, free, renewable energy by installing *solar thermal collectors* and *photovoltaic (PV)* panels to heat water or generate electricity on-site, reducing your dependence on grid-supplied energy. The price of *PV* panels has fallen significantly over the past several decades. In addition, solar thermal and *PV* systems are eligible for Federal tax credits, State sales tax exemptions and other incentives helping to offset costs of these systems.

Definitions

Peak Wattage
A measure of a solar panel's maximum energy output in standardized test conditions.

Solar Photovoltaic (PV)
Solar photovoltaic (PV) panels absorb the sun's energy and convert it into direct current (DC) electricity, which can be stored or converted into alternating current (AC) electricity (using an inverter) for use in your home.

Solar Thermal Collectors
A solar thermal collector collects heat by absorbing sunlight, and commonly refers to a device for solar hot water heating.

When is This Applicable?

A solar energy system can be installed on almost any new or existing residential building. You need a location that gets direct, unfiltered sunshine for most of the year. Systems are typically mounted on a south-sloping roof where the sun's energy is directed most, but other locations and orientations may be workable.

What Makes it Green?

Solar energy systems will reduce your utility bills. They quietly produce clean energy that can reduce carbon pollution from utility-owned power plants. Solar energy systems that include battery storage can reduce or even eliminate your dependence on the electrical grid, making them attractive for home sites with no existing power supply, or locations prone to electrical power outages.

Solar energy systems – both those that generate electricity and solar hot water – can apply toward achieving green building certification through programs such as the Living Building Challenge, Built Green, LEED for Homes, Passive House and other green building rating systems.

Best Practices

The following table provides considerations and examples for solar energy systems for your project.

System Type & Benefits	Considerations
Solar Photovoltaic (PV) Panels. There are two main types of PV panels – rigid crystalline panels and thin-film panels. Rigid crystalline panels tend to be more efficient at converting solar energy to electricity; thin film PV is lighter, more flexible, and generally cheaper - but less efficient.  Solar PV system being installed on a metal roof. *Source: Studio Hamlet Architects* Once installed, a solar PV electric system produces clean, renewable energy for almost no cost. PV panels are very durable and have low maintenance requirements.	• PV systems producing AC current can be connected to the electricity grid through a utility net-metering agreement that allows you to "sell" electricity to your electric utility provider when you have a surplus, and "buy" electricity from your electric utility provider when you need more than your system can produce. • DC systems typically store electricity in on-site battery banks. Stored electricity can be converted from DC to AC before use in a home that is also connected to the grid. Some off-grid homes use DC throughout the house, but this limits lighting and appliance options • The capacity of a PV array is typically defined by "*peak wattage*". A typical panel of 15 square feet in area is rated at 250 to 400 peak watts. • Actual *PV* output depends on the angle and orientation to the sun, amount of shading and hours of sunlight exposure. For King County, an easy rule of thumb is that one 250-Watt *PV* panel with good exposure will generate about 250 kWh per year.
Solar Shingles or Tiles work similar to *PV* systems but can either cover your existing shingles or replace the roofing material on your roof. They are made of a thin *PV* material and have a uniform, appearance, which some prefer to the large black panels on the roof. Shingle sizes vary by manufacturer, but are typically about 1' x 7' and weigh approximately 13 pounds per square foot. Shingles are made of either copper or silicon. The copper semiconductors have an efficiency of 10 to 12%, while the silicon semiconductor efficiency is 15 to 20%. Silicon shingles are typically more costly. Most shingles produce 13 to 63 watts of power, which can result in a 40% to 70% reduction in your utility bills. Similar to solar panels, shingles have a service life of up to 20 years. This is comparable to asphalt shingle warranties. Look for a manufacturer's warranty to compare warranted life.	• Consider your roof type and which direction the surface of your roof faces. North facing surfaces will not collect as much as south facing surfaces. Unlike roof mounted systems, shingle location and angle cannot be adjusted to better capture the suns rays. • Like other *PV* systems, areas of your roof shaded by trees, buildings, or other tall items will reduce the amount of solar collection. • The technology is still new and evolving. There are not a whole lot of roofing manufactures offing these yet.

Solar Thermal Collectors or Solar Water Heaters absorb and collect the sun's radiant heat and transfer it to a hot water system.

There are two main types of collectors: "flat plate" and "evacuated glass tube." Flat plate collectors tend to have lower upfront cost and are more durable. Evacuated glass tube collectors are more expensive, however they are generally believed to generate more heat in King County's cloudy weather.

Solar thermal collectors are very efficient, relatively inexpensive, have a service life of 20 to 25 years, and require moderate maintenance. A standard sized system can reduce an average household's water heating bill by 50% to 70%.

Flat Plate solar thermal collector. *Source: EPA*

Evacuated tubes solar thermal system. *Source: Batt + Lear*

- In King County, the best application for solar thermal is for domestic water heating. It is less effective for space heating because solar thermal is most efficient in the summertime, when heating is not required.
- In addition to solar collectors, you will also require a larger than average, well-insulated combined solar/electric tank water heater, or a separate "solar pre-heat" tank to store your heated water, before running it into the regular water heater.
- Select a reputable solar installer who will properly assess your needs and the site's best solar assets, size and design your system. Make sure they tell you what scope is included in their bids.

Go Further:
In some "net zero energy" projects, where value is not only measured in dollars, *solar thermal collectors* may be used to capture and store summertime heat in the ground. A ground source heat pump (see the "Heat Pumps and Efficient Heating and Cooling Systems" Green Sheet) is then used to move that heat into the house in the winter.

Cost Information / Incentives

Solar PV: The cost of *solar PV* depends on how big of a system you want to install. Although residential systems range in size from 3kW to 12kW, the average residential system is between 5kW and 8kW. Under the Federal Inflation Reduction Act, a 6kW rooftop solar array that costs $15,300 to install may be eligible for a tax rebate of up to 30% of the cost, or $4,600 – bringing the installed cost down to $10,700!

King County's Solar Smart Handout identifies other federal, state and local solar incentives and rebates you may be eligible for.

Solar Hot Water: A family of 3 or 4 would typically use an 80-gallon tank which costs about $5,000 for the equipment and $2,000 for installation. The cost may be less if you opt for 60-gallon tank, which is more typical for 2- and 3-person households. Green loan options may help finance the install.

Puget Sound Energy and Seattle City Light incentives – The utilities provide information on net metering programs.

Permit Tips

When considering installing a rooftop mounted solar system in unincorporated King County, use this handy King County checklist to see if a permit is required. King County's Solar Smart Handout identifies applicable Zoning, Fire, Electrical and Plumbing Code requirements to be aware of when designing your system. If a permit is required, the following tips provide additional considerations to smooth your permit application and inspection process.

For solar thermal or *PV* panels, you will need to engineer the roof for dead loads of the panels and note the information on your plans. Many systems do not exceed the standard dead load limits for roof design;

Consider talking to Department of Local Services, Permitting Division staff before submitting your application.

Codes, Standards, & References

King County's Solar Smart handout identifies applicable fire, residential, and zoning code requirements when installing your solar system.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email dperwebinquiries@kingcounty.gov or call 206-296-6600.

Also see these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Insulation
- Heat Pumps and Efficient Heating and Cooling Systems
- Hiring the Best Professional for Your Project
- Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces
- Passive Solar
- Roofing Materials
- Routine Home & Yard Maintenance

Solar Water Heaters - This Department of Energy site provides additional information for system type, storage considerations, and installation and maintenance details.

Solar Washington -This nonprofit organization works to advance the solar industry in our state.

Office of Energy Efficiency & Renewable Energy Solar Photovoltaic Resources - This site contains a plethora of information, cost estimates, market data, and resources.

High Efficiency Appliances

Overview

High-efficiency appliances are designed to deliver comparable or improved performance over conventional appliances while using fewer resources such as electricity, gas and water. High-efficiency models exist for a wide variety of appliances; knowing the best efficiency ranking will help you select the best product. While some high-efficiency appliances may have a slightly higher up-front cost, they will save resources and money during use, delivering a return on your investment. Your utility company may offer incentives for replacing older appliances or buying new high-efficiency appliances.

When is This Applicable?

Replacing old appliances with new, energy efficient ones make sense when renovating or when an appliance wears out, but it's also worth looking at if you notice a jump in your utility bills because older appliances run less efficiently than when they were first purchased. If an appliance is 15 years old or older, it may be a good candidate for a high-efficiency replacement. When you're building a new home, high-efficiency appliances should be your first choice.

What Makes it Green?

High-efficiency appliances use less energy, water, or both, and are typically rated using a third-party evaluation of energy use and water efficiency, as well as performance. Using efficient high-performing appliances will save resources and reduce utility bills. Additional positive features of high-efficiency appliances include:

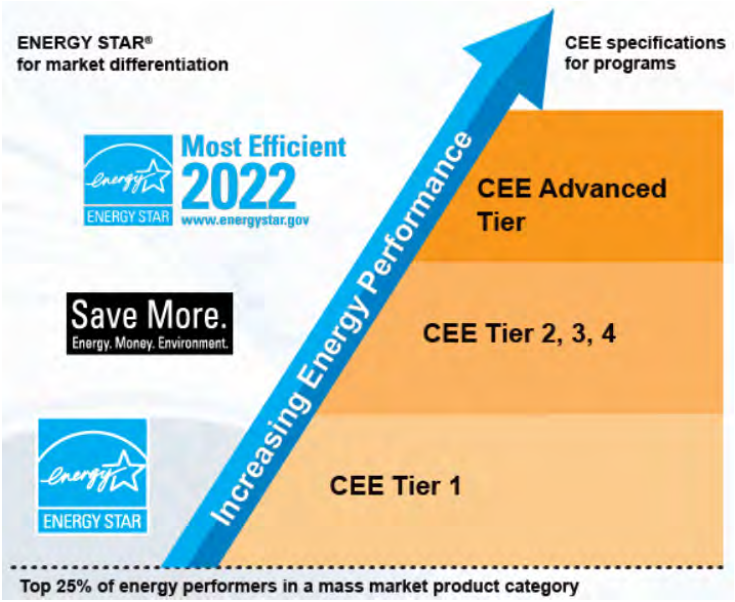
- Lower overall water, gas and electricity use
- Automatic water level adjustment on clothes washers to prevent over-filling
- Less detergent and other laundry products needed per wash
- Soil sensors on dishwashers to reduce wash and rinse time
- Less standby heat loss from water heaters
- More controllability for various types of wash cycles; and
- Finer control of refrigerator and freezer temperature.

The ENERGY STAR Certified Homes Program requires ENERGY STAR labeled appliances and high-efficiency water heaters, and you can earn additional points in Built Green and LEED for Homes for choosing high-efficiency appliances.

Look for the ENERGY STAR label when choosing appliances such as dishwashers, refrigerators, and clothes washers/dryers. *Stock images*

Best Practices

In order to find the most efficient appliances, look for a third-party efficiency label such as ENERGY STAR or Consortium for Energy Efficiency (CEE). The ENERGY STAR label products usually exceed minimum federal standards by a substantial amount, while CEE goes beyond ENERGY STAR and delivers greater savings. In conjunction with product selection, check your local utility providers and the ENERGY STAR website for rebates on high-efficiency appliances.

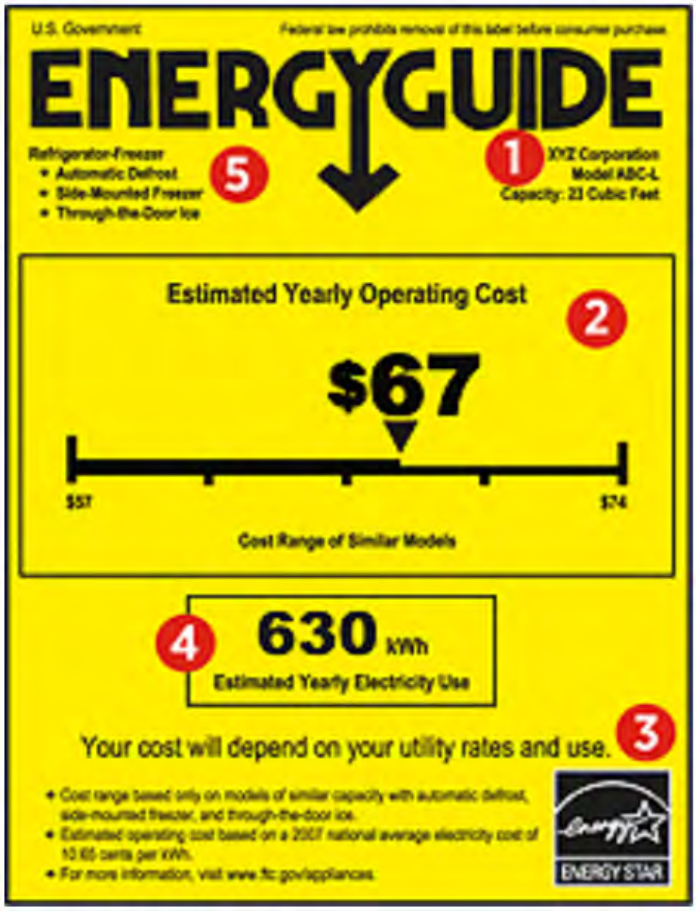


The relationship between ENERGY STAR and CEE Tiers.
Source: cee1.org/content/cee-tiers-and-energy-star

Higher Efficiency considerations for Home Appliances

(ENERGYSTAR rated is the entry level for all eligible appliances.)

Appliance	Most Efficient Label	Considerations
Dishwasher	CEE Tier 1	ENERGY STAR dishwashers are not more expensive than a comparable non-ENERGY STAR unit. Dishes don't need to be pre-rinsed – they can simply be scraped.
Refrigerator	CEE Tiers 2 & 3	ENERGY STAR and CEE Tier 1 both are 10% more efficient than federal minimum standards. CEE Tier 2 is 15% more efficient and Tier 3 is 30% more efficient. Side-by-side refrigerator freezers use more electricity than over-under refrigerators. Further energy savings are possible through purchasing the smallest fridge that meets your needs. Products without ice makers use the least energy, while models where you access ice on the outside face of the refrigerator use the most.
Clothes Washer	CEE Tiers 2 & 3	Washers with a higher modified energy factor means more clothes washing with less electricity and remaining water. Lower water factor (WF) means more efficient use of wash water. Front load washers use less water, cause less wear and tear, and are better at cleaning clothes with equal durability to a top-loader. Labels with these terms may be found on some washers for comparison.
Clothes Dryer	ENERGY STAR heat pump clothes dryer, CEE Tiers 2 & 3	Dryers with a higher Combined Energy Factor mean a more efficient appliance. Look for low heat drying, moisture sensors and/or auto-cycle termination.
Range and Oven	ENERGY STAR and CEE do not rate residential ovens, stoves or microwaves	Cooking typically consumes only 5% of annual household energy, so savings opportunities are relatively low. Avoid gas units with a standing pilot light, and consider switching to an Electric model if your current electric panel has the capacity. Keeping with electric appliances reduces indoor air pollutants, which is especially important if there are children or asthmatics in the home. Convection style ovens cook more effectively at lower temperatures. Consider an Induction stovetop or plug-in range. Induction cooking works using magnetic currents and transfers 90% of the heat to the food; see the "Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces" Green Sheet for more information on induction cooktops. Keep cook-tops and ovens clean for more efficient cooking.
Water Heating		See the "Efficient Water Heating" Green Sheet for specific information about this type of appliance.



The EnergyGuide Label

This information can be found on the energy.gov website (click the picture for the link). The EnergyGuide label is required to be placed on all appliances by the manufacturers. The label provides information about energy consumption, and shows you how much energy an appliance uses compared with similar models. Keep in mind that the numbers are averages: actual costs will differ somewhat depending on how you use them. The label shows the following:

- Maker, model number, and size of the appliance.
- Estimated yearly operating cost (based on average national electricity cost), and the range of operating costs for similar models.
- The ENERGY STAR® logo indicates this model meets strict energy efficiency criteria.
- Estimated yearly electricity consumption.
- Key appliance features and similar models that contribute to the cost comparison range.

Maintenance

Keep your appliances running as efficiently as possible and prolong their life by following these best practices:

- If you have a tank water heater, check the outside for corrosion, which can lead to cracks and leaks.
- Remove mineral buildup from your dishwasher by running an empty machine using a cup of vinegar or a biobased detergent as a cleaning agent. If your dishwasher has a removable filter, rinse out any built up food debris. Clean the door gaskets to make sure the seal is secure.
- Check washer and dryer hoses, vents and wiring for broken or kinked lines every couple of months. Make sure the dryer exhaust is free from lint build up or debris from the inside back of the dryer all the way to the exterior.
- Read your owner's manual when your new appliance is installed for maintenance tips, and keep it handy for future use troubleshooting problems that may come up. If there is a warranty registration card, send it in to the manufacturer. Repairing a small problem will be less expensive, and greener, than replacing the whole appliance.
- Consider having one of our local salvage retailers sell an unwanted appliance so it can be used by someone else.

Disposal

Once an appliance has reached the end of its life, it's important to dispose of it properly. Consider donating unwanted appliances to one of the Habitat for Humanity ReStores, or having one of our local salvage retailers sell an unwanted appliance so it can be used by someone else. Alternatively, you can contact your local waste management department for resources to dispose of old appliances. In some cases, when you purchase a new unit, installers will remove and haul the existing appliance for you.

Cost Information / Incentives

For some people new appliances may be cost prohibitive. Check with local appliance dealers in your area. Many stores have warehouse sales for equipment that gets scratched or banged up during shipment and delivery. If the appliance is inset into cabinets and closets you might not ever see its blemishes. It's a great way to buy new appliances at discounted prices.

Puget Sound Energy (PSE) rebates: PSE Offers some cost saving rebates for upgrading to more energy efficient appliances.

Seattle City Light (SCL) rebates: SCL has a variety of cost savings options for new heat pump appliances including water heaters. There are some other qualifying upgrades also.

Permit Tips

Simply replacing an appliance for another, more efficient appliance of the same type does not require a permit. However, a full kitchen remodel, especially if appliances are being relocated, may require coordination with your local building department.

Resources

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- Duct Sealing
- Efficient Water Heating
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- Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces
- Heat Pumps and Efficient Heating and Cooling Systems
- Insulation
- Routine Home & Yard Maintenance

ENERGY STAR Qualified Products: Database of efficient appliances and key criteria. Use the gallery of menu items under "For Your Home."

Consortium for Energy Efficiency – Program Resources: Database of efficient appliances and key criteria. Be sure to expand the menu for "Residential."

Energy.gov: Shopping guidance for energy-saving appliances.

Consider donating unwanted appliances to a Habitat for Humanity ReStore, or having one of our local salvage retailers sell an unwanted appliance so it can be used by someone else.

King County Appliance Disposal information: Information on how to properly dispose of all kinds of appliances in King County.

Going Electric: Converting Gas Appliances, Wood-Fired Stoves, and Fireplaces

Overview

Gas and wood-fired appliances for home heating and cooking have been popular at times, but new research is showing they can pose serious risks to our health, along with harmful environmental impacts. One of the biggest things you can do to improve your home's indoor air quality and reduce harmful climate impacts is to convert fossil fuel and wood-burning appliances to electric.

Definitions

Burner

Burner refers to the individual circular heating elements on a stovetop used to cook food. Most stovetops have two or more burners.

Combustion

The process by which chemicals or materials combine with oxygen in the air to generate heat. Wood, natural gas (methane), and propane are commonly used as fuels in heating and cooking in homes. Combustion produces heat, but also hazardous chemicals like carbon monoxide. A more comprehensive list is provided in Table 1.

Fossil Fuel

A hydrocarbon-containing material such as coal, oil, or natural gas, formed naturally in the earth's crust from the remains of dead plants and animals that is extracted and burned as a fuel.

When is This Applicable?

When building new, remodeling, or otherwise upgrading appliances in the home. With the current incentives and rebates available, it can be surprisingly affordable to replace older, less efficient, or hazardous appliances and heating equipment with electric replacements.

What Makes It Green?

Converting from combustion appliances to electric is critical for a number of reasons including health impacts from poor indoor air quality, reduced dependence on wood and fossil fuels, and the elimination of chances of explosions and carbon monoxide emissions. Pollutants released by gas stoves have shown to cause a 44% increase in rates of asthma in children. Even vented stoves pose asthma-related problems. A study found that after cooking for just an hour with a gas stove and oven, the levels of nitrogen dioxide exceed both state and federal outdoor air-quality standards in more than 90% of homes. More details about pollutants and their health effects from indoor gas and wood combustion are described in the below table.

Pollutant	Health Effects	
	Acute	Chronic
Nitrogen oxide (NOx)	Decreased lung function, asthma exacerbation, respiratory infection, stroke	Premature mortality, lung and breast cancer, cough, shortness of breath, asthma, wheezing, respiratory illness in children
Carbon monoxide (CO)	Death, brain damage, seizures, memory loss, dementia, headaches, dizziness, nausea	Brain and heart toxicity, heart failure and cardiovascular disease, low birth weight
Fine particulate matter (PM 2.5)	Stroke, increased blood pressure	Premature mortality, bronchitis, asthma onset and exacerbation, low birth weight and preterm birth
Ultrafine particles (UFP)	Increased blood pressure	Cardiovascular disease, neurological disorders
Formaldehyde	Respiratory/eye/skin irritation, sneezing, coughing, nasal congestion, drowsiness, chest tightness, shortness of breath, asthma exacerbation, death (higher doses)	Cancer, asthma and bronchitis in children; damage to respiratory system; headache;, sleep disorders; memory loss; birth defects; low birth weight; spontaneous abortion.

Table 1. Acute & Chronic Health Impacts Associated with Combustion Pollutant Exposure

Best Practices

Do your research prior to purchasing new equipment or hiring a contractor. While we recommend replacing combustion equipment for your health and cost savings, it may not always be possible. Read the following section on converting to electrical appliances for details on how to approach the process.

Some contractors (even electricians) still prefer the idea of gas fireplaces. Please also refer to the "Hiring the Best Professional for Your Project" Green Sheet for tips on navigating these professional relationships.

Converting to Electrical Appliances

To reduce onsite burning of fossil- or carbon-intensive (wood) fuels, and reduce exposure to indoor air pollution, you may choose to replace your wood or gas appliances with electric. These are your simple process steps:

- Hire an electrical contractor to install the appropriate outlet and any other associated electrical work (or Do It Yourself).
- Whoever is doing the work must obtain an electrical permit.
- Schedule an electrical inspection once the work is complete.
- Consider recycling your used appliance after installing the new appliance.
- Have a good maintenance plan for the appliance and electrical system.

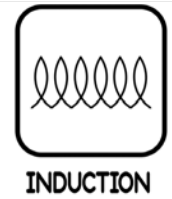
Deeper green: Induction Cooktops, Stoves, and Burners

Consider replacing your gas stove with an induction stove, cooktop, or burner. Older stove technology transfers heat to your cookware, but induction technology uses magnetism to generate heat directly in the metal of the pot or pan itself. Induction cooking benefits include:

- Cook faster. Induction heats faster than its peers, boiling water nearly twice fast.
- Cook more efficiently. Roughly 90% of the energy from induction transfers directly to the food, compared to 40% from a gas stove.
- Cook safer. Heat is not generated unless metal cookware is present. There is no open flame or hot coils; and many induction cooktops have safety features such as an "auto-off."

Safer than a gas combustion appliance. No indoor air pollutants are generated from the induction process. However, venting is still recommended to manage steam, smoke and grease generated during the cooking process.

Additional notes about induction cooking:



Your cookware matters. Flat-bottom pans containing iron will work with induction, including cast iron, stainless steel, carbon steel and clad cookware. Hybrid aluminum or copper cookware may also work but must be tested; you can always test your cookware to see if a magnet strongly sticks to the bottom (if it does, it is a good match). When buying new cookware, look for "induction-compatible symbol:

- Although induction cooktops have increased safety compared to conventional cooking ranges, still NEVER put your hand on a cooktop recently used for cooking. The hot pan may have transferred its heat to the surface.
- Induction cooktops emit medium-frequency electromagnetic waves. According to the World Health Organization, there is no compelling evidence indicating medium-frequency magnetic fields have long-term health effects. While there is little research on how these electromagnetic fields may affect pacemakers or implantable cardioverter defibrillators (ICDs), we recommend that users consult with their doctors or pacemaker manufacturers before purchase.

Gas and Wood Fireplace Conversion

Wood and natural gas fireplaces can impact indoor air quality, particularly during the winter when a home has reduced natural ventilation. If possible, consider converting to an electric fireplace because they are:

- Less expensive to install
- Cheaper to operate
- Require little to no maintenance
- Pose few safety risks – no natural gas (i.e., methane) leaks; glass doors not hot enough to burn.
- There are also electric fireplaces that can create the illusion of realistic flames while still generating efficient warmth.

Converting from a gas fireplace to electric can require an electrician and a plumber to remove the existing unit, disconnect the electrical and gas pipe connections, and seal the gas line. Electric inserts can be fitted into any existing fireplace. This can be performed by you or your contractor and usually takes about 30 minutes.

If you have a wood stove that can't be replaced at this time, add catalytic convertors and install tight-fitting glass doors because these modifications will improve its efficiency and greatly improve your indoor air quality. Other upgrades could include installing a flue top damper, air vents that are

vented to the outside, heat exchangers and/or a fireplace insert with a blower. With any combustion device, make sure to install a carbon monoxide detector to ensure the safety of people who live there.

Cost Information / Incentives

Electric fireplaces typically range from $300 to $900 when purchased new. If your electric fireplace requires new home wiring, you can expect to pay between $300 and $700 for an electrician to install it.

Capping an old gas line is expected to cost around $200 when done by a plumber.

The total combined costs range from $800 to $1,800.

A new induction cooktop to replace a wood stove is expected to cost about $1,000.

Some installers will remove and dispose of the old equipment when they install new units.

Washington State Low-Income Home Energy Assistance Program (LIHEAP) – The LIHEAP program may provide funding to replace old, malfunctioning, or broken heating or cooling equipment in qualifying-income households.

PSE Home Heating Incentives and Rebates - Puget Sound Energy provides incentives and rebates for certain energy efficiency upgrades including those on air and water heating systems.

A Pocket Guide to All Electric Retrofits of Single Family Homes – This guide provides costs, benefits, and strategies around replacing existing gas appliances with efficient electric alternatives.

Permit Tips

An electrical permit is required and should be obtained before to installing the appropriate outlet and any other associated electrical work. The permit must be obtained by the person doing the work, whether it is a DIY project or handled by a contractor. You must request inspection prior to covering any electrical work.

L&I Electrical Permitting Information for Homes and Business Owners - Washington State Labor and Industries (L&I) has basics for home and business owners and is the first step in getting a permit if your project is located in unincorporated King County.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related King County Department of Local Services, Permitting Division (DPER) Green Building Handbook Green Sheets:

- Fresh Air Ventilation
- High Efficiency Appliances
- Hiring the Best Professional for Your Project
- Routine Home & Yard Maintenance

Climate Solutions' Building Electrification Memo – A memo providing additional information on health impacts associated with exposure to combustion pollutants.

Gas and Electric Ovens and Stoves – This article from Energy.Gov article discusses the various types of cooking appliances, which includes a lot of information about induction cooking appliances.

The Economics of Electrifying Buildings - This article by RMI (formerly Rocky Mountain Institute) provides insights as to why we should move away from using gas and gas appliances.

Construction & Demolition (C&D) Materials Management

Overview

Nearly all construction projects, whether building a new structure or embarking on a remodel, produce some quantity of leftover *construction and demolition (C&D) materials* as well as wastes such as paint cans and insulation scraps. Past research has found that roughly 92% of construction and *demolition* materials generated in King County have value for *reuse*, *recycling*, or as a processed fuel source. Unless thoughtful decisions are made to recycle and *salvage* as much of this material as possible, they will end up in a landfill.

When you throw *construction and demolition (C&D) materials* "away," where does it go?" In King County, but outside Seattle, nearly all *C&D material* that is not *reused*, *recycled*, or burned as a fuel at paper mills is transported to landfills in northeastern Oregon or southcentral Washington. Knowing your options and best practices can help you minimize waste, save money, and keep valuable resources out of the landfill.

Definitions

Construction and Demolition (C&D) Materials
Result from construction, remodeling, repair or removal of buildings, roads or other structures. It includes (but is not limited to) wood, concrete, drywall, masonry, roofing, siding, structural metal, wire, insulation, asphalt, and packaging materials related to construction or demolition.

Demolition
The process of razing, relocating, or removing an existing building or structure, or a portion thereof.

Divert
The reuse, recycling, or beneficial use of construction and demolition materials.

Deconstruction
The systematic disassembly of a structure, in order to salvage building materials or components for the primary purpose of reusing materials to the maximum extent possible, with a secondary purpose of recycling the remaining materials.

Recycling
The process of transforming or remanufacturing waste materials into useable or marketable materials for use other than landfill disposal or incineration.

Reuse
The return of a material into the economic stream for use.

Salvage
The recovery of construction and demolition building material and components from a building or site in order to increase the reuse or repurpose potential of these materials and decrease the amount of material being sent to the landfill. Salvaged material may be sold, donated, or reused on site.

When is This applicable?

King County and Washington State both have requirements related to the handling of *C&D materials* that permit holders and project contractors should know and comply with. These include the following:

- Washington State requires that if there is a collection container on your project site for materials that are going to be *recycled/diverted*, then there must also be a container present for the collection of waste – thereby safeguarding the *recycling* container from getting contaminated by materials destined for a landfill.
- Where to take *C&D materials*
  - Materials generated in King County, but from not within the City of Seattle, should be taken to County designated facilities to ensure compliance with the King County Waste Acceptance Rule.
  - Materials generated within City of Seattle should be taken to a qualified facility.
- You and your contractor are required to meet health and safety requirements related to *C&D materials* [lead/asbestos/safe hauling].

Additionally

- When planning for any minor or major remodel, *deconstruction*, *demolition*, or new project; planning out material quantities carefully in advance can help you or your contractor more efficiently manage *C&D materials* and save time and money during the project.

- During any project, know what to do with *C&D materials* and identify safe, convenient places to store them for *reuse*, *recycling*, or disposal so they don't get in the way of your project or get contaminated.
- If pursuing a green building certification, you may be able to earn 'points' based on the amount of *C&D materials diverted* from the waste stream – note that you'll need documentation showing how much was *diverted* throughout the duration of the project.

What Makes it Green?

Using just the right amount of the right materials in your project, and *recycling* or reusing the leftovers is inherently good for the environment and for your pocketbook.

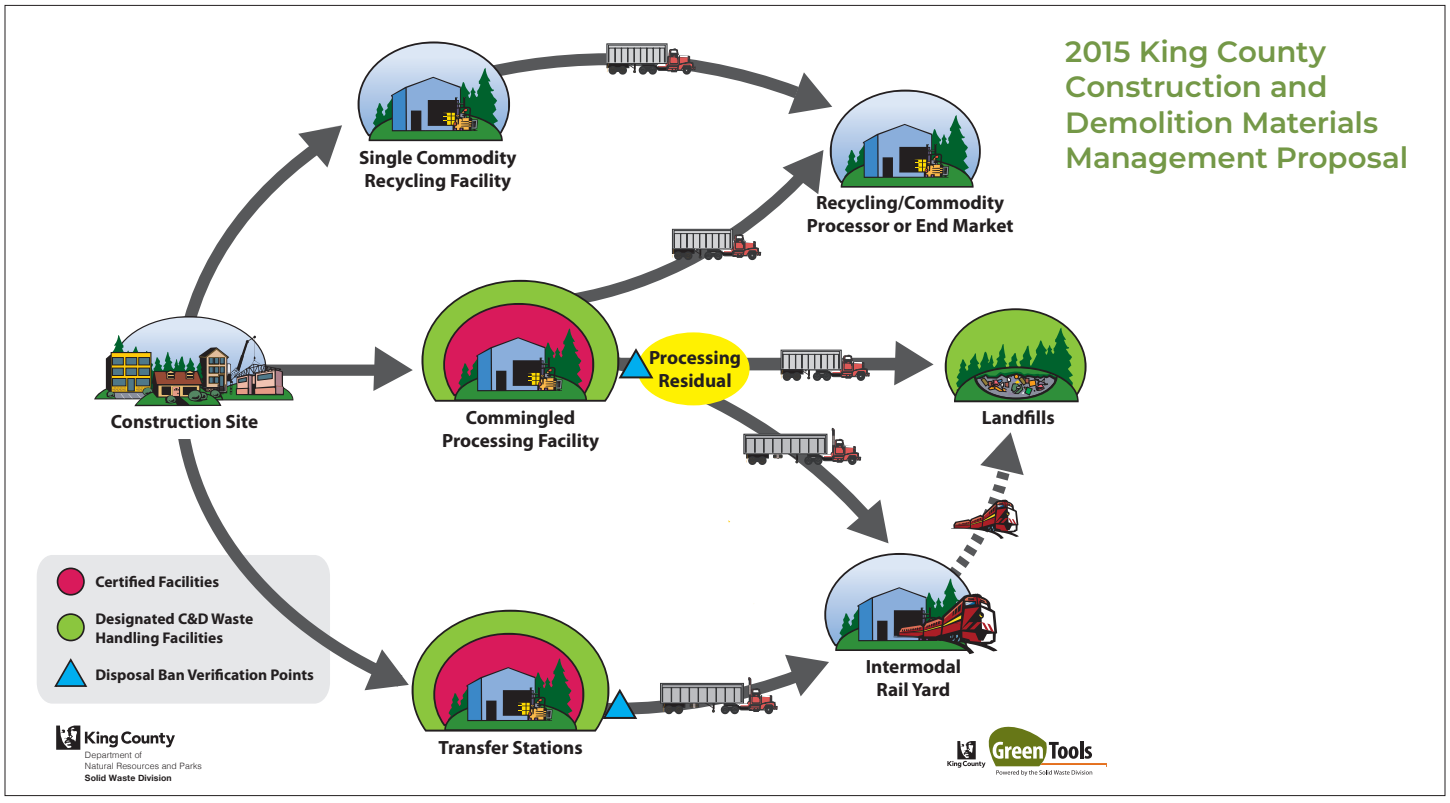
- Reducing the amount of materials used in the first place results in less energy used to harvest and extract raw materials from the earth, and to process and manufacture building products. It also means you spend less!
- Reusing *salvaged* materials from one project in another project reduces the need for transportation associated with hauling; this, in turn, reduces air pollution and greenhouse gas production, as well as minimizing impacts on roads and other infrastructure. It also saves time and money!
- *Recycling* leftover construction materials further conserves natural resources, extending the life and usefulness of materials.

Best practices

Best practices for minimizing waste generated from construction projects starts with identifying ways to reduce, *reuse* or repurpose as much of the material as possible before exploring options for *recycling* or disposal. Planning ahead to minimize the amount of waste that is generated and sent to the landfill will save you money in tipping fees. For example, taking cardboard to the *recycling* bin at most transfer stations is free, and taking clean wood to a transfer station that accepts it costs less in King County. Call ahead or check the website for current details. Involve your contractor in the planning process as you consider the following:

Planning

- For whole structure removal, consider deconstructing the building instead of standard *demolition*. Review the King County Building Removal Assessment Tool for resources about building relocation, *deconstruction*, material *salvage*, and a listing of companies that you can contact to help assess your situation.
- Before beginning your project, consider the types of *C&D materials* that will be generated, and research different options for minimizing waste, and know in advance where to take materials that you cannot use (see the Resources section, including *salvage* options).
- When buying materials, buy only what you need in order to minimize leftover materials.



Separating waste onsite helps improve the overall recycling rate and can save you money

On Site and Hauling

During your project, have the appropriate number of bins to be able to source-separate major material groups and be sure to properly label those containers. Depending on if you self-haul or hire someone to haul for you, you may be able to co-mingle construction materials, but keep in mind that source separating always results in higher resource recovery rates, lower fees for getting rid of the material and less landfill-destined materials.

Proper labeling has a big impact on the success of your materials management. Be sure to use multiple languages if you are working with contractors and subcontractors whose first language is not English.

Some separated materials (ex. cardboard) can be dropped off by King County residents at Bow Lake, Cedar Falls, Enumclaw, Houghton, Renton, Skykomish, Shoreline and Vashon transfer stations and drop boxes. Unpainted/untreated lumber can be taken to Bow Lake, Enumclaw, Factoria, and Shoreline. *Recycling* services vary by facility. None of the transfer stations or drop boxes currently accept commingled *C&D materials* for *recycling*. Download a printable copy of "Your Guide to King County Solid Waste Recycling and Transfer Facilities" The Factoria transfer station also offers a household hazardous waste service for residential customers and pre-approved small businesses. Additional options for *recycling C&D materials* can be found by looking in the "What Do I Do With…?" database.

Further best practices include

- If the materials are something that can be *reused*, then repurpose them yourself in other projects, ask your contractor to repurpose them, ask a *salvage* store if they will take them or simply give them away.
- Small amounts of *C&D materials* are accepted at King County solid waste transfer stations. Customers using dump trucks, flat beds that dump, or roll-off boxes may not dispose of *C&D materials* at these transfer stations unless *C&D* comprises less than 10% of the total volume of the load. (Note: Dump trucks, flat beds and roll-offs with *C&D* are accepted at the Vashon transfer station.)

Safety Considerations

- If asbestos or vermiculite insulation is found, you'll need to ensure you know what can go where. Check "What Do I Do With…?" database to determine where to take materials and quantity limitations. Note that guidance for vermiculite can be found under "asbestos." Contact the Puget Sound Clean Air Agency for permit/info.
- Lead paint was banned from being sold in 1978, so if working in a house built prior to 1978, the paint may contain lead; Because countless gallons of lead paint may have been purchased and stockpiled prior to 1978, it may still have been used in buildings after 1978 so you may want to have paint tested if built after that time. If you are hiring a contractor, they are required by law to follow Safe practices. Although homeowners are not required to follow the same rules, to protect your health and your family's health, follow best practice guidelines. See Lead Paint Requirements for *Salvage/Deconstruction* for more information.
- Safely securing the load of materials you're hauling materials is not only important, it's the law.

Cost Information / Incentives

Once you have established a plan for *recycling* and reusing materials, you can determine the cost-effectiveness of your efforts by using the Recycling Economics Worksheet to calculate your disposal and *recycling* costs.

Permit Tips

If you are deconstructing or demolishing a structure or portion of a structure that is greater than 120 square feet, you will need a *demolition* permit (see the Residential Demolition Permits information sheet for guidance if your project is located in unincorporated King County).

If your project requires a permit, check with your local jurisdiction to see if you'll be required to submit a waste diversion report which shows what *C&D materials* from your project were *salvaged*, *recycled*, or landfilled, and their quantity.

Codes, Standards, & References

King County Waste Acceptance Rule: King County accepts wastes for disposal at County facilities pursuant to this Rule. This Rule promotes governmental efficiency and affords citizens fair notice and process. This Rule is promulgated to preserve and protect the public health, safety, and welfare.

Puget Sound Clean Air Agency Asbestos Fact Sheets: These links provide helpful information for identification and removal of asbestos.

Lead Paint Requirements for *Salvage/Deconstruction*: Outlines legal requirements and best practices related to lead paint on *salvage*, remodel, and *deconstruction* projects.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Advanced Framing
- *Deconstruction* and *Reuse*
- Hiring the Best Professional for Your Project
- Green Products and Building Components

Salvage & Salvage Retail Resources

Northwest Building Salvage Network: A resource providing the names and locations of stores that sell *salvaged* building materials for *reuse* as well as a list of *deconstruction* contractors/*salvage* verifiers in our area.

The Habitat for Humanity Store: features building *salvage* materials and donation pick-ups from your next project.

Recycling Resources

What do I do with...?: King County's interactive website allows you to indicate the materials you are looking to recycle/dispose of and provides location contact information for many sites.

LinkUp: The LinkUp program may have resources for you or your contractor to help determine what you can recycle and where. There are many links to numerous resources.

Deconstruction and Reuse

Overview

Deconstruction is the systematic disassembly of a structure, in order to salvage building materials or components for the primary purpose of reusing materials to the maximum extent possible, with a secondary purpose of *recycling* the remaining materials. Unlike the process of *demolition*, deconstruction preserves the integrity of materials so salvaged materials can be *reused*, and a higher amount of material recycled. Therefore, deconstruction often results in *diversion rates* of 95% or higher – preventing all that material from ending up in a landfill.

If you deconstruct a structure, you can choose to retain reusable materials for use in a future project, donate the materials to a non-profit that sells or uses reclaimed materials, or most commonly, allow your contractor to save and sell the materials - or direct them to a local *reuse* store. When materials are donated to nonprofits, the value of those materials can sometimes also be claimed as a tax deduction which can be economically beneficial.

Full deconstruction of a garage.
Source: Re-Use Consulting, reuseconsulting.com

Definitions

Abate
Abatement is the proper removal of hazardous materials like lead and asbestos - often by licensed and trained professionals.

Demolition
The process of razing, relocating, or removing an existing building or structure, or a portion thereof.

Diversion Rate
In this context, diversion rate refers to the amount reused + amount recycled divided by the total amount (disposal + recycling + reuse). Example: 45 pounds reused, 45 pounds recycled, 10 pounds disposed of = 100 pounds and diversion is 90 pounds or a 90% diversion rate.

Recycling
The process of transforming or remanufacturing waste materials into useable or marketable materials for use other than landfill disposal or incineration.

Reuse
The return of a material into the economic stream for use.

Salvage
The recovery of construction and demolition building material and components from a building or site in order to increase the reuse or repurpose potential of these materials and decrease the amount of material being sent to the landfill. Salvaged material may be sold, donated, or reused on site.

Example of a Pan Abode brand structure 'designed for deconstruction.' *Source: De-Construction Services, LLC. panabodehomes.com*

Reclaimed wood available at a local reuse store.
Source: Reuse Center reusecenter.net

When is This Applicable?

Salvage and *reuse* should be considered for every remodeling or whole building removal project. Nearly all projects will have some materials worth salvaging and most projects are good candidates for deconstruction. Working with a *salvage* or deconstruction professional will be the best way to find out what materials have value, and what are the safest and most cost-effective approaches to unlocking that value. A structure may not be worth deconstructing or salvaging materials from if the building is fire damaged, has been subjected to prolonged water exposure, or has significant dry rot or pest damage.

When it is decided that a structure (building, fence, etc.) must be removed, moving the structure intact, deconstructing it with maximum *reuse* and

Some of the benefits of reclaimed vs. new materials. *Source:* Re-Use Consulting

recycling of the components, or salvaging it prior to *demolition* should be considered in that order. Therefore, almost every project can involve saving materials from disposal, or purchasing reclaimed materials for use in the new structure. Deconstruction will become the common way to take down a building or structure as more people seek these materials for their projects.

What Makes It Green?

Deconstruction of a structure is much more sustainable than *demolition*. Materials that are *salvaged* from a deconstructed project and then *reused* are among the most sustainable materials in the world due to their low carbon footprint. When comparing reclaimed wood flooring and framing extracted from a building to the equivalent volume of newly manufactured material, reclaimed products require 11-13 times less energy to produce and generate 3-5 times less greenhouse gas emissions. This is why structures being removed should be deconstructed whenever feasible, and as much *salvaged* material should be *reused* in a new project as is possible. As much of the remaining material should be recycled so very little of the remaining material goes to the landfill. If enrolled in a green building certification program, deconstruction can help achieve higher points on a checklist through material *reuse* and high *diversion rates*.

Deconstruction does much more than prevent the majority of materials from going to the landfill! Making *salvaged* materials and building components available for *reuse* reduces the volume of trees that will be cut down or materials mined in order to make new materials. It also greatly reduces the amount of energy needed to manufacture new products.

According to the Delta Institute's Deconstruction and Reuse Guide, the other benefits include green-collar job creation as deconstruction/*reuse*/*recycling*/remanufacturing creates about 6 to 8 times more jobs than *demolition*/landfilling does. Also, people can find affordable alternatives in *salvaged* materials compared to buying new materials.

Best Practices

Bringing in a *reuse* or deconstruction contractor/consultant or experienced general contractor early in the planning process will ensure the time for *salvage* and deconstruction will be incorporated into the construction; If the project includes new construction, it will allow you that time to identify the *salvaged* materials that could be reincorporated.

Interview your contractor thoroughly to make sure that they can provide quality deconstruction services and that they won't charge a premium to do so. Expectations should be clearly communicated to all contractors working on the project, including:

- Which materials will be disassembled for *reuse*.
- Which materials will be sorted out for *recycling*.
- Which materials will be saved for *reuse* on the project.
- How much time is allowed for this scope of work.
- What resources the project can offer the contractor like storage space, extra time, head-start, etc.
- Where other reusable materials will be directed to (most become the property of the contractor).

When developing their bids, experienced deconstruction contractors will factor in costs and savings when planning around which materials will be sold, donated, or *reused* onsite. Some deconstruction contractors may be willing to walk through the project with you to discuss the items that have higher chances of sale or donation, which can be helpful when comparing bids or just expanding your own understanding of green building features and material values.

It is best to expect the unexpected in deconstruction projects. For example, some materials scheduled for *reuse* might be glued together and can't be saved - or more hazardous material may be found and have to be *abated*, resulting in less material that can be *salvaged*. Hazardous materials should be identified early in the process and the deconstruction contractor made aware of the results. Buildings over 40 years old often contain lead or asbestos

which are hazardous to human health. Materials containing silica can also present health concerns if that dust that gets into the lungs. When hazardous materials are found, the more work an abatement company performs can reduce the amount of material to be deconstructed and can reduce deconstruction costs.

Cost Information / Incentives

It is generally assumed that the process of deconstruction will take more time than *demolition* and cost more than mechanical *demolition*. This is because the bulk of the deconstruction work is done by hand, and the bulk of *demolition* is done with machines. The longer deconstruction takes, the more it will likely cost.

However, some costs of a deconstruction project can be offset by the amount of *salvaged* material that can then be *reused* in the construction phase of the project or that could be donated for a tax deduction. The process of *demolition* is just a cost with no way to recoup the cost.

Here are some tips to help save costs throughout the process:

Multiple bids – Let contractors know that you are getting multiple bids because competition may encourage lower bids. Also consider using 'bid alternatives' - This is where you ask for a base bid with certain expectations along with an alternative bid that includes additional work resulting in higher levels of performance. For example, you could ask for a base bid of building deconstruction with a requirement of 85% landfill diversion, and then request an alternative bid asking for the same base requirements but also includes 500 sq ft of fir flooring be carefully *salvaged* and returned to the owner. The two prices will give you a way of deciding whether the *salvaged* flooring is financially worth keeping, selling, or donating for a tax deduction.

Get a head start – Before the abatement contractor is scheduled to start, allow the deconstruction contractor to get started on selective work that is deemed safe and permittable. This can help keep the project on schedule and takes pressure off of the deconstruction contractor to move too fast or necessitate the hiring of extra personnel which can increase costs.

Consider 'owner-reuse' – Materials *salvaged* and returned to the owner represent a benefit. The true cost of deconstruction is the cost of the service minus the benefit of the value of the materials the owner *reuses*. Example: a building is deconstructed for $20,000 even though the *demolition* bid was $18,000. The deconstruction contractor removes and returns 750 square feet of flooring to the project owner that has a value of $3,000. The net cost of deconstruction is now $17,000 which is less than the cost for *demolition*.

Get the contractor involved early in the process – When a deconstruction contractor is involved early in the process, they have time to seek out demand for the supply of reclaimed materials from the project. The resulting demand generated through this process leads to materials

A load of reclaimed wood at a reuse center. *Stock image*

being removed from the project without inputting added costs of hauling reusable materials to another location. This incentivizes the contractor to bid lower.

Let the deconstruction contractor help determine the scope of work – Many deconstruction contractors are not set up to perform all types of work that might be required. Talk with the deconstruction contractor to discuss what they commonly do and try to work with them on a plan that will help keep their bid costs down.

Donate materials – Materials that are donated to 501c3 non-profit organizations may benefit the project owner by providing a tax deduction. The materials must be appraised by a certified appraiser when over $5,000 in value, and the IRS keeps an eye out for those that might over-value materials so review product appraisals and question those that are higher than anticipated. The tax deduction value can be subtracted from the deconstruction cost to determine the new, lower net cost. Find more information on this topic through this series of articles.

City of Seattle Deconstruction Incentives – If you are removing a residential building in City of Seattle, a suite of incentives are available for qualified projects by application:

- Through Seattle's Department of Construction and Inspections Deconstruction Incentive Program, *demolition* permits can be expedited, thereby allowing more time for your building to be deconstructed – this is particularly helpful when typically having to wait for a partnering construction permit to be issued.
- Through their Deconstruction Incentive Pilot Program, Seattle Public Utilities is providing grants of $4,000 for each qualified incentive project in order to help offset project costs. As a further incentive, Seattle City Light will fast track deconstruction projects for electrical service disconnects.

Permit Tips

If you are deconstructing or demolishing a structure or portion of a structure that is greater than 120 square feet, you will need a *demolition* permit. However, certain nonstructural work on a project such as pulling out reusable carpets can be performed prior to receiving a permit. If this and other similar work is completed prior to receiving the permit, it provides a head-start for deconstruction.

Some jurisdictions issue special permits for green building performance and deconstruction, which may allow projects to get their permits faster, thus offsetting or negating the extra time that deconstruction may require. Some projects are not allowed to proceed at certain times of the year due to issues like ground disturbance during the wetter months. Deconstruction does not need to disturb the ground and may be allowed. This is another example where deconstruction may be the cheaper and faster option.

(see the "Residential Demolition Permits" information sheet for guidance if your project is located in unincorporated King County).

If your project requires a permit, check with your local jurisdiction to see if you'll be required to submit a *salvage* assessment form which identifies which materials on the project may be *salvageable*, or waste diversion report that identifies which C&D materials from your project were *salvaged*, recycled, or landfilled, and their quantity.

Codes, Standards, & References

Section R602.1.1.1 of the Washington Residential Code now allows the *reuse* of *salvaged* lumber without the cost of grading so consider reusing wood and other materials in your home project.

Resources

For the complete King County Green Building Handbook and individual Green Sheet PDF files, please visit our website. For additional information, please email permitquestions@kingcounty.gov or call 206-296-6600.

See these related Department of Local Services, Permitting Division Green Building Handbook Green Sheets:

- Construction & Demolition (C&D) Materials Management
- Green Products and Building Components

Visit King County's Alternatives to Demolition web page to learn more about *salvage* and deconstruction.

The Northwest Building Salvage Network is a resource providing the names and locations of stores that sell *salvaged* building materials for *reuse*, as well as a list of deconstruction contractors/*salvage* verifiers in our area.

The Habitat for Humanity Store features building *salvage* materials and donation pick-ups from your next project.

The EPA has developed a Deconstruction Rapid Assessment Tool to help determine if your project is a good candidate for *salvage* and/or deconstruction.