

GREEN REMODELING PLAN BOOK



About The Plan Book?

The Green Remodeling Plan Book (GRPB) was originally conceived of as an online resource to help homeowners approach their home improvement projects using healthy sustainable practices and to provide product information that has been thoroughly researched and evaluated for its effectiveness. Given its commitment to environmental responsibility, the Roseville Housing and Redevelopment Authority (RHRA) decided to spearhead the development of a Green Remodeling Plan Book, the vision of which was to provide practical ideas to make any remodeling project a green project – from a fresh coat of paint to a complex room addition.

Initially created in collaboration with the Family Housing Fund and managed by the Roseville Housing and Redevelopment Authority, the content of the GRPB was developed by students from the University of Minnesota's Sustainable Design Department who relied on the advice and expertise of the following experts in the field of green building techniques and energy efficiency: Janne K. Flisrand of Flisrand Consulting, Karen Filloon of Southview Design, Patrick Huelman of the University of Minnesota Extension's Cold Climate Housing Program, Cindy Ojczyk of Simply Green Design, Rebecca Olson of the Minnesota Building Performance Association, Tom Sagstetter of Elk River Municipal Utilities, and William Weber of the University of Minnesota's College of Design.

The GRPB was first made available in 2011 and has since become a well-used resource by both Minnesota homeowners and others around the country who use it for educational purposes. The GRPB also received recognition at the Minnesota Healthy Communities Conference and received a Twin Cities Community Development Program Initiative Award from the Local Initiative Support Corporation (LISC) in 2013.

When the RHRA first developed the Plan Book, they made a commitment to review and update the material every 3 to 4 years. The first update was completed in early 2016 by a student from the University of Minnesota Architecture program whose area of study is Sustainable Design. The GRPB is now available online and as a PDF download. During the recent update the content was also reformatted so that it is printer friendly.

Did the GRPB Help You!

Sent comments about the Plan Book to

eda@cityofroseville.com

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What Is The Plan Book?

Maybe you're a new homeowner ready to knock down walls and refinish floors to make your new house a home, or maybe you've been settled for quite some time and your home could use some updates and a fresh look. No matter what the scenario, you've decided to remodel your home, and the task that lies ahead is not always a simple one. Remodeling your home is more than new colors and textures; it is an opportunity to make your home more affordable, comfortable, efficient, safe, and sustainable. Likewise, green remodeling is not just a trend; it is a practical choice that will optimize the results of your remodeling investment. Along with being an environmentally conscious decision, it also promotes a healthier home for you and your family, cheaper maintenance and utility costs, and a home built to last. *The Green Remodeling Plan Book* is a tool to help you make home remodeling choices that benefit your family, your pocket book, and the neighborhood you live in. Assembled by the Roseville Housing and Redevelopment Authority (RHRA¹) in collaboration with the Family Housing Fund² (The Fund), the *Plan Book* provides homeowners with the information and resources they need to make environmentally conscious, healthy, and practical renovations to their homes.



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GREEN REMODELING CONCEPTS

As you approach green remodeling projects, it is important that you educate yourself and your family about the general sustainability concepts, including the tradeoffs associated with them. Thoroughly analyze the green, economic, and practical attributes of the products you are interested in using to determine which ones best fit your needs and values. The bottom line to green remodeling is to do more with less; remember, the greenest square foot of your home is the one that isn't built.

The 3R's

Reduce: Can I do it with less space or fewer materials?

Reuse: What can I reuse or repurpose from my remodeling project or what can I purchase from local reuse centers?

Recycle: What waste can I recycle? Are there new products I can purchase that are made from recycled materials? Are there products that can be recycled at the end of their lifecycle?

Questions to Ask

Resources and Manufacturing

- What is it made of?
- Is the material rapidly renewable (i.e., wood) or made of **recycled content**?
- How does the harvesting/extracting affect the surrounding environment?
- Are the materials sourced locally?
- Are the materials sourced sustainably?
- How is it manufactured and how does that process affect the surrounding environment?
- How far is it transported to get to my home?
- What quantity of greenhouse gases does its production, use, and disposal emit?
- Does the manufacturing process release toxins or create hazardous waste?

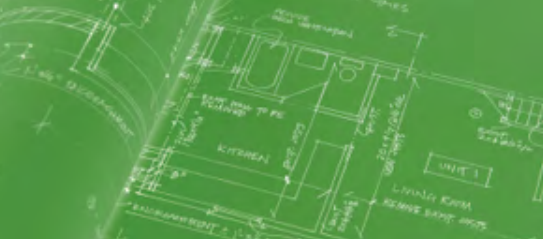
Performance and Cost

- What is the product's life expectancy?
- How durable is it?
- Is the material right for the situation (e.g., soft pine floors in a home with large dogs)?
- What maintenance does it require?
- What are the operating costs in comparison to the initial cost?
- What energy sources does it depend on to operate?
- What, if any, is the **payback period**, or the period of time it takes for the product to earn back the amount of money it initially cost (solar panels, for example, payback over time through reduction of energy costs)?

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What Is The Plan Book?

Environmental Effects

- Does it encourage energy efficiency (either the energy you use or the **embodied energy**)?
- What is the impact on water consumption (either through its use in your home or yard or through its production)?
- Does it increase storm water runoff when it rains?
- How will it affect the indoor environmental quality of my home? For example, will it emit harmful chemicals or gases or improve ventilation?
- How durable is the product or the project?
- How much waste will be created during the project?
- What effects will it have on the surrounding area when harvesting or mining the raw materials or when transporting it to my home?
- What happens to it when I'm done with it?

Life-Cycle Analysis or LCA

Life-Cycle Analysis or LCA is “a technique to assess environmental impacts associated with all the stages of a product's life from cradle to grave (i.e., from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).” It is a holistic approach to evaluating a product that incorporates the environmental impacts identified above.

*NOTE:

It is also possible to use a life-cycle analysis for cost, such as with a specific building product, where both the initial cost and the cost of operating are considered. Ideally, LCA can compare very different products, such as fiberglass batt insulation and spray foam insulation, in an apples-to-apples manner and clarify which is a more environmentally friendly choice. Unfortunately, the best tools to access LCA results are either very technical or may require a relatively expensive subscription. This guide encourages you to understand the concepts that go into an LCA, or to ask contractors to use their subscriptions to help you access LCA information. Interior designers and architects that specialize in green building are fairly likely to have subscriptions.

How many green attributes does this product have?

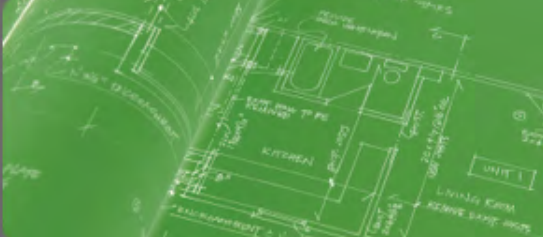
- Waste reduction (Was it made from something that would otherwise have gone into the waste stream like remnant stone, was it removed from a demolished home, or will it eliminate production waste by being made in a form on site?)
- **Recycled content** (like reclaimed wood or recycled glass)
- Durability (Will it stand up to wear and tear or is it able to be refinished or repaired on site?)
- Locally sourced
- Environmentally friendly production (like **FSC**-certified wood)
- Third-party certified (**FSC**-certified wood, GreenGuard Indoor Air Quality, **SCS Recycled content** or other)
- Healthy (low-**VOC** emissions)
- Recyclable or compostable

Here's an example of how to compare green attributes: A locally quarried granite countertop sourced from remnant scrap would have two green attributes, whereas a new slab of local granite has one green attribute.

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WASTE MANAGEMENT

Planning out your new construction projects, big or small, can save money by looking at the materials you'll be adding or removing in your addition or remodel. Remember, the most environmentally friendly and affordable square foot of your home is the one you don't build. Reduce by eliminating unnecessary material and space.

Reduce

Before construction begins, look at the materials you'll be adding or removing in your addition or remodel. Consider everything from framing to finish materials. To reduce harmful environmental impacts associated with manufacture, transport, use, and disposal of products, determine ahead of time what you really need and do thorough research on those products. Reduce by eliminating unnecessary material and space.

Reuse/Reclaim

Next, determine what products and structural components can be reused or reclaimed. Salvage doors, windows, and finishes from your home and local re-use sites such as salvage stores. For example, reclaimed wood products can make beautiful finishes and divert waste from landfills.

Check out these salvage options:

- [A to Z Disposal Guide](#)³
- Craigslist
- Private architectural salvage stores
- [The Freecycle Network](#)⁴
- [Twin Cities Free Market](#)⁵
- [Twin Cities Habitat for Humanity ReStore](#)⁶

Recycle

Lastly, if you must purchase new products, look for items that can be recycled at the end of their life or are made from recycled materials. When removing old materials, identify proper [disposal methods](#).⁷ If you hire a construction waste hauler, choose one that sorts and recycles waste. Be aware of city ordinances that mandate where and how certain waste is disposed of. Separate recyclables from hazardous, yard, and landfill waste. Most counties have annual pick-ups and drop-off points for appliances, organics, and hazardous waste products. [Learn more](#).⁸

3) ramseyatoz.co.ramsey.mn.us/pages/default.aspx

4) www.freecycle.org/

5) twincitiesfreemarket.org/

6) restore.tchabitat.org/shop

7) ramseyatoz.co.ramsey.mn.us/pages/default.aspx

8) ramseyatoz.co.ramsey.mn.us/pages/default.aspx

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What Is The Plan Book?

HOUSE AS A SYSTEM

Your house is made up of many different systems – heating, moisture management, ventilation, plumbing, electrical, and structural – and changes to one system will often affect the others. For most projects, we recommend working with building performance professionals who have studied how these systems interact and who have tools to test what is happening in your home. This way of understanding houses is also called a “whole-building” approach. [Learn more](#)⁹

- Check out this [video](#)¹⁰ on the house as a system.
- [Find](#)¹¹ local building performance professionals.
- [Sign up for a free energy audit or a home improvement loan offered by the City of Roseville](#)¹²

Certify Your Green Remodeling Project

Benefits of a green home include lower energy and water bills, reduced greenhouse gas emissions, and less exposure to mold, radon, formaldehyde, and other indoor toxins. How can you be sure you're getting these benefits from your remodel? Certifying your project through a program is one way to have an expert verify that the work will provide the benefits you expect, and certified green homes have been shown to sell faster and for higher prices in multiple real estate markets around the country.

Minnesota's Certification Options

Four active residential programs in Minnesota – [LEED® for Homes](#)¹³, [Minnesota GreenStar](#)¹⁴, [MN Green Path](#)¹⁵ and [Energy Fit Homes](#)¹⁶ are designed to help with the following:

- Ensure a credible, objective green standard is met
- Prioritize the most important aspects of green building
- Create healthier and safer homes by encouraging best construction practices

LEED® for Homes is a very thorough certification process that provides a full project team, a Green Rater, which provides on-site verification and documentation for the project, and a **LEED** for Homes Provider that will oversee all the work and submit the final certification report. However, **LEED** for Homes is quite expensive, starting at over \$2,000 for registration and certification.

Minnesota GreenStar certification is more do-it-yourself oriented. There are many online resources available, such as the free GreenStar Checklist and Manual. There are also webinars that help you to generate project scopes, bids, and specifications and develop accountability forms for general contractors, designers, and sub-contractors. You can also sign up for a third-party GreenStar inspection.

MN Green Path has three different levels of certification tailored to the specific needs of your project. They go from very basic certification to an intensive Master Certification. MN Green Path also provides you with a list of remodeling options and suggestions.

9) www.bpihomeowner.org/home-performance

10) www.youtube.com/watch?v=yrCACpRwdsE

11) www.mbpa.us

12) www.cityofroseville.com/1632/Housing-Programs-Energy-Assistance

13) www.usgbc.org/certification

14) greenhomeinstitute.org/greenstar/

15) www.mngreenpath.org/checklist/

16) thenec.org/EnergyFit

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What Is The Plan Book?

Energy Fit Homes is a new program of the Neighborhood Energy Connection (NEC) and Center for Energy and Environment (CEE), two local non-profits with a long history of helping homeowners improve home efficiency. The program involves a home assessment including an on-site inspection and evaluation of the efficiency of your heating system, insulation and air sealing, windows, lighting, and ventilation and combustion safety. The assessment will be used to produce an Energy Fitness Score from 1 to 100. The higher the score, the more efficient the home. Schedule a home assessment [here](#).¹⁷

Passive Housing

Passive Housing design and building principles are a great way to achieve high energy efficiency without compromising comfort. The five primary principles of passive building are as follows:

1. Continuous insulation
2. Airtight building envelope
3. High-performance, multi-paned windows and doors
4. Natural ventilation and heat storage for heating and cooling instead of mechanical systems
5. Utilization of solar energy

Learn more about [Passive Houses](#)¹⁸ and how to get connected with a certified Passive House Consultant to optimize solar energy capabilities and transform your house into a healthy, energy efficient home.

Home Performance with Energy Star

The [Home Performance with Energy Star](#)¹⁹ program also provides a system for whole-house assessment, remodeling recommendations, and tools to track your improved energy performance.

¹⁷) mncee.org/Find-Programs/HES/

¹⁸) www.phius.org/home-page

¹⁹) www.energystar.gov/index.cfm?fuseaction=hpwes_profiles.showSplash

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What Is The Plan Book?

SELECTING A GREEN NEIGHBORHOOD

Greening your Neighborhood

Take your personal green remodeling interest to a larger scale and make your neighborhood a more sustainable, environmentally friendly community. Be an advocate for improvement and encourage both children and adults to take part in more sustainable habits. Some great community health and safety improvement ideas include wider sidewalks, improved nighttime lighting, bike lanes, parks and playgrounds, off-road trails, and community gardens. Visit [Smart Growth Online](#)²⁰ to access resources and network partners that can help provide ideas and implementation strategies for the safe and healthy growth of your community.



Transportation

Fuel emissions from transportation account for nearly a third of our [Greenhouse gas emissions](#).²¹ Sidewalks and bike infrastructure encourage alternative, low-impact transportation methods. Walk, bike, or take transit to destinations rather than drive whenever you can. You can assess how walkable your community is and what amenities are nearby using the website [WalkScore](#).²²



Biking

- Check out <http://www.mplsbike.org/> for information on biking events, policy initiatives, and volunteer opportunities.
- The [Bicycle Alliance of Minnesota](#)²³ also has great resources, such as locations of bike repair shops and air pumps, group bike rides, and general information about biking equipment.
- [Nice Ride Minnesota](#)²⁴ is a bike share program that allows you to rent a bike, get where you would like to go, and return it to any of the Nice Ride stations throughout Minnesota.

Public Transportation

Whether it be a city bus, carpool system, or park and ride, public transportation is an opportunity to reduce the environmental impacts of individual transportation. Check out [metrotransit.org](#)²⁵ to map out routes and discover other ways to get around and to work!

- Apps: The [Transit App](#)²⁶ shows all nearby transit options based on your location and how long each of them will take!
- Other transportation options when you don't own a car:
 - [Car 2 Go](#)²⁷
 - [Hour Car](#)²⁸

20) www.smartgrowth.org

21) www.c2es.org/docUploads/ustransp.pdf

22) www.walkscore.com

23) www.bikemn.org/resources

24) www.niceridemn.org/

25) www.metrotransit.org

26) transitapp.com/

27) www.car2go.com/en/minneapolis/

28) www.hourcar.org/

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What Is The Plan Book?

Amenities

Local amenities such as grocery stores, hardware stores, schools, and clinics help boost local economies and provide jobs for local community members. Taking advantage of these local services reduces transportation cost and environmental impacts for both you and the service provider. Supporting local business allows smaller retailers to better compete with big box stores. [Learn more](#)²⁹

Community Spaces, Trails, and Natural Areas

Take pride in public spaces and recognize the environmental importance of undeveloped areas in order to create a healthier, greener community. Preserving natural areas helps not only add aesthetic value to your neighborhood, but also helps manage water, provide entertainment, and create habitat for birds and native plant species. To learn more about parks and recreation in Roseville, check out the [Roseville Parks and Recreation Page](#)³⁰

LEED for Neighborhood Development

For growing communities, the USGBC's *LEED* for Neighborhood Development outlines strategies and improvements to create a sustainable community. Following the structured credit system, a neighborhood can achieve levels of certification that address topics of water management, density and urban planning, community connectivity, historic preservation, energy and waste resources, and ecological impact (just to name a few). Learn more about the rating system by visiting the [USGBC's *LEED* for Neighborhood Development](#)³¹ website.



29) www.visitroseville.com/Shopping

30) www.cityofroseville.com/2243/Renewal-Program

31) www.usgbc.org/articles/getting-know-leed-neighborhood-development

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What Is The Plan Book?

KEY TERMS GLOSSARY

Here you'll find definitions and explanations for many key terms used throughout the Plan Book. If you have a resource suggestion or better definition to share, please email us at grpb@cityofroseville.com.

Air Barrier

“An air barrier is any material or assembly of materials that stops the flow of air. To stop the flow of air, an air barrier must be free of holes and punctures. Otherwise, a pressure differential will drive significant quantities of air (and potentially water vapor) through the hole in a short period of time. Therefore, particular attention must be paid to preserving the continuity of an air barrier by reducing or eliminating even small punctures” ([Minnesota Sustainable Housing Initiative](#)³²). In your home, the drywall, vapor barrier, ***building wrap***, ***sheathing***, cladding, windows, ***flashing***, and other details work together to form an air barrier. Learn more about air barriers from the [Building Science Corporation](#).³³

Annual Fuel Utilization Efficiency (AFUE)

The annual fuel utilization efficiency is a percentage used to describe the heating efficiency of different furnaces by measuring heat output in relation to energy consumed. [Learn more](#)³⁴ from Energy.gov.

ASTM

ASTM International is an organization that develops standards and testing methods for products. ASTM standards are used globally “to improve product quality, enhance safety, facilitate market access and trade, and build consumer confidence” ([ASTM.org](#)³⁵).

Attic Card

Any professionally installed insulation is required to be accompanied by a receipt. Attic insulation receives an “attic card” to record the type of insulation installed, manufacturer, installer, ***R-value***, area insulated, and quantity installed.

Backdrafting

Backdrafting occurs when low pressure from running fans causes exterior air to be pulled down chimneys and exhaust vents. It can lead the accumulation of hazardous carbon monoxide in a home. [Learn more](#)³⁶ about backdrafting from the Environmental Protection Agency.

Building Wrap

Also known as house-wrap, building felt, or building paper, this is a layer of material applied over ***sheathing*** on the exterior side of the house. As part of the drainage plane, building wrap provides a surface for water to drain down. It acts as an ***air barrier***, not a vapor barrier. This means it allows ventilation, but water vapor will dry before getting into the walls and causing molding. [Learn more](#)³⁷ about housewrap from Wikipedia.

32) www.mnshi.umn.edu/toolbox/glossary.html

33) buildingscience.com/documents/digests/bsd-104-understanding-air-barriers

34) www.energy.gov/energysaver/articles/furnaces-and-boilers

35) www.astm.org

36) www.epa.gov/iaq/homes/hip-backdrafting.html

37) en.wikipedia.org/wiki/Housewrap

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What Is The Plan Book?

Capillary Action

A capillary break stops capillary action. Capillary action is the attractive force created by surface tension in water, creating movement within the confined spaces of a porous material or between two adjoining hydrophilic materials. You can see this where water is higher on the edges of a glass than in the middle. In a wall or foundation, a capillary break is a layer of a hydrophobic material or non-porous material (such as glass, plastic, or metal) or gap between parallel layers of material (often less than 1/16" or 1.5 mm) sufficient to stop capillary action.

Certified Installers

Many manufacturers establish certification programs and require that trained professionals install their products to ensure warranty compliance. Contact the manufacturer directly or research their website to locate qualified installers.

Diffusion

Diffusion is the process by which moisture vapor moves through a material because of pressure or temperature difference. Diffusion moves moisture vapor from areas of high to low pressure or from warm to cold in a wall assembly. This is why we design our wall systems to promote outward drying.

Draft Hood testing

A draft hood is attached to a hot water tank or furnace in order to keep the appliance separate from any draft that could contain dangerous gases or toxins. To learn how to conduct a test and how to decide if the hood needs to be replaced, go [here](#).³⁸

Dual-Flush Toilets

Dual-Flush toilets have two flush-volume settings, usually controlled with two buttons or an up/down lever to flush liquid or solid waste. [Learn more](#)³⁹ about dual flush toilets from Wikipedia.

Embodied Energy

"Embodied energy refers to the total amount of energy associated with the creation of a material or product up to its point of use, including energy consumed in raw material extraction, manufacture, transportation, and installation" (Minnesota Sustainable Housing Initiative). [Learn more](#)⁴⁰ about embodied energy from Wikipedia.

Flashing

Flashing is a thin, continuous sheet of metal, plastic, rubber, or waterproof paper used to prevent the passage of water through a joint in a wall, roof, or chimney (Sustainable Housing Initiative). [Learn more](#)⁴¹ about flashing from Wikipedia.

Forest Stewardship Council (FSC)

This non-government organization takes on the responsibility of monitoring sustainable forestry practices worldwide. An FSC-certified product has a chain of custody and verifies the origin of the wood product and its responsible harvest. [Learn More](#)⁴².

38) www.trutechtools.com/Performing-a-Draft-Test_c_260.html

39) en.wikipedia.org/wiki/Dual_flush_toilet

40) en.wikipedia.org/wiki/Embodied_energy

41) en.wikipedia.org/wiki/Flashing_%28weatherproofing%29

42) us.fsc.org

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What Is The Plan Book?

Global Warming Potential (GWP)

"The Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is a measure of how much energy the emissions of one ton of a gas will absorb over a given period of time, relative to the emissions of one ton of carbon dioxide. The larger the GWP, the more that a given gas warms the Earth compared to carbon dioxide over that time period" (EPA). Learn more about the GWP of specific gases from the [EPA Website](#)⁴³.

Greywater

"Greywater is any water that has been used in the home, except water from toilets. Dish, shower, sink and laundry water comprise 50-80% of residential 'waste' water. Greywater systems collect and hold water for use in landscape irrigation and for flushing of toilets," according to the Minnesota Sustainable Housing Initiative. [Learn more](#)⁴⁴ about greywater from Wikipedia.

HRV

A heat recovery ventilator, or HRV, also called an air-to-air heat exchanger, can be installed to increase ventilation, which will help reduce the radon levels in your home. An HRV will increase ventilation by introducing outdoor air while using the heated or cooled air being exhausted to warm or cool the incoming air. HRVs can be designed to ventilate all or part of your home, although they are more effective in reducing radon levels when used to ventilate only the basement. If properly balanced and maintained, they ensure a constant degree of ventilation throughout the year. HRVs can also improve air quality in homes that have other indoor pollutants. For more, see the [Installation and Operating Cost Table](#)⁴⁵.

LEED

LEED stands for Leadership in Energy and Environmental Design. It is a certification program that recognizes best strategies and practices in environmental building design. To earn a LEED certification, building projects satisfy prerequisites and earn points to achieve different levels of certification. Learn more about LEED certification and best practices [here](#)⁴⁶.

Locally Sourced Materials

Locally sourced materials are products that are harvested and manufactured close to your home; this is important for both environmental and economic reasons. Less energy spent on transportation saves money and releases fewer fuel emissions. Supporting local business provides jobs and invests the money you spend in your local economy.

Off-gassing

Off-gassing is the leaching of toxic chemicals into our environment. Off-gassing negatively contributes to air quality and can cause adverse health effects.

Payback Period

The payback period is the amount of time it takes to recover the initial cost of an investment. It is an important factor in whether or not a project is worth undertaking. Learn more [here](#)⁴⁷

43) www3.epa.gov/climatechange/ghgemissions/gases.html

44) en.wikipedia.org/wiki/Greywater

45) www.epa.gov/radon/pubs/consgrid.html#installtable

46) www.usgbc.org/leed

47) www.investopedia.com/terms/p/paybackperiod.asp

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What Is The Plan Book?

Phantom Loads

Phantom loads, also known as vampire power, is electricity used by our appliances when they are turned off. They are caused by internal clocks, glowing lights, and remote control sensors. Phantom loads can account for 75% of home electronic energy use. [Learn more](#)⁴⁸ about phantom loads from Wikipedia.

Rapidly Renewable Resources

Rapidly Renewable Resources are those that can be naturally grown and harvested in a period of ten years or less. [Learn more](#)⁴⁹ about rapidly renewable resources and third-party certification from Green Circle Certified.

Recycled Content

Using products that contain recycled content reduces our dependency on diminishing natural resource supplies. “Post-consumer recycled content” refers to “an end product that has completed its life cycle as a consumer item and would otherwise have been disposed of as a solid waste.” “Pre-consumer recycled content” is the use of waste generated as a by-product or as excess material scrap from a manufacturing process. Learn about [pre-consumer recycling](#)⁵⁰ and [post-consumer recycling](#)⁵¹ from Wikipedia.

R-Value

R-value is the term of measurement used to describe the resistance of a material to heat flow. The higher the R-value, the less it transmits heat! [Learn more](#)⁵² about R-Value from Wikipedia.

SCS

SCS is a ***recycled content*** certification that evaluates products made from pre-consumer or post-consumer material diverted from the waste stream. The certification measures the percentage of ***recycled content***, which allows recycling facilities to make credible claims. SCS can also help in achieving ***LEED*** sustainability ratings. Learn more [here](#)⁵³

Sheathing

On your home, sheathing is the layer of material attached to the exterior of your studs. Sheathing helps to both strengthen your framing and protect your home. Sheathing is often a wood product like plywood or OSB (Oriented Strand Board); it can also be a gypsum or cement board product.

Subfloor

Subfloor is the base layer on which the finish flooring product is applied. It is usually made of wood or composite wood. Subfloors should always be clean, dry, and stable before installing any finish floor product.

Thermal Break

A thermal break is an element that slows conduction. In a window assembly, it is often a piece of plastic or rubber used to disrupt thermal energy transfer through the frame.

48) en.wikipedia.org/wiki/Standby_power

49) www.greencirclecertified.com/database/

50) en.wikipedia.org/wiki/Pre-consumer_recycling

51) en.wikipedia.org/wiki/Recycling

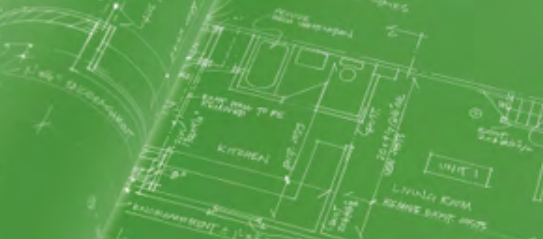
52) en.wikipedia.org/wiki/R-value_%28insulation%29

53) www.scsglobalservices.com/recycled-content-certification

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What Is The Plan Book?

Thermal Bridging

"Thermal bridging refers to an area of the building with a lower ***R-value*** than surrounding areas that conducts heat across the building envelope. A steel stud or uninsulated window frame can act as a thermal bridge, undermining the overall thermal efficiency of the building," according to the Minnesota Sustainable Housing Initiative. [Learn more](#)⁵⁴ about thermal bridging from Wikipedia.

USGBC

USGBC is the U.S. Green Building Council, which is in charge of the ***LEED*** certification program. Made up of builders, environmentalists, corporations, nonprofits, teachers, students, and lawmakers, the council works to educate the public on and encourage sustainable design of buildings and communities. Learn more [here](#)⁵⁵

Vapor Permeable

Vapor permeable means that water vapor is allowed to pass through the material rather than be impeded or trapped by it. Measured in perms, the rate at which water molecules diffuse through a material, vapor permeable materials have a permeance of greater than 10 perms.

Volatile Organic Compounds (VOC)

VOCs are pollutant gases that can be released from building materials over the entire lifetime of the product including during application, storage, and removal. VOCs are found in paints and coatings, adhesives, furniture, composite wood products, carpet, flooring, and other products. Exposure to VOCs can irritate eyes, nose, throat, and skin, cause allergies, or aggravate asthma. Respiratory problems, headaches, nausea, and organ and central nervous system damage are side effects of excessive exposure to VOCs. [Learn more](#)⁵⁶ about VOCs from Wikipedia.

Whole Building Approach

Buildings – including single family homes – are a combination of systems that function together. Ventilation, water management, heating and cooling, insulation, and structural systems all work together, and even minor changes to one may affect how another functions. Adding livable space in a basement or addition, installing air sealing and insulation, or making other updates may result in problems or in improvements in how other systems perform. A whole building approach takes these interactions into consideration.

Window-to-Floor Ratio

Window-to-Floor Ratio describes the area of windows in a room relative to room size, as a percentage. To calculate, use the following formulas:

Area = Length x Width

Window Area (WA) = Sum of all window areas

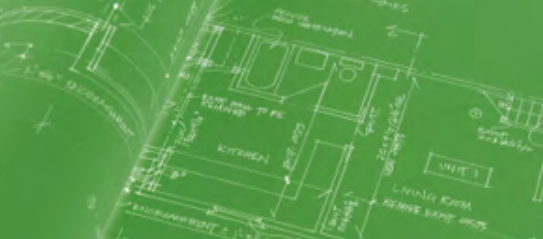
Floor Area (FA) = Floor area

$(WA / FA) \times 100 = \text{Window-to-floor ratio as a percent}$

54) en.wikipedia.org/wiki/Thermal_bridge

55) www.usgbc.org/about

56) en.wikipedia.org/wiki/Volatile_organic_compound



What Is The Plan Book?

RESOURCES AND LINKS

Here you'll find links to resources and organizations that might help you with your green remodeling projects. If you have a resource suggestion or a link to an organization to share, please email us at grpb@cityofroseville.com

Building Science

American Council for an Energy Efficient Economy (ACEEE): <http://www.aceee.org/site-map>
Building Performance Institute: <http://www.bpi.org/home.aspx>
Building Science Information: <http://www.buildingscience.com/index.html>
Minnesota Dept. of Health- Radon: <http://www.health.state.mn.us/divs/eh/indoorair/radon/index.html>
Minnesota Sustainable Housing Initiative: <http://www.mnshi.umn.edu/index.html>
National Association of Home Builders: <http://www.nahb.org/default.aspx>
National Comfort Institute: <http://www.nationalcomfortinstitute.com>
The Efficient Windows Collaborative: <http://www.efficientwindows.org/>
University of Minnesota Extension: Housing Technology: <http://www.extension.umn.edu/HousingTech>
U.S. Department of Energy: Energy Efficiency & Renewable Energy: Energy Savers: <http://www.energystar.gov>
U.S. Green Building Council's Green Home Guide: <http://greenhomeguide.com>
Whole Building Design Guide: <http://www.wbdg.org/index.php>

Codes and Regulations

City of Roseville – City Code: <http://cityofroseville.com/index.aspx?nid=1613>
Environmental Protection Agency: <http://www.epa.gov>
Home Ventilating Institute: <http://www.hvi.org>
International Code Council: <http://www.iccsafe.org/CS/Pages/default.aspx>
MN Office of the Revisor of Statutes – Dept. of Administration – Rules: <https://www.revisor.mn.gov/rules/?agency=103>
MN Residential Code: <http://www.doli.state.mn.us/ccld/CodesRes.asp>
U.S. Dept of Energy: Energy Efficiency & Renewable Energy: Energy Building Codes Program: <http://www.energycodes.gov/>

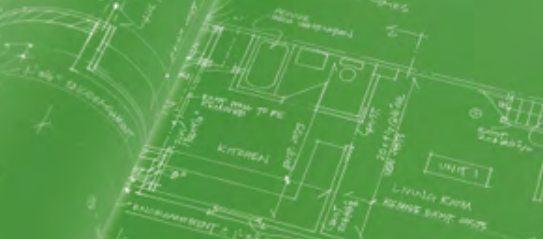
Energy and Utilities

Alliance for Water Efficiency: <http://www.allianceforwaterefficiency.org/default.aspx>
City of Minneapolis – Graywater Systems: download http://www.ci.minneapolis.mn.us/www/groups/public/@regservices/documents/webcontent/convert_259379.pdf
Clean Energy Resources Teams: <http://www.cleanenergyresourceteams.org>
Duluth Energy Efficiency Program: <http://duluthenergy.org>
Energy Star, Energy Star Yardstick: <https://www.energystar.gov>
Home Energy Advisors: Heating Index: <http://www.homeenergyadvisors.com/HHI.asp>
Minnesota Blue Flame Gas Association: <http://blueflame.org/>
Minnesota Dept. of Health – Geothermal Well Management: <http://www.health.state.mn.us/divs/eh/wells/geothermal.html>
MN Office of Energy Security – Water Heaters: download <http://mn.gov/commerce/energy/images/WBP-Water-Heater.pdf>
Minnesota Renewable Energy Society: <http://mnrenewables.org/>

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National Renewable Energy Laboratory: <http://www.nrel.gov>

North American Board of Certified Energy Practitioners (NABCEP): <http://www.nabcep.org>

U.S. Dept of Energy: Energy Efficiency & Renewable Energy: Energy Consumption in Minnesota: <http://apps1.eere.energy.gov/states/residential.cfm/state=MN#avgheat>

U.S. Dept of Energy: Energy Efficiency & Renewable Energy: Energy Savers: <http://www.energysavers.gov>

WeGoWise: <https://wegowise.com>

Wind Powering America: http://www.windpoweringamerica.gov/wind_maps.asp

Financial

Energy Savers: Tax Credits for Energy Efficiency: <http://www.energysavers.gov/financial/70010.html>

Database of State Incentives for Renewables & Efficiency (DSIRE): <http://www.dsireusa.org>

MN Dept. of Commerce: Division of Energy: <http://mn.gov/commerce/#>

Tax Credits, Rebates, and Savings: http://energy.gov/savings/search?f%5B0%5D=im_field_rebate_state%3A860051

General Sustainability Concepts

Choosing a Healthy Home: download http://mngreencommunities.org/publications/download/HealthyHome_checklist.pdf

Home Energy Magazine: <http://www.homeenergy.org>

Roseville Recycling: <http://www.cityofroseville.com/436/Recycling>

Sins of Greenwashing: <http://sinsofgreenwashing.org>

Smart Growth Online: <http://www.smartgrowth.org>

WalkScore <http://www.walkscore.com>

Landscape and Outdoors

The Beez Kneez: <http://www.thebeezkneezdelivery.com/>

Colony Collapse Disorder: <http://www.plosone.org/article/info:doi/10.1371/journal.pone.0006481>

Hummingbird Society: <http://www.hummingbirdsociety.org/index.php>

Lady Bird Johnson Wildflower Center: <http://www.wildflower.org>

Landscape Plants that Attract Birds: <http://www.hoyaadubon.org/documents/UWExtension-LandscapePlantsThatAttractBirds.pdf>

MN Dept. of Natural Resources: Native Plant Suppliers: <http://www.dnr.state.mn.us/gardens/nativeplants/suppliers.html>

MN Dept of Natural Resources: Stewardship in your back yard: <http://www.dnr.state.mn.us/backyard/index.html>

MN Weatherization Field Guide – MN Office of Energy Security: download <https://mn.gov/commerce/energy/images/Weatherization-Field-Guide.pdf>

Monarch Watch: <http://monarchwatch.org/>

Natural Capital Plant Database: <http://permacultureplantdata.com/>

Permaculture Research Institute: <http://www.pricoldclimate.org>

Rain Garden Design, City of Maplewood, MN: <http://www.ci.maplewood.mn.us/index.aspx?NID=1035>

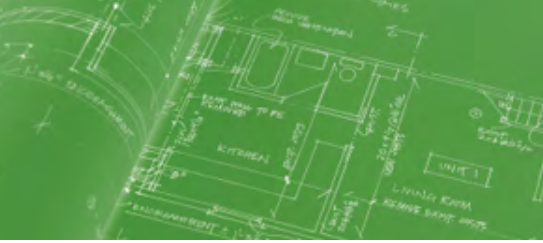
Rain Gardens and Plants: <http://www.mninter.net/~stack/rain>

University of Minnesota Extension: Mowing Practices: <http://www.extension.umn.edu/garden/landscaping/maint/mowing.htm>

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What Is The Plan Book?

University of Missouri Extension: Tree Placement on Home Grounds: <http://extension.missouri.edu/publications/DisplayPub.aspx?P=g6900>

Urban Bee Gardens: <http://nature.berkeley.edu/urbanbeegardens>

Wild & Edible Fruits of Minnesota: <http://www.extension.umn.edu/garden/yard-garden/fruit/wild-and-edible-fruits-of-minnesota/>

Local Resources

Bike Walk Twin Cities: <http://www.bikewalktwincities.org>

Family Housing Fund: <http://www.fhfund.org/>

Gopher State One Call: <http://www.gopherstateonecall.org/>

Metro Transit: <http://www.metrotransit.org>

Midtown Greenway Coalition: <http://midtowngreenway.org/>

Minnesota Building Performance Association: <http://mbpa.us>

Minnesota Climatology Working Group: http://climate.umn.edu/doc/twin_cities/twin_cities.htm

MN Department of Commerce: Division of Energy Resources: <http://www.state.mn.us/portal/mn/jsp/home.do?agency=Energy>

Roseville Housing & Redevelopment Authority: <http://www.cityofroseville.com/eda>

Product Certification and Standards

Carpet & Rug Institute's Green Label & Green Label Plus Program: <http://www.carpet-rug.org/commercial-customers/green-building-and-the-environment/green-label-plus/index.cfm>

Energy Star Certified: <http://www.energystar.gov>

EPA Watersense: <http://www.epa.gov/watersense/index.html>

Federal Trade Commission: EnergyGuide label <http://www.ftc.gov/bcp/edu/pubs/consumer/homes/real4.shtm>

Forest Stewardship Council: <http://www.fsc.org>

Green Seal Certified: <http://www.greenseal.org/Home.aspx>

MBDC Cradle to Cradle Certification: <http://www.mbdcc.com>

National Fenestration Rating Council – Window Labeling: <http://www.nfrc.org/label.aspx>

Resilient Floor Covering Institute- FloorScore: <http://www.rfci.com>

USDA Organic: <http://www.ams.usda.gov/AMSv1.0/nop>

Whole-Building Energy Certification & Standards

Home Performance with Energy Star http://www.energystar.gov/index.cfm?fuseaction=hpwes_profiles.showSplash

Passive House <http://www.passivehouse.us/passiveHouse/PHIUSHome.html>

Whole-Building Green Certification & Standards

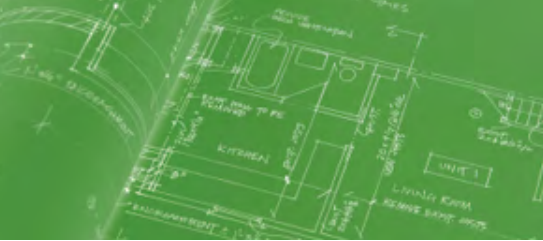
MN GreenStar: <http://www.mngreenstar.org>

USGBC – LEED Rating System: <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=51>

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What Is The Plan Book?

Miscellaneous

About.com Architecture: Housing Styles: <http://architecture.about.com/od/periodsstyles/ig/House-Styles>

Healthy Homes Maintenance Checklist: http://www.hud.gov/offices/lead/library/hhi/Healthy_Housing_CheckList.pdf

Insulated concrete forms (ICF): <http://www.forms.org>

Mid-America Regional Council: <http://www.marc.org>

MN Dept of Natural Resources: Mining in MN: <http://www.dnr.state.mn.us/education/geology/digging/mining.html>

Minnesota Window Fact Sheet – Efficient Window Collaborative; download <http://www.efficientwindows.org/factsheets/Minnesota.pdf>

Popular Window Replacement Myths: National Alliance of Preservation Commissions: download <http://napc.uga.edu/Popular%20Window%20Replacement%20Myths.pdf>

Safety Source for Pest Management: <http://www.beyondpesticides.org/>

Structurally insulated panels (SIPs): <http://www.sips.org>

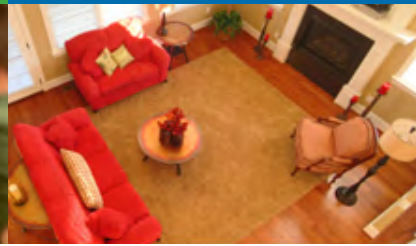
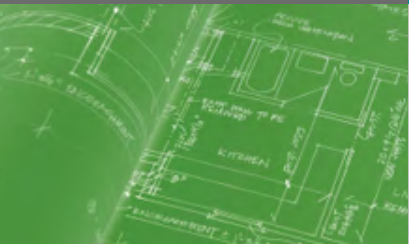
U of M Extension: Molds: <http://www.extension.umn.edu/environment/housing-technology/moisture-management/molds-your-safe-home/>

USGBC and ASID remodeling resource REGREEN: <http://www.regreenprogram.org>

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Before Remodeling

Prior to remodeling, it's important to recognize the important structural and aesthetic characteristics of your home. It's also vital to understand the way utility systems function within your home in order to prioritize your remodeling needs.

Consult design professionals to help reorganize existing spaces. It's advisable to look beyond big-box retail centers for this advice and contact licensed contractors, architects, and interior designers. If expanding your home by adding space or finishing the basement is inevitable, their design skills can help you efficiently utilize your site and integrate the addition with your existing home.

Keep in mind that changes both major and minor can affect how your home operates. The new addition must be designed to work seamlessly with the existing building envelope to avoid compromising wall, roof, or insulation systems. Make sure to address home mechanical systems as well. You may also want to work with a building scientist, as home additions and sometimes even minor changes can dramatically alter the way your home operates in terms of heat distribution, utility efficiency, moisture flow, and ventilation. Depending on the scope and type of project you are undertaking, you will want to consult different professionals. For a list of good ones, look [here](#)¹

Depending on the extent of your project, you may want to consider hiring a contractor for part or all of the work. Choosing a contractor, signing a contract, and monitoring the progress of your project can be complex. The National Association of the Remodeling Industry's Minnesota Chapter has a useful guide to help you navigate the process successfully. It provides helpful tips for even small contracts. [Learn More](#)²



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Cape Cod	5
Folk Victorian	5
Ramble/Ranch	6
Split-Level Ranch	6

PRIORITIZING YOUR NEEDS . . 7

1) www.mbp.a.us/find-professional
2) www.narimn.org/pages/what-is-nari



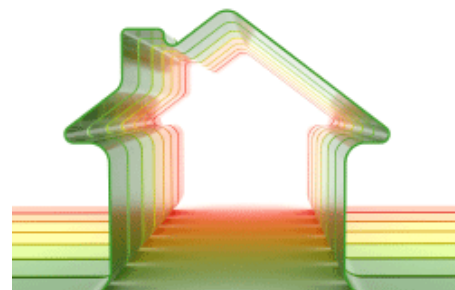
Before Remodeling

UTILITY CONSUMPTION

Tracking your energy and water usage is the first step towards understanding the way your utility systems perform and improving your home's efficiency. Here are some resources you can use to track your energy usage and discover ways to conserve:

Home Energy Ratings and Tracking Systems

Energy Star Home Advisor³ allows you to create a detailed profile of your home's energy efficiency features and get a list of energy-saving recommendations prioritized for your home.



Energy Star Yardstick⁴ is a basic performance-based home assessment that analyzes actual energy use in your home (based on your last 12 months of energy bills) and compares it to other similar homes. A score of '10' means your home performed well compared to other homes of your type, while a score of '1' means your home performed comparatively poorly.

Home Energy Monitors track your up-to-the-minute energy usage. An electricity monitor, for example, will measure how much energy each gadget in your home is using at any given time, even when they are switched off. Monitors like these are good reminders to unplug items when they aren't being used. Power check energy meters are available for checkout at the Ramsey County Library⁵

The Home Energy Rating System⁶ (HERS) is based on the HERS Index⁷, a nationally recognized scoring system for measuring a home's energy performance. A higher score on the index indicates more energy use, and a lower score indicates energy efficiency. Usually performed by a certified RESNET Home Energy Rater, whom you can find on the RESNET website⁸, the diagnostic testing may include a blower door test, duct leakage test, combustion analyzation and an infrared test, which finds leaks, evaluates insulation effectiveness, and discovers combustion and safety issues. Unlike an energy audit, an energy rating measures a home's energy performance as compared to similar homes, whereas audits show homeowners where and how their homes are losing energy.

Home Heating Index⁹ (HHI) is generally accepted as a good measure of a home's energy efficiency because the thermal energy efficiency of houses can be compared across the country, although it is especially pertinent in the northern climates. The HHI is the amount of heat needed to keep a home at a comfortable temperature in winter expressed as the number of BTUs of heat needed per square foot of floor area per heating-degree-day (The number of degrees that a day's average temperature is below 65, summed over the year, is the number of heating-degree-days). The lower the HHI the better.

3) www.energystar.gov/campaign/assessYourHome

4) www.energystar.gov/index.cfm?fuseaction=home_energy_yardstick.showgetstarted

5) www.rclreads.org/about/library-news/energy-meters

6) www.resnet.us/energy-rating

7) www.resnet.us/hers-index

8) www.resnet.us/directory/search

9) www.usgbcnm.org/Resources/Documents/HHI%20article.pdf

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Before Remodeling

Energy Audits

A [Do-it-yourself Home Energy Audit](#)¹⁰ is a simple way to save money and deal with many home performance problems right away. Although it is not as thorough as a professional energy audit, it is a good way to get to know your home a little better and it can save time and money if you decide to do a professional audit. You can also use the [Choosing a Healthy Home Checklist](#)¹¹ available from Minnesota Green Communities to self-assess the health qualities of your home.



A Home Energy Survey is a visual inspection that doesn't include the use of diagnostic testing equipment. Its purpose is to assess the general energy performance of your home including:

- Building envelope features and ages
- The type, characteristics, and ages of your heating, cooling, and ventilation equipment
- Appliance and lighting characteristics
- Comfort complaints
- Visible moisture issues
- Visible health and safety issues

A Home Energy Survey professional will conduct the survey and provide a complete assessment and offer basic recommendations for improving your home's energy efficiency. Surveys typically take about an hour to complete. Find out more [here](#)¹².

A [Professional Home Energy Audit](#)¹³ helps to pinpoint where your house is losing energy and what you can do to save resources and money. To prepare yourself for a professional audit, check out this [infographic](#)¹⁴. For financial assistance on Energy Audits (Ramsey County, Minn. only), check out these resources:

- [Xcel Energy Audits](#)¹⁵
- [Energy Audit Waiver](#)¹⁶ through the City of Roseville
- [Ramsey County Weatherization Office](#)¹⁷. Although the weatherization assistance program primarily serves low-income residents, those not meeting the income restrictions can also apply.

To find certified professionals to conduct the audit, check out these resources:

- [Minnesota Building Performance Association](#)¹⁸
- [Residential Energy Services Network \(RESNET\)](#)¹⁹

10) energy.gov/energysaver/do-it-yourself-home-energy-audits

11) mngreencommunities.org/publications/download/HealthyHome_checklist.pdf

12) www.resnet.us/types-of-energy-audits

13) energy.gov/energysaver/professional-home-energy-audits

14) energy.gov/articles/energy-saver-101-infographic-home-energy-audits

15) www.xcelenergy.com/Energy_Solutions/Residential_Solutions/Rebates_&_Energy_Savings/Home_Energy_Audit

16) www.cityofroseville.com/1632/Housing-Programs-Energy-Assistance

17) www.capr.org/community-action-services/energy-conservation/

18) www.mbpa.us/news/category/Energy%20Audit

19) www.resnet.us/directory/search

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Before Remodeling

Professional audits should consist of the following:

- **Blower door test:** This test helps determine a home's airtightness. Proper tightness can lower energy consumption caused by air leakage, help avoid moisture condensation problems, and reduce uncomfortable drafts caused by cold air leaking in from the outdoors. The blower door test can also determine how much mechanical ventilation might be needed to provide acceptable indoor air quality. [Learn More](#)²⁰
- **PFT Air Infiltration Measurement Technique:** Like the blower door test, the PFT (Perfluorocarbon tracer gas) technique provides information about air leakage. [Learn More](#)²¹
- **Thermographic Inspection:** Thermography uses infrared video and still cameras to measure and record temperature variations in the building's envelope. Images recorded by the inspection device range from white for warm regions to black for cooler regions. These images help an energy auditor determine if and/or where insulation might be needed. [Learn More](#)²²

The audit should also include an assessment of your combustion appliances and a visual inspection of the roof, attic, walls, basement, and foundation for moisture, structural, or any other issues that may be present. Ask the auditor for help writing a work scope for improving the efficiency and comfort of your home.

20) energy.gov/energysaver/blower-door-tests

21) energy.gov/energysaver/pft-air-infiltration-measurement-technique

22) energy.gov/energysaver/thermographic-inspections

Key

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Before Remodeling

ARCHITECTURAL STYLES

Gathering information on your home's style, year constructed, and modifications made by previous owners will give you a better idea of the materials and building technologies used. In addition to the styles listed below, [browse](#)²³ through these other styles. Keep in mind that many 20th-century homes are a hybrid of different styles.

Bungalow (Craftsman Style)

Though an American Bungalow can take on many different shapes and styles, it can generally be characterized by the following features: one-and-a-half stories, most living spaces on the ground floor, low-pitched roof, living room at the center, connecting rooms without hallways, and built-in cabinets, shelves, and seats. [Learn More](#)²⁴



Cape Cod

Cape Cod homes are very simple and practical. They were designed for easy construction and efficient heating. While traditional Cape Cod style homes had low ceilings and a central chimney to make heating the house more efficient, 20th-century versions include large dormers for expanded living space on the upper story, decorative shutters, and single-paned double-hung windows. A steeply pitched roof helps slough off snow in the winter. It's important not to compromise roof insulation and roof structure when remodeling these homes. [Learn More](#)²⁵



[Download](#)²⁶ Cape Cods & Ramblers: A Remodeling Planbook for Post-WWII Houses.

Folk Victorian

Victorian homes, a result of the industrial revolution, feature ornate detailing and rich architectural character. They usually have a square, symmetrical shape and porches with ornate trim. Pay attention to the fragility and level of detail involved in the decorations when remodeling this type of house. [Learn More](#)²⁷



23) architecture.about.com/od/periodsstyles/ig/House-Styles/

24) architecture.about.com/od/periodsstyles/ig/House-Styles/Bungalow-Styles.htm

25) architecture.about.com/od/periodsstyles/ig/House-Styles/colonial-cape-cod-2268048.htm

26) www.cityofroseville.com/DocumentCenter/Home/View/1062

27) architecture.about.com/od/periodsstyles/ig/House-Styles/Folk-Victorian.htm

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Before Remodeling

Rambler/Ranch

Ranch style homes are very simple, one-story homes with low-pitched gable roofs, a horizontal layout (long, narrow, and low to the ground), rectangular, L-shaped, or U-shaped design, large windows, and a patio. Built from natural materials, they have very few decorative details. Variations on the ranch style include the Raised Ranch²⁸ and the Split-Level Ranch (see below). Remodeling these homes often includes finishing the basements, which optimizes space but must be handled correctly to manage moisture and heating issues. Learn more²⁹ or Download³⁰ Cape Cods & Ramblers: A Remodeling Planbook for Post-WWII Houses.



Split-Level Ranch

Split-level ranch homes feature intentionally divided spaces. Take care when removing walls to open up the floorplan as these homes take advantage of load-bearing walls to achieve larger roof spans. Basement remodeling is also popular in these homes and can present challenges in moisture and heating management. Learn more³¹ or Download³² Split Visions: A Planbook of Remodeling Ideas for Split-Level and Split-Entry Houses.



28) architecture.about.com/od/periodsstyles/ig/House-Styles/Raised-Ranch-Style.htm

29) architecture.about.com/od/periodsstyles/ig/House-Styles/Ranch-Style.htm

30) www.cityofroseville.com/DocumentCenter/Home/View/1062

31) architecture.about.com/od/periodsstyles/ig/House-Styles/Split-Level-Ranch.htm

32) www.cityofroseville.com/DocumentCenter/Home/View/1063

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Before Remodeling

PRIORITIZING YOUR NEEDS

In terms of both budget and material resources, it is a good idea to find ways of doing more with less. This list can help you prioritize your remodeling needs:

- Make sure to keep up with Routine Home Maintenance³³ to minimize remodeling needs and expenses.
- Create a list of remodeling *needs* vs. remodeling *wants*. Anything that is degrading the physical condition or safety of your home should be a high priority. These issues are often also the most financially beneficial investments.
- Invest in energy efficiency. With rising energy costs, payback on these improvements will offer the most bang for your buck. The Pyramid of Conservation³⁴ will help you prioritize energy efficiency options based on the complexity and amount of investment each option entails. Always consult with your local energy provider³⁵ prior to a remodeling project to check for available rebates or grants for energy efficient upgrades to your home or appliances.
- Determine which projects you can do yourself using the guidelines of a Do-it-yourself home energy audit³⁶.
- Find an accredited professional to help you conduct a Professional Energy Audit³⁷, if you deem it necessary.
- Remodeling has a price tag so budget accordingly. Invest in quality products for performance, environmental impact, and warranty. Use these resources to look for available tax credits, rebates, and remodeling incentives:
 - Database of State Incentives for Renewables and Efficiency (DSIRE)³⁸
 - Energy.Gov³⁹
 - Energy Star Appliances⁴⁰
- Consider **payback periods** when investing in remodeling products and technologies. Simple payback is the time it takes for a return on an investment to compensate for the initial cost. Here's a very basic way to think about payback:

Initial Cost ÷ Savings per year = # of years for payback



**Keep in mind that this simple payback calculation does not consider inflation, interest, maintenance, or operating costs, all of which affect the long-term value of your investment. A more in-depth payback analysis addresses these factors.*

33) www.hud.gov/offices/lead/library/hhi/Healthy_Housing_CheckList.pdf

34) www.mnpower.com/energyconservation/foryourhome

35) www.xcelenergy.com/Energy_Solutions/Residential_Solutions

36) energy.gov/energysaver/do-it-yourself-home-energy-audits

37) energy.gov/energysaver/professional-home-energy-audits

38) programs.dsireusa.org/system/program?state=MN

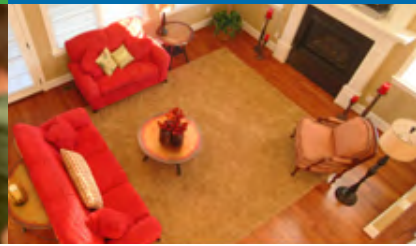
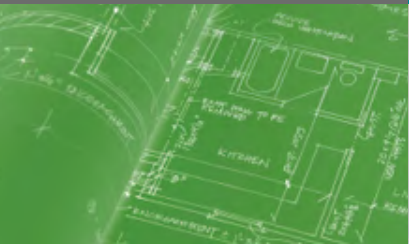
39) energy.gov/savings/search?f%5B0%5D=im_field_rebate_state%3A86005

40) www.energystar.gov/rebate-finder

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Home Exteriors

The shell of your home should be durable and functional so that your home is comfortable, protective, airtight, and efficient. Additionally, the landscaping surrounding your home should not only be aesthetically pleasing, but should consider water drainage, food production, pollinator habitats, and safety. Remodeling any part of the building exterior will be an extensive project, so it is important to consider how it will impact other parts of your home. To ensure both your own health and your home's durability, be sure to pay attention to combustion safety, ventilation, air sealing, and insulation. By using a whole-building approach when you remodel, you can be confident that the mechanical and structural systems of the home are fully integrated.

BUILDING ENVELOPE

Your home's "building envelope" is designed to protect you from the external environment and to ensure your comfort and health. The building envelope consists of the walls, the roof, and any openings such as windows and doors. Weaknesses in the envelope often play a significant role in the energy efficiency, cost, safety, and the comfort of your home. Especially critical in Minnesota when considering your "building envelope" is attention to moisture control. Following are several environmentally friendly resources and tips to guide you as you remodel the shell of your home to make it more durable, functional, and beautiful.



BUILDING ENVELOPE

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Insulation, Air Sealing, and Moisture Management

With rising energy costs and growing concerns about the environment, it is important to evaluate all the ways our homes use energy and make sure we are making energy efficient choices when doing remodeling projects. This can result in substantial savings and reduced environmental impact.

As you get started, keep the phrase “Build it tight and ventilate right” in mind. Start by first considering your walls, which enclose, separate, and protect your interior spaces. Your walls also control the heat in your home, the air movement (infiltration and ventilation), and moisture content. When done correctly, the walls of your home should be designed to dry to the outside. This means that moisture that inevitably enters your walls through **diffusion** should dry through the exterior face of the wall (rather than the other way around) to prevent mold growth and moisture damage. Check out [The Perfect Wall](#)¹.

Insulation (Heat)

The natural tendency of heat is to move from areas of hot to areas of cold. In the winter, this can become a problem because the heat we need to warm our homes wants to leach back into the cold outdoors. Insulation, however, is designed to keep that hot air from moving, thereby reducing the amount of energy required for comfort.

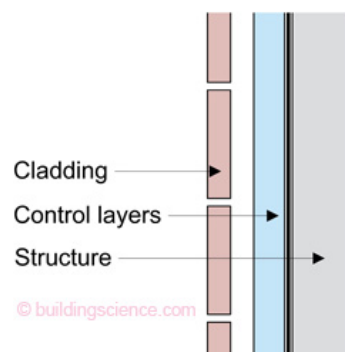
Insulation Materials

Insulation products can be made from a wide variety of natural, synthetic, and recycled materials and vary in form – some are bulky and flexible while others are rigid boards. The more popular materials for insulation include fiberglass, foam, polystyrene, extruded polystyrene, and expanded polystyrene.

When choosing insulation, you'll need to know about **R-values** (resistance to heat flow) and U-values. Products with higher **R-values** are better at keeping heat from leaving your home. U-values measure the conductivity of an insulation assembly, which is basically the opposite of **R-value**, so a low U-value means it's a good insulator and a high U-value means it's a poor insulator.

REMEMBER:

With any home improvement project, you need to research reputable installers before hiring a contractor. For projects that have to do with air sealing, drainage planes, **flashing**, and vapor barriers, proper installation and product durability is key. As a system, if one of these components fail, the entire system can fail resulting in lost energy, moisture damage, and degraded building materials.



CAUTION:

If you are remodeling an older home, you may have Vermiculite and Perlite Insulation, which was commonly used as attic insulation in homes built before 1950. The substances aren't widely used today because they sometimes contain asbestos. According to the Environmental Protection Agency (EPA), few products have been found to contain more than trace amounts. However, it's best to be careful when dealing with attic insulation. Do not disturb it. Use an insulation contractor who is trained and certified in handling asbestos.



Home Exteriors

The bottom line is that, overall, the more layers of insulation material you have, the more heat you'll retain. Here is a list of available insulation materials with their ***R-values*** and a note about their sustainability:

Material/General Information	Forms	R-Value/in.	Sustainability
Fiberglass Consists of extremely fine glass fibers and is the most common insulation material. Loose-fill insulation must be applied using an insulation-blowing machine	Blanket (batts and rolls) Loose-fill	Batt: R-3.14 Blown (attic): R-2.20 Blown (wall): R-3.20	Most manufacturers use 20-30% recycled glass content
Mineral Wool Insulation Rock Wool: man-made material consisting of natural minerals like basalt or diabase Slag Wool: a man-made material from blast furnace slag (leftover scum on the surface of molten metal)	Blanket (batts and rolls) Loose-fill	Batt: R-3.14 Blown (attic): R-3.10 Blown (wall): R-3.03	75% post-industrial <i>recycled content</i> No additional chemicals required to make it fire-resistant
Cellulose Paper is first reduced to small pieces and then fiberized, creating a product that packs tightly into building cavities and inhibits airflow	Loose-fill	Blown (attic): 3.21 Blown (wall): 3.70	Made from recycled paper products, primarily newsprint, and has a very high recycled material content, generally 82% to 85%
Plastic Fiber	Batt	Batt: R-3.8 to R-4.3 depending on density	Primarily made from recycled milk bottles
Cotton Natural fiber Costs 15-20% more than fiberglass	Batt	R-3.4	85% recycled fibers and 25% plastic fibers treated with borate, a flame retardant. Non-toxic
Sheep's Wool Natural fiber Useful because it can hold large quantities of water	Batt	R-3.5	Treated with borate to resist pests, fire, and mold
Straw Bale Natural fiber Somewhat low <i>R-value</i> due to the large gaps between the stacked bales	Bale	R-2.4 to R-3.0	No chemical additives or treatments
Hemp Natural fiber Relatively uncommon in the U.S.	Batt	R-3.5	All-natural No chemical additives
Polystyrene Made from colorless, transparent thermoplastic	Board Concrete Block Loose-fill Molded Expanded Polystyrene (MEPS) Expanded (EPS) Extruded (XPS)	R-3.8 to 5.0	

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Material/General Information	Forms	R-Value/in.	Sustainability
Polyurethane Foam insulation materials that contains that contains a low-conductivity gas in its cells. The R-value of polyurethane insulation can drop over time as some of the low-conductivity gas escapes and is replaced by air. Most of this phenomena, called thermal drift, occurs within the first two years after the insulation is manufactured	Foam Boards Liquid sprayed foam Foil and plastic facings on foam boards can help stabilize the R-value , slowing down the process of thermal drift. Reflective foil, if installed correctly and facing an open air space, can also act as a radiant barrier. Depending upon the size and orientation of the air space, this can add another R-2 to the overall thermal resistance.	R-5.5 to R-6.5	Soy-based polyurethane is available
Cementitious Foam	sprayed-foam foamed-in-place insulation	R-3.9	Nontoxic Nonflammable Made from minerals extracted from seawater

Environmental Impacts

Whenever possible, look for products with recycled or bio-based content and compare the lifetime performance and environmental impact of different products. Learn more about insulation types and their environmental impacts [here](#)².

- **Avoid:** Petroleum-based rigid board insulation
- **Minimize:** Products that are non-recyclable or made from raw materials

Installation

Proper installation is critical to proper performance. It's best to work with a building scientist or home performance contractor to determine the type of insulation you should use and the **R-value** you should try to achieve. You'll also want to discuss **air and bypass sealing**, which is necessary to "tighten up" your home, and confirm that combustion appliances will have adequate ventilation after the work is complete.

When hiring an insulation contractor, look for a product-specific certified installer to do the installation and be sure to ask them for the **Federal Trade Commission (FTC) fact sheet** for your specific insulation. This provides regulated details about the product being installed. If you're hiring someone to insulate ceilings or attic spaces, an "**attic card**" should be provided describing your specific insulation installation.

TIPS ON WHAT INSULATION TO USE WHERE:

- New construction of an addition, with unfinished or open wall cavities, floors, or ceilings: Bio-based spray foam, Natural fiber batt, Natural fiber loose fill, Expanded Polystyrene (EPS) Rigid Board insulation
- Insulating existing enclosed wall cavities: Bio-Based spray foam, Natural Fiber Loose Fill
- Attic insulation: Bio-based spray foam, Natural fiber batt, Natural fiber loose fill
- Interior foundation (basement) insulation: EPS Rigid Board insulation

For more tips on where to insulate, go to <http://energy.gov/energysaver/where-insulate-home>

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Home Exteriors

Once the installation is done, have a certified energy auditor perform a blower door test and infrared scan to confirm that the insulation is installed properly. The post-construction **blower door test** will show if the level of air-tightness you expected has been achieved and the post-construction **thermographic (infrared) scan** will verify that the insulation performance will meet your needs. These tests should be performed with the contractor present so the installer can correct any installation errors.

If you choose to install insulation yourself, make sure to do a thorough research of products and installation techniques. And before you begin installing the new insulation, locate and seal off any places where you have air or moisture leaks. Whether you do it yourself or hire a certified installer, insulation should always be installed according to the manufacturer's recommendations to ensure your warranty. [Learn More](#)³.

Additional Resources:

HandymanWire.com⁴

MN Dept. of Commerce - [Home Energy Guide: Home Insulation](#)⁵

[Minnesota Green Affordable Housing Guide](#)⁶

Infiltrating Air (Air Barrier and Sealant)

There are two ways fresh air enters our homes: Ventilation and Infiltration.

Ventilation (exchanging air in a controlled way, which is preferred) is necessary to maintain healthy indoor air quality and to ventilate combustion appliances like gas stoves and hot water heaters. Ventilation also removes moisture and pollutants.

Infiltration (uncontrolled air leakage of unknown origin, which is bad) occurs through air leaks and can allow moisture and pollutants through your walls, resulting in higher energy demands to heat and cool your home. This can account for up to 40% of a home's heating and cooling costs. The best way to combat heat loss/gain and moisture problems is through proper air sealing and ventilation.

A "blower door test" is the best way to determine where any leaks or openings in your building envelope might be. Attic bypasses in particular can be difficult to identify as they are often covered with insulation. Perhaps the best way to identify a bypass is to have a home energy audit.

Sealing Up Bypasses

A bypass is an area that allows conditioned air (either warmed or cooled) to pass into an unconditioned area of your home. Bypasses are often found where a conditioned space meets an unconditioned space, such as an area where an exterior wall framing meets the floor of the attic or where vents, chimneys, and other objects penetrate the floor of your attic. They are also common in walls and ceilings adjacent to unheated garages, attics, floor cavities, and porches.

Since heat rises, it's important to make sealing your attic bypasses a priority – an air-tight and properly insulated attic floor will help solve many roofing and energy efficiency issues and prevent the warm, moist air in your living spaces from leaking into the attic. To seal bypasses, first perform minor air sealing by [caulking](#)⁷ any cracks and penetrations and use weather stripping and rigid insulation to insulate around the edges of attic hatches.

3) energy.gov/energysaver/types-insulation

4) www.handymanwire.com/articles/rvalues.html

5) <http://mn.gov/commerce-stat/pdfs/home-energy-guide.pdf>

6) www.greenhousing.umn.edu/comp_insulation.html

7) www.consumerenergycenter.org/residential/tightenup/caulking.html

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Home Exteriors

Be aware that insulation alone will not do the trick; you'll need something solid, like an **air barrier**, which prevents drafts and slows vapor movement, to stop the air passage through these openings. An **air barrier** is often a mix of materials and components including wall **sheathing**, housewrap, contractor's tape, caulk, spray foam, gaskets, drywall, and weatherstripping. Your ceiling assembly of drywall or plywood is also intended to act as an **air barrier** and is an integral component of sealing bypasses. Learn more about air barriers from [Wikipedia](#)⁸ and check out the [Minnesota Weatherization Guide](#)⁹ for more information on sealing bypasses.

Ice Dams

Ice dams are a common problem in many Midwestern homes. Ice dams occur when snow is melted by the heat that escapes through the roof and refreezes on the edge of the roof. This ice then prevents melted water from draining off the roof. Subsequently, the water backs up and makes its way through your roofing material, eventually leaking into your home. The permanent solution to ice dams lies in properly air sealing and insulating your attic floor or roof space. If you aren't able to seal or insulate your roof, there is another solution: you can remove the snow (using a roof rake) from your roof as soon after a snowfall as possible. This low-tech, cost effective solution can be a good stop-gap measure until you are able to properly seal and insulate. For more guidance, see [this helpful resource](#)¹⁰.

Weather Barrier/Drainage Plain

A home's weather barrier or drainage plain is responsible for keeping water out, protecting the structural elements of the building, and keeping insulation from getting wet. To manage the moisture that will inevitably get behind your siding or exterior finish, a drainage plane is created by lapping the surfaces of exterior building materials so that water drains down and away from the interior of the wall. This will help you avoid the problem of mold and moisture, it will prolong the life of building materials substantially, and it will contribute to an overall healthier indoor environment.

Your home's drainage plain is typically established through a combination of house-wrap, building felt, or paper and **flashing** around windows, doors, and other openings. In our climate, all **building wraps** should be **vapor permeable** in order to promote outward drying of any moisture that may enter the wall cavity.

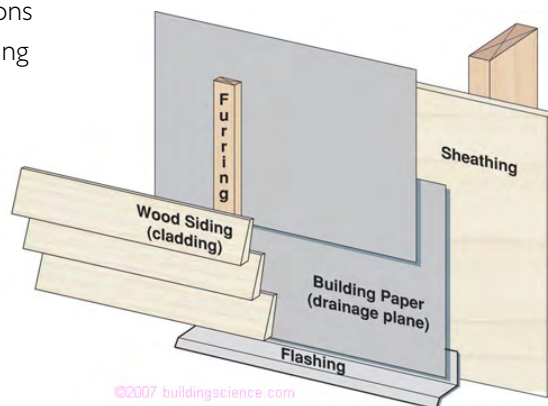
Building wraps also help keep the warm air in your home during heating seasons and out of your home during the summer months. This can help reduce cooling needs in the summer and contribute to a more air-tight home.

Additional Resources:

Building Science Digest: [Drainage Plain/Water Resistive Barrier](#)¹¹

Building Science Digest: [Understanding Drainage Planes](#)¹²

*When done correctly, the walls of your home should be designed to dry to the outside. This means that moisture that inevitably enters your wall through **diffusion** should dry through the exterior face of the wall (and not the other way around) to prevent mold growth and moisture damage. A popular and commonly used weather barrier is Tyvek, which is a breathable polypropylene that prevents water from getting in but also allows water vapor to escape.*



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8) en.wikipedia.org/wiki/Air_barrier

9) <https://mn.gov/commerce/industries/energy/service-providers/wap/>

10) <http://www.extension.umn.edu/environment/housing-technology/moisture-management/ice-dams/>

11) buildingscience.com/documents/information-sheets/drainage-plane-water-resistive-barrier

12) buildingscience.com/documents/digests/bsd-105-understanding-drainage-planes

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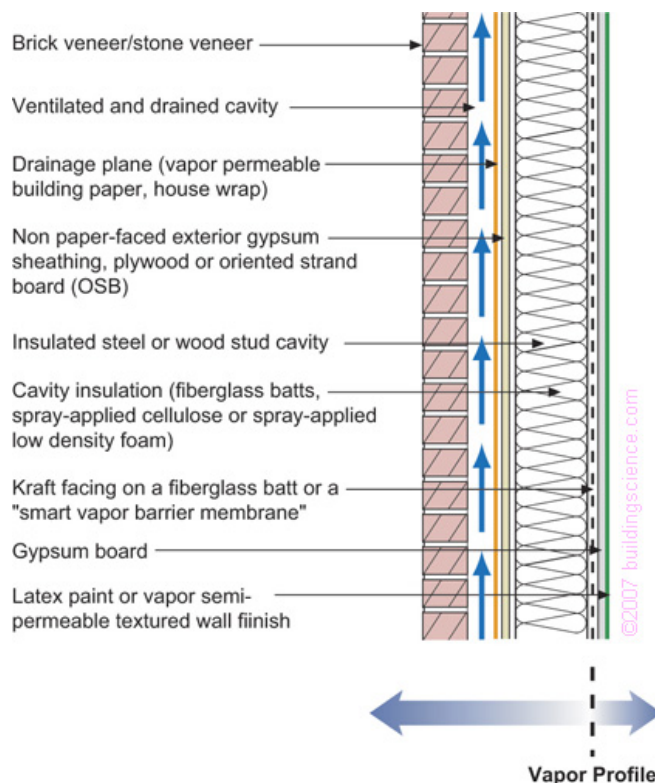
Home Exteriors

Vapor Retarder

A vapor retarder prevents warm, moist air from condensing within the wall cavity and promotes outward drying of any moisture that may enter the wall cavities. It should always be located on the warm side of the interior of a wall, behind drywall or other finished surface.

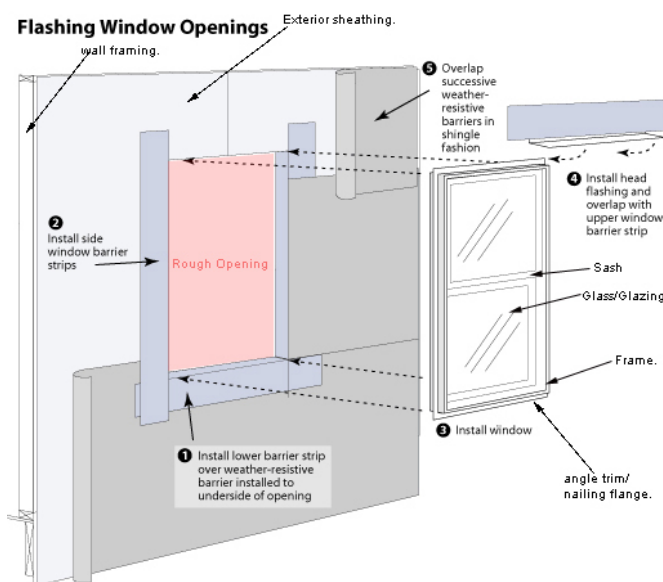
Some materials, like Polyethelene (PE) sheeting, act as both an **air barrier** and vapor retarder. Other products, like paper-faced batt insulation, or even paints and wall coatings can also offer built-in vapor retarder capabilities. While these membranes are typically thinner than a sheet applied product, the most important thing to having an effective vapor retarder is continuity. A seamless membrane on the warm side of the wall will offer better vapor retarder performance. [Learn More](#)¹³ about installing vapor **diffusion** retarders.

The best time to install a vapor retarder is when your remodeling project includes the replacement of paneling or drywall.



Flashing

Windows, doors, vents, or any openings are opportunities for moisture and air to get in or out of your home. This does not mean that we should build our homes to be dark, windowless boxes. Rather, the solution is to properly flash around all openings so air flow and moisture can't get in to walls and do damage. **Flashing**, which is integral to maintaining an effective drainage plane, must be installed so that layers of material overlap to send water away from the interior of the wall and let it run off the outside harmlessly. **Flashing** around window heads, jambs, and sills should be done with self-adhering elastomeric products, metal, or plastic **flashing** components. You'll want to void glues and tapes as these products tend to fail over time. Talk to your installer about what type of **flashing** products are best for your home. [Learn More](#)¹⁴.



¹³ energy.gov/energysaver/vapor-barriers-or-vapor-diffusion-retarders

¹⁴ buildingscience.com/documents/information-sheets/common-flashing-details

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Home Exteriors

Exterior Finishes

Refinishing the exterior of your home by repainting or patching the siding is typically more cost-effective and environmentally-friendly than replacing it. Before deciding to replace the exterior of your home, complete a life-cycle analysis of the project that takes into account the environmental impact of harvesting and manufacturing the siding, where it is made, the transportation impact of getting it to your home, the durability and performance of the product, the maintenance requirements, the impact of disposal when it comes time to replace it, and the cost of the product over its lifetime. The initial investment of certain products may be higher than others but may be a less expensive over the product's lifetime.

With proper maintenance, most cladding products can last the life of the building.

As you'll see in the cladding information below, each product has both favorable and unfavorable sustainability attributes. To highlight some of the defining qualities among the options, fiber cement board balances lifetime performance, maintenance, durability, cost, and manufacturing. Wood siding has a very low **embodied energy** and, depending on harvesting methods, the lowest environmental impact. Brick and steel are very long lasting but their manufacturing process uses lots of energy and releases carbon dioxide and pollutants into the air. Vinyl is a poor environmental choice in nearly all these ways. When choosing an option that's good for the environment, look for exterior finishes that can withstand our harsh Minnesota climate, that are sourced locally from sustainable resources, and contain **recycled content**. Cladding comparison graphs¹⁵

Fiber Cement Board is a composite product of sand, cement, and wood pulp developed to replace asbestos and be an alternative to vinyl and wood siding. It is available in a wide variety of sizes, shapes, textures, and colors. Some manufacturers offer prefinished products that last longer than paint-applied products. Fiber cement board does not expand or contract as much as wood, reducing the frequency of repainting. Durability of fiber cement board is dependent on proper installation. All cut ends and joints must be sealed. The product is also heavy and can produce silica dust during cutting and installation, which can cause respiratory issues.



Fiber Cement Board and Shake



Fiber Cement Board

Wood plank or shake siding is a traditional building material from milled, solid wood planks, often of red cedar, redwood, cypress, northern white cedar, and eastern white pine tree species. With proper maintenance, wood can last the lifetime of the building. Wood finish options depend on the species. If you are considering using wood, look for products that are **Forest Stewardship Council (FSC)** certified.



Wood siding



Home Exteriors

Steel and Aluminum siding products are available in a wide array of colors and textures. New color coatings are available to protect the finishes from wear. Lower gauge siding will reduce susceptibility to denting, which prolongs the life of your siding. Metal siding is relatively easy to install. Be sure to look for high **recycled content** when selecting metal siding.



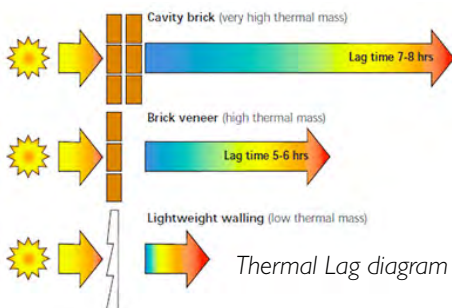
Aluminum siding

Stucco is a cementitious mixture used atop a metal mesh or lath. Stucco is a strong durable material that has historically been chosen as an inexpensive and weather-impermeable siding product. Be sure to hire an experienced installer. "External Insulation Finishing System" or EIFS utilizes artificial stucco for both commercial and residential construction. This product is good for adding an additional layer of insulation, but is susceptible to impact. If improperly installed, mold and durability problems can result. Be sure windows are flashed properly.



Stucco on MN craftsman style home

Brick or masonry on your home requires skilled labor to replace. Adequate weep holes help to drain water away from the building and brick ties with secure the brick and prevent cracking. Brick is especially useful in northern climates because it does a good job of capturing and retaining heat. Brick is durable and weather resistant, but it can be expensive to purchase and install.



Precast Concrete offers flexibility by allowing the thickness of the insulation to be chosen freely and offering many different design possibilities. Combined with additional insulation, it provides a comfortable indoor climate and is reliable, durable, and relatively low maintenance.

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Home Exteriors

Stone is labor intensive to install and repair, and requires expert involvement. Stone is typically installed with a system of mesh and grout. As a result, some pieces may crack during the freeze and thaw cycles of Minnesota winters. Stone, like brick, has a high thermal mass, and it therefore able to capture and retain heat well. Try to source stone locally or with **recycled content**.



Local Minnesota limestone on Eden Prairie home

Engineered Wood comes in a variety of products of varying quality. It is typically made of a compressed mixture of wood fiber and resin binders and is available as unfinished, pre-primed, or pre-finished. Be sure that cut ends are sealed before installation. Look for products that are **Forest Stewardship Council (FSC)** certified.



Engineered wood siding

Vinyl is a popular siding materials that is low in cost but not very ecologically sound. It is approximately 80% poly-vinyl-chloride (PVC), which uses petrochemicals and releases dioxin during its production process. Insulated vinyl siding is available with a backing of polystyrene to provide thermal and acoustical insulation. If you have a historic home, residing with vinyl can lower the value as it is not a traditional building material.



Vinyl siding

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Home Exteriors

	Content	Lifecycle data	Lifetime	Maintenance	Durability	Manufacturing Process	Disposal
Fiber Cement Board	45% cement 45% silica sand 10% wood fiber	GWP / sf: 6.12 lbs of CO ₂ Lifetime GWP : data not available Fossil Fuel Consumption / sf: 80.65 MJ Embodied Energy / sf: 41.20 kWh/ton/year Solid Waste: .048 lbs/sf/yr Air Pollution Index: data not available	50 years when properly maintained	Requires joint sealant every 5-7 years Requires repainting if not a prefinished product (less often than wood siding)	Very durable and impact and crack resistant Rot resistant Non-combustible	Decarbonization of limestone releases carbon dioxide Blending and compressing of materials to form fiber cement is energy intensive Cement production uses large amounts of water and releases carbon dioxide Locally sourced materials are available across the US (sand, cement, wood pulp)	Some recycling facilities are now available Can be ground and used as road fill Inert landfill waste
Wood	100% wood	GWP / sf: 1.4525 lbs of CO ₂ Lifetime GWP : approx .03 lbs of CO ₂ / sf / yr Fossil Fuel Consumption: none Embodied Energy / sf: 15,405 BTU or 25.6 kWh/ton/year Solid Waste: 0.2282 lbs Air Pollution Index: 0.1259	25 to 75 years with proper maintenance	Relatively high maintenance Requires repainting, staining, and/or sealing every 5-7 years	Impact resistant Susceptible to rot, shrinkage and expansion, and warping Combustible	Look for FSC certified wood to prevent over-harvesting of wood resources Look for locally sourced wood products Look for products that are Forest Stewardship Council (FSC) certified.	Biodegradable Can be burnt, but will release CO ₂
Steel and Aluminum	Metal (may be pure or alloy)	GWP / sf: 11.8583 lbs of CO ₂ Lifetime GWP : approx .3 lbs of CO ₂ / sf / yr Fossil Fuel Consumption / sf: 162.68 MJ Embodied Energy / sf: 49,891 BTU Solid Waste: 1.7274 lbs Air Pollution Index: 0.6918	20 to 50 years	Little maintenance Individual panel replacement is available if damaged	Rot resistant Susceptible to fading and oxidation under harsh conditions High quality finishes help to resist fading and peeling Aluminum may warp or dent	Metal processing is energy intensive Look for high recycled content Raw material mining is environmentally detrimental and uses large quantities of water	High recyclability

- Embodied energy refers to the energy required to extract raw materials, manufacture and transport the materials required to build a home, as well as the energy required to assemble and construct the house.
- The manufacturing processes used to produce paint, stain and seal are energy intensive, contributing to the embodied energy in the structure calculated over the life of the structure.
- Life expectancy depends on quality of maintenance and installation.

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Home Exteriors

	Content	Lifecycle data	Lifetime	Maintenance	Durability	Manufacturing Process	Disposal
Stucco	Portland cement Lime Sand	Lifecycle data GWP (lbs of CO ₂): 2.3576 Lifetime GWP : approx 0.035 lbs of CO ₂ / sf / yr Fossil Fuel Consumption: data not available Embodied Energy / sf: 23,769 BTU Solid Waste (lbs): 0.2179 Air Pollution Index: 0.13889	75 years (dependent on proper installation)	Occasional light washing Joint maintenance to prevent water infiltration Repainting	Moisture resistant Rot resistant	Can be made with recycled content (plaster and metal lath) Look for locally sourced limestone	Metal lath is recyclable Plaster is diverted to landfills
Brick	54-61% silica 22-32% aluminum	GWP / sf: 15.0744 lbs of CO ₂ Lifetime GWP : approx .15 lbs of CO ₂ / sf / yr Fossil Fuel Consumption: data not available Embodied Energy / sf: 111,691 BTU or 12.4 kWh/ton/year Solid Waste: 2.3758 lbs Air Pollution Index: 1.3953	Around 100 years or building life (with proper, skilled installation)	Little maintenance Highly dependent on use of proper mortar mixes-select qualified installers	Impact resistant Rot resistant	Energy intensive firing process Clay mining can be environmentally detrimental and requires large quantities of water Any brick debris during the manufacturing process can be reused Locally sourced clay can be mined from the Minnesota river valley	Can be salvaged and used as fill
Precast Concrete	7-15% Portland cement Aggregate Additives Steel reinforcement	GWP / sf: data not available Lifetime GWP : not available Fossil Fuel Consumption: not available Embodied Energy: not available Solid Waste: not available Air Pollution Index: not available	Over 60 years	Little maintenance – cleaning on an as-needed basis	Impact resistant Fire resistant Weather resistant Rot resistant	Production of cement is energy and water intensive Little to no waste is produced Locally produced	Waste is often crushed prior to disposal so that steel reinforcing can be removed and recycled Concrete itself can be used as aggregate or fill Frequently disposed of in landfills

- Embodied energy refers to the energy required to extract raw materials, manufacture and transport the materials required to build a home, as well as the energy required to assemble and construct the house.
- The manufacturing processes used to produce paint, stain and seal are energy intensive, contributing to the embodied energy in the structure calculated over the life of the structure.
- Life expectancy depends on quality of maintenance and installation.

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Home Exteriors

	Content	Lifecycle data	Lifetime	Maintenance	Durability	Manufacturing Process	Disposal
Stone	Stone	GWP / sf: data not available Lifetime GWP : not available Fossil Fuel Consumption: not available Embodied Energy / sf: not available Solid Waste: not available Air Pollution Index: not available	Building life (with proper maintenance and installation)	Little maintenance Highly dependent on use of proper mortar mixes-select qualified installers	Impact resistant Rot resistant	Landscape impacts of rock quarrying can be environmentally detrimental Look for locally sourced limestone	Can be salvaged and used as fill
Engineered Wood	Wood strands, particles, fibers, or boards Adhesive	GWP / sf: data not available Lifetime GWP : not available Fossil Fuel Consumption: Embodied Energy / sf: not available Solid Waste: not available Air Pollution Index: not available	Varies by product	Repainting every 5-7 years	Varies by product	Energy intensive composite process Binders and resins release VOCs during manufacturing Can use wood pulp from recycled sources Look for FSC certified wood to prevent overharvesting of wood resources Locally sourced wood products are available	Landfill waste Difficult recyclability
Vinyl	80% PVC (Polyvinyl chloride) 20% other ingredients	GWP / sf: 5.0032 lbs of CO ₂ Lifetime GWP : approx. .14 lbs of CO ₂ / sf / yr Fossil Fuel Consumption: Embodied Energy / sf: 45,313 BTU or 76.8 kWh/ton/year Solid Waste: 0.3527 lbs Air Pollution Index: 0.4247	50 years, but suffers sun degradation over its lifetime	Annual power-washing to prevent mildew growth (typically on North side)	Brittle in cold weather; and may buckle in very hot weather Will not rot, rust, or peel Susceptible to fading Highly combustible	Releases toxic dioxins during manufacturing (80% PVC) and if burned	Landfill waste Burning, but releases toxins Look for newer vinyl products are recyclable

- Embodied energy refers to the energy required to extract raw materials, manufacture and transport the materials required to build a home, as well as the energy required to assemble and construct the house.
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Home Exteriors

Roofing

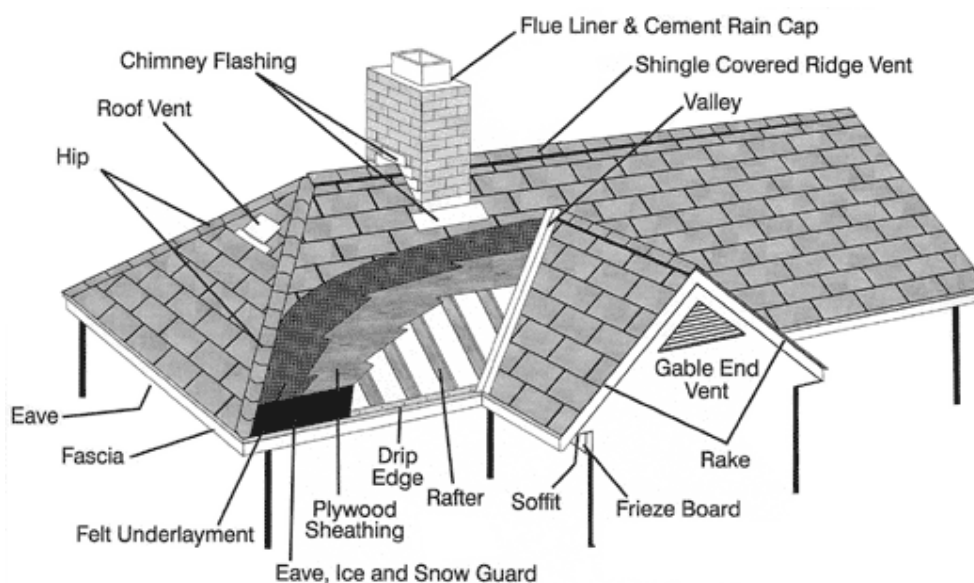
Like siding, the roof of your home should be durable, functional, and aesthetically pleasing while still being sustainable. Because the roof is your first line of defense against precipitation, the same **drainage plane** principles (see chapter 3, page 6) that apply to siding apply to roofing and the materials you choose should provide moisture resistance that enhances the energy performance of your home. In addition, you'll want to make sure your installer puts an ice and water shield on the bottom edge of the roof and in any valleys and that they seal and flash any roof penetrations to prevent leaks and damage to your roof material. If the moisture resistance properties of your roofing material fails, it could damage your attic, wall insulation, framing and finishing materials. The same is true for the insulation in your attic or roof space. If improperly insulated, winter **ice dams** (see chapter 3, page 6) can form and damage roof materials.

*Your roof is an integral part of your building envelope! Proper installation of roof materials is vital to its performance. Many manufactures require product-specific **certified installers** to maintain warranties. For those that do not, make sure you select a reputable, experienced installer.*

Roofing Materials

Since re-roofing is typically done out of necessity alone, products are commonly selected based on initial cost, rather than considering the product's cost over its useful life. As a general rule, though, products that offer longer lifetime performance are more cost effective. Even if they are more expensive initially, the higher cost of a more durable product may be recouped by less frequent replacement.

When deciding on the type of roofing material you are going to use, you'll also want to consider lifetime performance, recyclability, and the effect the roofing material will have on the water that runs off it. For example, when comparing metal roofing to asphalt shingles from manufacturing to disposal, asphalt shingles are a poorer choice in terms of lifespan, runoff, and other environmental impacts. The following table will help you determine which solution is right for you.



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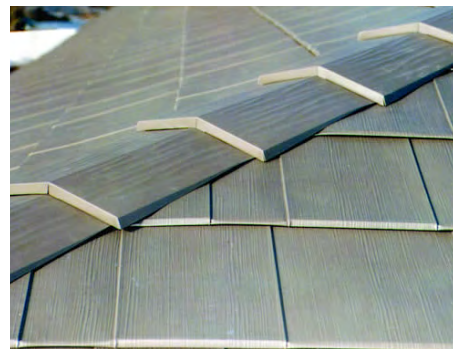
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Home Exteriors

Metal (lead-free) Roof Products

Like metal siding, metal roof products are a great option if you are looking for something with **recycled content**. Standing seam metal is the familiar style, but metal shingles and tiles are also available and offer a more traditional residential aesthetic. Metal roofing is also available in a wide variety of colors, textures, and even shapes. There are several benefits to metal roofs: the highly reflective colors and finishes can reduce cooling loads and heat island effect, snow slides off easily, they are more resistant to wind and hail damage than asphalt shingles, and most manufacturers offer a warranty that will last the life of your home. With a longer lifespan and little to no required maintenance over the years, the initial higher cost of a metal roofs can make it a lower-cost option when analyzed over its life-cycle. One drawback to a metal roofs can be noise. On homes with inadequate attic and ceiling insulation, the sound of rain can sometimes be loud indoors.



Steel Roof Shingles – Wood texture



Metal shingles & standing seam roofing on a home

Wood Shakes and Shingles

Wood shake and shingle roofs are another option. They are often sourced from western red cedar, cypress, or redwood tree species, which are species known for their resistance to decay. Other tree species are sometimes used, but they must be pressure treated or impregnated with chemicals to improve performance and lifespan. When considering a wood roof, remember that a thicker roof will perform better than a thin one and that wood roofing material is not recommend for low slopes.

The life of a wood roof can be extended by using sealants. However, use caution if choosing to apply a sealant as many contain hazardous chemicals can both off-gas and leach into soil from roof runoff. Sealants can also impact the water quality of the water collected from the roof, making it unsuitable for watering and food gardening. Also, one of the benefits of wood shingles is that they are biodegradable, but once a chemical sealant is added, the roof material can be harder to dispose of. Read more¹⁶ about wood shingle maintenance.



Wood Shingles

16) pnwhandbooks.org/plantdisease/pathogen-articles/nonpathogenic-phenomena/care-and-maintenance-wood-shingle-and-shake-roofs

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Home Exteriors

Clay Tile

Natural roofing materials such as clay offer a timeless aesthetic that may be architecturally traditional to your home. Clay requires careful, skilled installation which increases the initial cost.

Fiber Cement Shingles

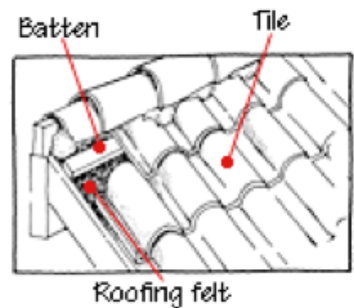
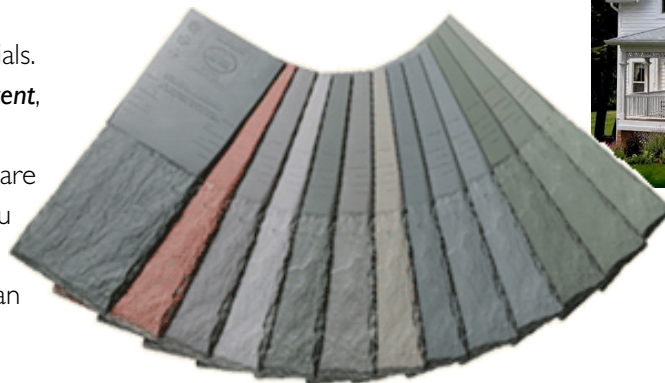
Fiber cement shingles use the same materials as fiber cement siding and are manufactured to look like asphalt, slate, shake, and Spanish tile. Like metal roofs, the initial cost can be an issue as they are expensive up-front and require skilled installation. Long manufacturer warranties, however, offset the initial cost to make fiber cement shingles a long-term affordable option. In fact, most manufacturers will back their products for 50 years. Also, in terms of durability, fiber cement board does not rot, is impact resistant, and is non-combustible.

There are a few disadvantages to fiber cement shingles, but the primary one is the weight of the product. Because these shingles are very heavy, an evaluation of your roof's structure will be necessary to verify its weight-bearing capacity. The shingles' weight may also make the material hard to work with. Another drawback is the process of blending and compressing materials to form fiber cement board, which can be energy intensive because cement production uses large amounts of water and releases carbon dioxide. On the other hand, the three materials used to make fiber cement are available in many locations across the US. Depending on where the manufacturing plant is located, fiber cement siding can often be sourced locally. Also on the plus side is the recyclability of fiber cement board, which is growing as facilities are being developed. In fact, waste fiber cement board is now being ground up and used as road fill.

Composite Recycled Rubber and Plastic Shingles/Tiles

Composite shingles are a lightweight, impact-resistant alternative to traditional slate, cedar, or asphalt roofing materials. They may contain **recycled content**, but end-of-life disposal may be difficult. Although UV blockers are added, confirm the product you are considering warrants against fading as this has been an issue for some manufacturers.

Array of slate-like composite recycled plastic roof shingles



Clay tile roof assembly



Fiber Cement Shingles – slate alternative



Recycled rubber roof shingles on a Iowa home

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Asphalt shingles

Asphalt shingles are fiberglass or organic felt mats soaked in asphalt and embedded with stone granules on the outward facing side. These granules work to protect the asphalt from the sun's UV rays, which can slowly degrade the asphalt shingle. Asphalt shingles are the most common residential roofing material and generally have the lowest initial cost. However, their relatively short lifespan make them the most often replaced roofing product and that translates to a more costly investment over time. Asphalt shingles do carry warranties of 20 to 30 years – sometimes even 50 years – but they are also highly susceptible to damage from high winds, snow, and hail, which means they often have to be replaced after only 15-20 years, long before the product reaches its expected lifetime performance.



If you do use asphalt shingles on your home, it may make sense to select a lighter colored product. The lighter color will reflect sunlight better, keeping your home cooler in the summer and reducing your home's contribution to the heat island effect. If your roof is shaded this consideration is unnecessary, and if you have a lower sloped roof, it may be better to use a darker color that will dry more quickly. You'll also want to choose a shingle that has a higher fire rating (class A rather than class B or C), is heavier, and has a tear resistance of 1700 grams or more.

	Lifecycle data	Lifetime	Maintenance	Durability	Manufacturing Process	Disposal
Metal (lead-free) Roof Products	GWP / sf: approx 5 lbs of CO ₂ Lifetime GWP : approx. .10 lbs of CO ₂ / sf / yr Embodied Energy / sf: approx. 55,000 BTU	50+ yrs	Little to no maintenance required	Lightweight, no additional structure required Rot and mold resistant Susceptible to denting from hail or impact High-quality finishes prevent oxidation, chipping, and resistance to fading	Energy intensive metal processing Look for recycled content : raw material mining is environmentally detrimental & uses large quantities of water Global warming potential: generates significant amounts of greenhouse gasses but offset by long lifetime performance	Recyclable
Wood Shakes and Shingles	GWP / sf: approx 3 lbs of CO ₂ Lifetime GWP : approx .9 lbs of CO ₂ / sf / yr Embodied Energy / sf: approx. 40,000 BTU	30-50 years	Leaf and debris removal to prevent moss growth	Lightweight Impact resistant Susceptible to moisture absorption which can lead to moss growth Good acoustical insulation Combustible	Look for FSC certified wood to prevent over harvesting of wood resources Locally sourced wood products	Biodegradable

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	Lifecycle data	Lifetime	Maintenance	Durability	Manufacturing Process	Disposal
Clay Tile	<i>GWP</i> / sf: data not available Lifetime <i>GWP</i> : data not available Embodied Energy / sf: data not available	30-50+yrs, when properly maintained, clay can last nearly 100 yrs	Little to no maintenance required	Heavy, can require additional structure Fireproof Impact resistant Rot and mold resistant	Manufacture energy-intensive firing process <i>Locally sourced materials</i> available across Midwest	Can be salvaged Inert landfill waste
Fiber Cement Shingle	<i>GWP</i> / sf: data not available Lifetime <i>GWP</i> : data not available Embodied Energy / sf: data not available	40-50+yrs	Little to no maintenance required	Medium to heavy weight, often no additional structure required Non-combustible Some concerns with cracking from freeze-thaw in our climate Impact resistant Rot and mold resistant	Available with <i>recycled content</i> Blending & compressing of materials to form fiber cement is energy intensive Cement production uses large amounts of water & releases carbon dioxide <i>Locally sourced materials</i> available across US (sand, cement, cellulose fiber)	Ground for use as fill Inert landfill waste
Composite Recycled Rubber and Plastic Shingles/ Tiles	<i>GWP</i> / sf: data not available Lifetime <i>GWP</i> : data not available Embodied Energy / sf: data not available	40-50 yrs	Little to no maintenance required	Medium to lightweight Extremely impact resistant Good acoustical insulation Added UV blockers to resist sun degradation	Manufacturing process Look for <i>recycled content</i> <i>VOC off-gassing</i> is potential from rubber and plastics during and after manufacturing	Difficult to recycle
Asphalt shingles	<i>GWP</i> / sf: data not available Lifetime <i>GWP</i> : data not available Embodied Energy / sf: data not available	40-50 yrs	Little to no maintenance required	Medium to lightweight Extremely impact resistant Good acoustical insulation Added UV blockers to resist sun degradation	Look for <i>recycled content</i> <i>VOC off-gassing</i> is potential from rubber and plastics during and after manufacturing	Difficult to recycle

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Home Exteriors

Solar Integrated Roofing Systems

Have you been wanting to incorporate solar energy into your home's energy plan but don't like the idea of a solar panel array attached to your roof? If so, new Building Integrated Photovoltaics (BIPV) roofing systems are now available as either applied or integrated solar panels to help generate power for your home. Integrated systems include shingles and tiles that blend in with traditional roofing materials. While one shingle will not do the trick, a series of shingles wired together can create quite a bit of electrical energy. Depending on the size and type of your BIPV array, you could generate anywhere from 4 to 12 watts/sq.ft. of added energy for your home! Another technology, surface-applied thin-film photovoltaic panels, can be adhered to portions of standing-seam metal roofs to reach the desired power supply size. [Learn More](#)¹⁷.

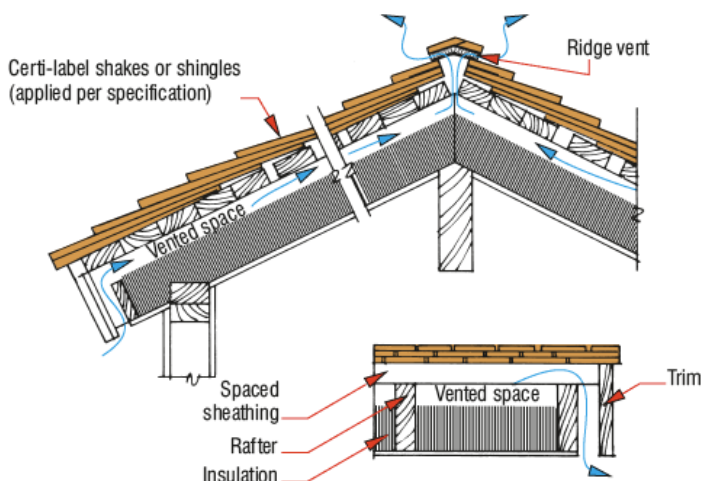
Green Roofs

A green roof – one literally covered in living plants – is great for slowing, cleaning, and even cooling stormwater before it enters the watershed, and they can help lessen a building's contribution to the heat-island effect. Green roofs are basically an assembly of plants, soil material, a drainage layer, and a waterproofing layer. Although green roofs are generally not recommended in residential settings due to cost, maintenance, and the risk of moisture damage, they can be done. You'll want to hire a skilled professional who can verify that your home's structure can bear the weight of a green roof and who can help you choose the right plants and growing medium. Once established, some green roofs require only annual maintenance. [Learn more](#)¹⁸ about green roof technologies.

Cold Roofs

As part of your building envelope, your roof and unconditioned attic space should be insulated so that you have a "cold roof." In cold climate areas, this means that the attic space is vented so that the cold air stays above the insulation but below the roof materials. Ventilation at the roof peaks will allow any warm attic air to escape and soffit vents will draw the cool outside air into your unconditioned attic. This will help prevent the build-up of ice dams on the roof and help regulate the roof temperature.

Avoid mechanical roof ventilation systems as they often lead to moisture issues.



Roof Penetrations

Roof penetrations (such as skylights, ventilation ducts, and chimneys that are uninsulated or improperly sealed) can lead to energy loss, ice dams, and roof deterioration. It's important to have proper **flashing** and insulation around any roof penetrations to avoid both air and water leakage.

17) www.renewableenergyworld.com/articles/2012/05/the-challenges-building-integrated-photovoltaics.html

18) www.igra-world.com/

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Home Exteriors

Skylights

Skylights are a great way to increase the amount of natural light you have in your home, and having more natural light can improve the overall environmental quality of your home, create more usable space, and even reduce the need for electric lighting. To obtain the optimum benefit of skylights, however, they must be placed in the right place, be of high quality, and be installed correctly. When deciding where to locate a skylight, remember that south or west-facing roofs will likely capture the most sunlight. When choosing a skylight, select one that is at least double-paned and has a low U-value (see “Windows” page 20). When installing the skylight, be sure to have adequate **flashing** to prevent heat loss and moisture leaks. Remember, a skylight will never insulate as well as solid roof, so it's important to reduce heat loss as much as possible.

One caveat about skylights is that on flat roofs they tend to make water ponding issues worse and are therefore not a good idea. An alternative to skylights is the solar tube, which is a roof-penetrating tube that captures and directs light into your home with less energy loss than a traditional skylight.

Chimneys and Vents

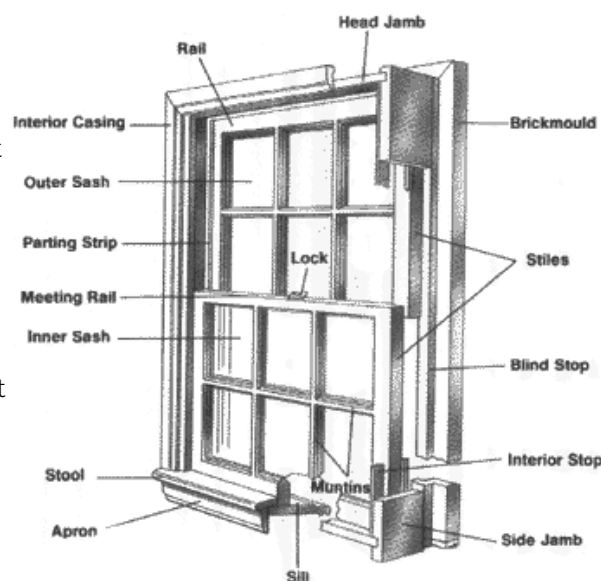
Vents and chimneys, which are necessary for proper ventilation for your fixtures and appliances, must be properly constructed and installed so that they operate effectively and don't contribute to air or moisture leaks. Property installed vents should extend above the roof plane -- vents that terminate just above the roof can release warm, moist air onto the roof surface, which can cause winter melting and ice damming. Vents must also be sealed and insulated as they pass through your attic and ceiling space to avoid condensation and warming in your attic that could ruin your attic insulation and create mold problems. Your vents must also have proper **flashing** with a sealant that can withstand shrinkage and expansion to prevent leaks.

Windows

Bringing more daylight into a room is a common goal for remodeling projects. Added daylight can reduce dependency on artificial lighting and contribute to a healthier overall indoor environment. In fact, Daylighting Studies¹⁹ show that spaces with natural daylight create a more stimulating and satisfying atmosphere. Unfortunately, adding or enlarging windows can negatively impact your home's overall energy efficiency because even the most efficient triple-pane fiberglass window can't insulate as well as a poorly insulated wall.

There are ways to combat this by choosing the right window for the job and by placing your windows in the right place. A south-facing placement will allow for passive solar gain in the winter and, if you have good shading, prevent unwanted solar gain in the summer. Also consider the size and number of windows. As a general rule of thumb, total window area should not be more than 15 to 18% of floor area – this is called the **window-to-floor ratio**. Following this rule will help balance cost, energy use, and indoor air quality.

Anatomy of a Window





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Should you Replace or Refresh Your Windows?

As with skylights, windows are common sources of air leaks and heat loss. Drafty windows, visible condensation, or frost build-up are just a couple indicators that your current windows aren't performing well. But new windows are expensive and can take many decades to payback so before you jump to completely replacing your windows, first look into the feasibility of improving your existing windows. Unless the actual window frame is showing signs of deterioration, rot, and/or moisture leakage, you may benefit from simple improvements such as air sealing, adding storm windows, and replacing window sashes and sills. The Efficient Window Collaborative is also a good resource to help you decide whether to repair or replace your windows and [How to Make Repairs](#)²¹.

If you do decide to refresh rather than replace your windows, start by repairing any damaged window panes or cracked and rotted sashes. If you are replacing sashes, invest in higher performing glazing whenever possible. Next, make sure that every window closes and locks to get a tight air seal. Finally, add weatherstripping to any window that has small leaks. Since these improvement to the window don't address air leaking from around existing window frames, if you're refinishing walls or reinsulating, remember to seal and insulate around window frames at that time as well! Adding storm windows to single-pane windows is also a good investment.

Selecting New Windows

If you do need to replace your windows because they cannot be repaired, investing in efficient windows will help create a more comfortable indoor environment and provide a reduction in heating costs. Rebates may also be available for window upgrades that can significantly help reduce the initial investment.

Before you start shopping, it will be helpful to know the components of a window and how windows are rated. The performance of a window is determined by a combination of factors relating to the frame and glazing type. The following are the best criteria for assessing the window effectiveness:

- **U-factor:** U-factor measures how well a product prevents heat from escaping. The rate of heat loss is indicated in terms of the U-factor (U-value) of a window assembly. U-Factor ratings generally fall between 0.20 and 1.20. The lower the U-value, the greater a window's resistance to heat flow and the better its insulating value.
- **Solar Heat Gain Coefficient:** Solar Heat Gain Coefficient (SHGC) measures how well a product blocks heat caused by sunlight. The SHGC is the fraction of incident solar radiation admitted through a window (both directly transmitted and absorbed) and subsequently released inward. SHGC is expressed as a number between 0 and 1. The lower a window's solar heat gain coefficient, the less solar heat it transmits in the house. For south facing windows intended for passive solar heating, look for higher SHGC to capture solar heat in the winter.
- **Visible Transmittance:** Visible Transmittance (VT) measures how much light comes through a product. The visible transmittance is an optical property that indicates the amount of visible light transmitted. VT is expressed as a number between 0 and 1. The higher the VT, the more light that is transmitted.
- **Air Leakage:** Air Leakage (AL) is indicated by an air leakage rating expressed as the equivalent cubic feet of air



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passing through a square foot of window area (cfm/sq ft). Heat loss and gain occur by infiltration through cracks in the window assembly. The lower the AL, the less air will pass through cracks in the window assembly.

- **Condensation Resistance:** Condensation Resistance (CR) measures the ability of a product to resist the formation of condensation on the interior surface of that product. The higher the CR rating, the better that product is at resisting condensation formation. While this rating cannot predict condensation, it can provide a credible method of comparing the potential of various products for condensation formation. CR is expressed as a number between 0 and 100. The higher the number, the better the condensation resistance.
- **Learn More**²² about performance ratings.

Additional Resources

- [Minnesota Sustainable Housing Initiative](#)²³
- NFRC Label ([National Fenestration Rating Council](#)²⁴): Check out the [EnergyStar rated NFRC windows](#)²⁵
- Look for the [Energy Star certification](#)²⁶ logo
- For more guidance selecting windows in Minnesota, download the [Minnesota Fact Sheet](#)²⁷ created by the [Efficient Windows Collaborative](#)²⁸.

22) energy.gov/energysaver/energy-performance-ratings-windows-doors-and-skylights

23) www.mnshi.umn.edu/kb/scale/windows.html

24) www.nfrc.org/Windowratings/index.html

25) www.energystar.gov/index.cfm?c=windows_doors.pr_ind_tested

26) www.energystar.gov/index.cfm?c=windows_doors.pr_anat_window

27) www.efficientwindows.org/factsheets/Minnesota.pdf

28) www.efficientwindows.org/factsheets/Minnesota.pdf

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Glazing

Although the most common windows found in homes today are double-glazed windows, triple-glazed windows are becoming more affordable as technology improves. Before considering a triple-glazed window though, you will need to determine whether your house framing is strong enough to support their extra weight. And, in many cases, the incremental cost between double- and triple-glazed windows is too high to justify the cost unless the entire house is being retrofitted and super-insulated.

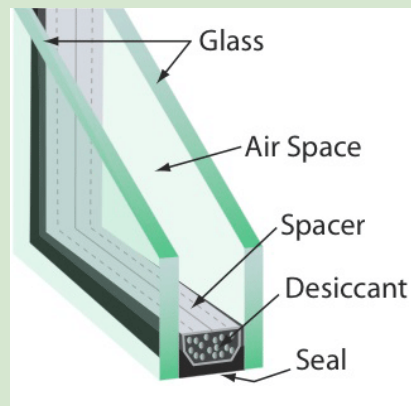
Triple-glazed windows can be useful in optimizing passive solar design strategies. For example, with south-facing windows that have summer shading, they offer a higher Solar Heat Gain Coefficient without sacrificing U-value. If you are considering triple-glazed windows, carefully evaluate the cost-effectiveness of the investment. It may make more sense to invest your money in energy-efficient equipment and insulation.

Photochromic and electrochromic glass are also becoming more widely available. These glass panes can change their properties with exposure to light or current. Such technology is useful for conserving energy because the windows automatically react to the light or heat conditions.

Low-E stands for Low Emissivity. Barely visible, this thin, metal or metallic oxide layer creates a “Low-E coating” that is applied to the surface of glass. It blocks the transfer of infrared radiation from one pane of glass to another. Which surface of glass the Low-E coating is on can make all the difference in the performance of the window. In a cold climate, such as our Minnesota climate, the Low-E coating should be applied to the innermost glazing surface within an IGU to capture the warmth from the winter sun without letting interior heat escape.

ANATOMY OF A WINDOW

Windows use multiple layers of glass spaced apart and often filled with insulating gas to achieve higher performance values. The spacers between layers of glass are often made of plastic or foam that seals the cavity created by the layers. The sealed space between the glass is then filled with inert gas of either argon or krypton to improve thermal performance. The space between glass layers should be determined based on its gas fill: Argon: 1/2", Krypton: 1/4" to 3/8". Argon is less expensive than Krypton but krypton insulates better. Both gasses are nontoxic, nonreactive, clear, and odorless. Over time, these filled gasses can leak out, increasing the U-value of the IGU. Some companies are researching methods on how to re-fill and re-seal IGU to regain performance values. These layered glazing assemblies are called Insulated Glass Units or IGU's.



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Frame Types

A very important aspect of your new windows will be the frames. Window frames are most commonly made of wood, aluminum, vinyl, composite, and fiberglass. When deciding on the type of frame, confirm that it has a ***thermal break***, evaluate its durability and maintenance, consider the environmental impact, and consider the frame's insulation properties (***R-value***). In addition to these factors, you'll also want to consider the frame's heat conductivity, which will vary based on the material. Remember that the higher the conductivity, the lower the window performance rating.

- **Wood Frames:** These frames have low conductivity but are susceptible to expansion and shrinkage. They do require finish maintenance to prevent rotting. However, well-maintained wood frames have a reputation for long lifetime performance. Wood windows can be a more expensive frame option but often retain their value better than vinyl frames. They can also add a type of aesthetic character to your home that might not be achievable with other frame types. Many manufacturers are now using **FSC** certified wood in their frames, helping to reduce overharvesting of resources by supporting sustainable forestry practices. Wood frames clad with another material are a good option to standard wood frames. The exterior fiberglass, metal, or vinyl reduces maintenance while the wood interior maintains insulating properties.
- **Aluminum or Metal Frames:** These frames conduct heat quickly. If you choose to use these durable, maintenance free frames, make sure the frames have a ***thermal break*** between the frame interior, exterior, and sash. A ***thermal break***, either a plastic or foam strip, interrupts conduction and helps insulate the frame. Even with a ***thermal break***, solid metal frames risk condensation in our cold climate. Metal-clad wood frames can help achieve the durability of metal frames without the increased cost. The process of harvesting resources and manufacturing metal is energy intensive but metal frames are recyclable at the end of their lives.
- **Vinyl Frames:** These frames are the least expensive frame option. Vinyl has low conductivity, and when the frame cavities are insulated with foam, they can be high performance windows. Although maintenance-free, vinyl tends to have a relatively short lifespan and extreme temperature conditions can cause thermal expansion and contraction, resulting in cracking and warping that substantially decreases the life of the window. The environmentally detrimental manufacturing process of vinyl releases dioxin and harmful **VOC's** such as PCBs and phthalates (EPA Website). There are only limited vinyl recycling facilities available, which means that most vinyl products end up in landfills or incinerators where the toxic materials in vinyl become air or water pollutants.
- **Composite Frames:** Composite frames are a popular alternative to vinyl and wood frames. They have low thermal conductivity, are strong, and require little maintenance. Composite products are energy intensive to make but can be sourced from by-product and recycled materials, lessening the environmental impacts of raw materials. The composite materials are commonly laminated wood or particle board.
- **Fiberglass Frames:** These frames are often a component of super-windows, a term used to describe extremely high-performing and more expensive windows. Like vinyl, when their hollow frame cavities are filled with foam insulation, they offer optimal insulating performance. Fiberglass is strong, durable, and moisture resistant, but **VOCs** released during the manufacturing process are an environmental and health concern.
- **Learn More**²⁹.

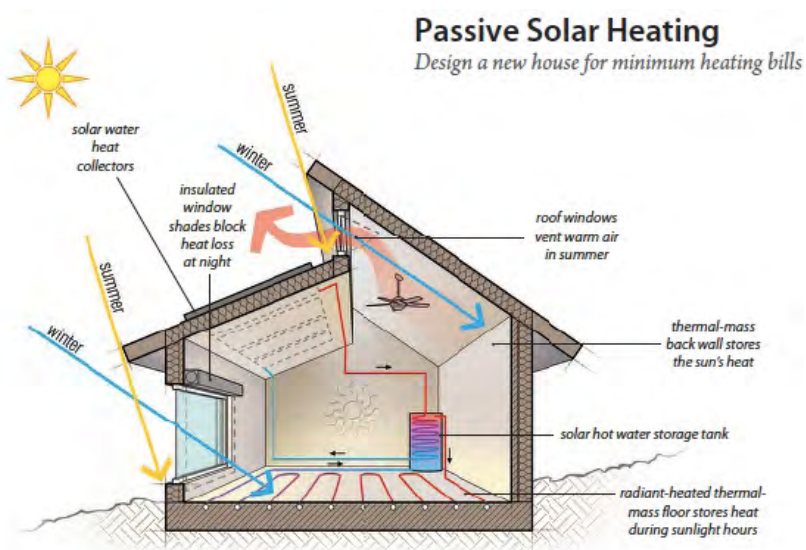


Home Exteriors

Location

In our heating-dominated climate, the largest windows should be located on south facing walls where they will capture the most direct sunlight and provide better indoor daylight. Although windows on north walls lose energy, they can offer a comfortable indirect source of natural light. Also, by using wall and floor materials such as brick, concrete, tile, or plaster that capture and hold the solar energy passing through the windows, you can take advantage of passive solar design strategies. To optimize this heat gain, utilize windows with an SHGC (Solar Heat Gain Coefficient) of .4 or greater but maintain a U-Factor of .32 or less.

Though welcome in the winter, the sun's free heat can be problematic in the summer. East and especially west facing windows can overheat in the summer; and because the sun angle is lower during summer, it can be difficult to shade these windows. To avoid increasing your air conditioning costs, you'll need to add shading devices such as roof overhangs or shade-providing landscaping. For more info on shading tactics, go [here](#)³⁰. [Learn more](#)³¹ about the details of window areas and orientation.



Installation

The entire exterior surface of your home is a barrier between the indoors and the weather; and windows should be integrated into that system. It is critical your windows be installed and flashed according to the manufacturer's recommendations to preserve the warranty and optimize performance. Failure to properly flash a window installation can result in water inside your walls and may result in severe damage to your home and health. Also be careful that the window installation does not compromise the drainage plane created by the housewrap and **flashing**.

As with any other product you put in your home, you'll want to select a qualified installer who has experience with the type of window you have chosen and is willing to meet with you to answer questions. Sometimes neighbors and friends can provide referrals but sure make the project they had done is similar in type and scope to the project you will be doing. It's also a good idea to interview more than one installer to make sure you're getting accurate information and competitive bids. And always look for a contractor who will warrant their work.



Home Exteriors

Storm Windows

Storm windows may dramatically improve the performance of your home by reducing heat loss and improving air tightness. They can also offer air sealing benefits that make them a valuable investment when window replacement is not necessary.

Storm windows are available as either interior or exterior panes of plastic or glass, both of which are available with coatings that can help improve visibility and performance. Interior storms tend to be more cost effective, are more convenient to install, and perform better than exterior storms, which require weep holes that diminish air sealing capabilities and can, over time, compromise the performance of the window they are protecting. Without proper drainage, trapped moisture can cause wood frames to rot and render the window inoperable. The table below describes benefits and disadvantages of types of storm windows:

	Benefits	Disadvantages
Glass Storms	Better visibility Longer performance life	Heavy to install Fragile More costly
Plastic Storms	Inexpensive Lightweight	Scratchable / easily damaged Yellowing & degraded performance over time Reduce visibility

Like replacement windows, storm windows are made of wood, vinyl, or aluminum frames and will have similar performance standards as replacement window frames. Each type of material has both its benefits and drawbacks. Wood storms, for example, have good thermal performance but can be susceptible to rot and thermal expansion/shrinkage, which can make them difficult to install and result in air leakage. Vinyl storms also offer good thermal performance but they can crack and warp under extreme temperature and they are manufactured using an environmentally detrimental process. Aluminum storms are very low-maintenance but they also transfer heat quickly. Perhaps the best option to maximize performance and lifespan is to choose a frame that is made from a combination of materials, such as a vinyl or aluminum-wrapped wood frame storm window.

Doors

Adding storm doors or replacing old, uninsulated exterior doors can add to the efficiency of your home, but it's not always necessary to get a whole new door. The first way to save energy on doors is to maintain them. For example, weatherstripping around doors, which helps reduce energy loss due to air leaks, wears out quickly so check it often to see if it needs replacement. If the door needs more than just new weatherstripping, you'll want to invest in the most efficient doors you can afford. Your investment will pay off in the long run.

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Home Exteriors

Types of Doors

One common type of exterior door is one with a steel skin and a polyurethane foam insulation core. This type of door usually includes a magnetic strip for weatherstripping and, if installed correctly, needs no further weatherstripping.

The **R-values** of most steel and fiberglass-clad entry doors range from R-5 to R-6, however; doors with windows in them will have a considerably lower **R-value**. And doors made completely of glass (like sliding glass patio doors) lose much more heat than other doors because glass is a very poor insulator. If you do decide to install a glass door, choose one with a metal frame and **thermal break**, which is a plastic insulator between inner and outer parts of the frame. Also, look for one with several layers of glass, low-emissivity coatings, and/or low-conductivity gases between the glass panes to increase insulation value. Keep in mind, too, that sliding doors don't seal as tightly and their weatherstripping often wears quickly so look for a manufacturer that will allow you to replace worn weatherstripping.

In general, polyurethane-filled steel and fiberglass doors insulate better than solid wood doors.

Storm Doors

Adding a storm door can be a good investment if your existing door is old but still in good condition, however; adding a storm door to a newer, insulated door is not generally worth the expense. Much like other doors and windows, storm door frames are available in a variety of materials and styles; most often they are made of aluminum, steel, fiberglass, or wood. And just as with windows, the various materials and configurations have advantages and disadvantages. For example, wooden storm doors can be aesthetically pleasing, but they require more maintenance than other types whereas metal-framed storm doors might have foam insulation inside their frames to make them more effective, but they might be less attractive.

There are also a wide variety of configurations. Some storm doors have self-storing pockets for the glass in summer and an insect screen in winter. Some have fixed, full-length screens and glass panels that slide out of the way for ventilation. Others are half-screen and half-glass, which slides past each other. Some are removable for cleaning. All of these features add convenience but also add cost. [Learn More](#)³².

Never add a glass storm door if the exterior door gets more than a few hours of direct sun each day. The glass will trap heat against the entry door and could damage it.

Installation

When you buy a door, it will probably be pre-hung and ready to install. Pre-hung doors usually come with wood or steel frames. You will need to remove an existing doorframe from the rough opening before you install a pre-hung door. Install new doors so they are square and seal tightly. Before adding the interior trim, apply expanding foam caulking around the frame and rough opening to ensure there will be no air leakage. If needed, you'll also want to add weatherstripping.

For products and services related to choosing doors and windows, go [here](#)³³.

32) energy.gov/energysaver/doors

33) energy.gov/energysaver/window-door-and-skylight-products-and-services

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Home Exteriors

HOME AND RENEWABLE ENERGY

Because investing in renewable energy can be costly, it's often more financially smart to focus on making sure your home is as efficient as possible by air-sealing, insulating, upgrading and maintaining utility systems and appliances, and reviewing your energy use habits. Once all this is done, though, you may want to go one step further and look at purchasing or generating renewable energy, which can reduce your dependence on fossil fuels and lessen your contribution to climate change. Solar and geothermal are the renewable energy systems most readily available for residential use, however, wind power is growing in accessibility as a power source.

If installing renewable energy isn't an option for you, you could consider purchasing clean energy credits (sometimes called wind energy credits) from your electric utility provider. Although your own electricity won't necessarily be generated by wind power, you'll be helping your electric utility provider to develop wind generation capacity above and beyond governmental mandates, and you'll be supporting wind farms in your area. For some residents of Minnesota, this can be done through Xcel's Windsource™ program. Invest in Renewable Energy³⁴

Wind Power

The environmental benefits of wind power are many. According to the American Wind Energy Association, wind power currently saves 2.8 billion gallons of water annually and reduces CO2 emissions by 4.9 million metric tons in Minnesota alone. Wind power also generates more than 15% of Minnesota's electricity, and Minnesota has been successful in attracting investment for wind energy manufacturing and large wind energy projects, with at least 24 active manufacturing facilities in the state. In 2014, wind energy provided 15.94% of all in-state electricity production, enough to power 831,000 homes! Learn More³⁵.

Small wind electric systems can:

- Lower your electricity bills by 50-90%
- Help you avoid the high costs of having utility power lines extended to a remote location
- Help uninterruptible power supplies ride through extended utility outages

If you are interested in integrating wind electric systems into your home, you will first want to do some planning. To help determine the suitability of your site for a wind system, look at your site's wind resource by doing the following:

- Consult Wind Resource Maps: will estimate the wind resource in your area. Maps can be found at the U.S. Department of Energy's Wind Powering America Program site³⁶

You will also want to look into zoning and permitting requirements for your region. You can do this by contacting a local building inspector, board of supervisors, or planning board.

PROVIDING ENERGY BACK TO THE GRID If you do decide to install a system to generate electricity at your home, contact your utility company early on in the process for details on inter-connection costs and requirements and to find out what price they pay to purchase electricity. This process make take time, so begin as soon as possible. Verification of meeting these requirements should also be part of the final inspection and certification process, so you'll want to be sure to include this in the installation contract.

34) www.xcelenergy.com/Energy_Solutions/Residential_Solutions/Renewable_Energy_Solutions/Windsource_for_Residences

35) awea.files.cms-plus.com/FileDownloads/pdfs/Minnesota.pdf

36) apps2.eere.energy.gov/wind/windexchange/wind_resource_maps.asp?stateab=mn

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Home Exteriors

Finally, you will want to analyze the economics of a small wind electric system by estimating costs, savings, ***payback period***, and wind characteristics of your region. Estimating these figures will help you to determine whether the investment is a good option for you, both environmentally and economically. The [Small Wind Guidebook](#)³⁷ from Open Energy Information will help you get started on these.

Check out the following pages from Energy.gov for information on preparation, installation, and maintenance of small wind electric systems:

- [Planning](#)³⁸
- [How They Work](#)³⁹
- [Installation and Maintenance](#)⁴⁰

Solar

If your home has access to solar resources, you might want to invest in solar energy, which harnesses the sun's heat to either generate electricity (photovoltaic or PV) or to transfer thermal energy (thermal) to heat your home's air and water. These strategies are called active solar, as opposed to passive solar, and require the installation of solar panels on a track, wall, or roof. The best way to determine which type of solar energy system would suit your home best (thermal or photovoltaic) is to have a **solar site assessment**.

Before having such an assessment, there are a few things you can evaluate on your own. For example, do you have a south-facing wall or roof area where you could place solar panels? If not, do you have a large south-facing yard area where you could install track or ground mounted panels? Is the wall/roof/yard area free of trees or shade from nearby buildings?

If your site is favorable for solar, you'll next want to have a professional site assessment and select an installer. When contacting installers, determine whether or not they are certified by [North American Board of Certified Energy Practitioners](#)⁴¹ (NABCEP). This organization sets standards for installers, so you'll be assured you are working with a knowledgeable, skilled solar professional. Be sure to ask how much a site assessment costs and what it will include. For a list of detailed questions to ask your installer, view the Division of Energy Resources' document, "[Questions to ask a Renewable Energy Installer](#)."⁴²

In addition to determining the type of solar system appropriate for your site, a professional installer will also be able to tell you how much space you will need and how much energy will be generated by the system. They'll also ask about your current electricity consumption in kWh and your natural gas consumption in therms (by month) to show you what of your current use will be replaced by the proposed system. Look up qualified energy installers [here](#)⁴³.

37) en.openei.org/wiki/Minnesota/Wind_Resources

38) energy.gov/energysaver/planning-small-wind-electric-system

39) energy.gov/energysaver/small-wind-electric-systems

40) energy.gov/energysaver/installing-and-maintaining-small-wind-electric-system

41) www.nabcep.org/

42) <https://pureenergies.com/us/questions-to-ask-your-solar-installer/>

43) mn.gov/commerce/energy/images/hiring-renewable-energy-installer.pdf

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Home Exteriors

A final, but critical consideration is cost. Although utility and government incentives can help make solar energy more affordable, you'll want to get a realistic idea of the initial investment as well as the payback timeframe.

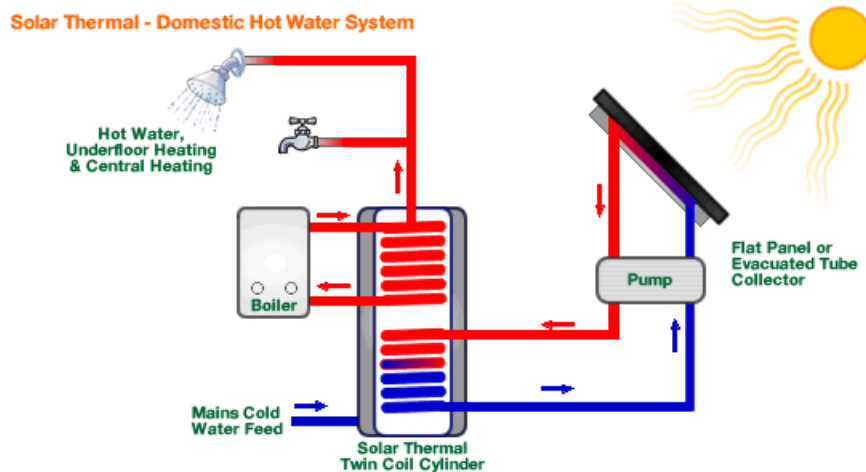
- [Made in Minnesota Solar Incentives Program](#)⁴⁴
- [Department of Commerce Incentives](#)⁴⁵
- [DSIRE Clean Energy Incentives](#)⁴⁶

Solar Thermal Air

Solar air heaters are typically the most cost-effective solar technology and have the shortest pay-back timeframe. These heaters use collector plates to absorb solar radiation, which heats the air inside the collector. The warmed air is then pushed into the room or duct system using a standard HVAC motors and fans. As the warm air leaves the collector, cool air is drawn in and heated. The heaters work best on a vertical surface and can be integrated into walls and used as either individual room heaters or to supplement a whole-house heating system.

Solar Thermal Water

Solar thermal water heaters are a cost-effective solar technology, however, the payback timeframe for these varies depending on available incentives and the fuel price of the device the solar thermal water is replacing/ supplementing. These collectors heat air, water, or an anti-freeze fluid called glycol, which, in turn, heats the water used in the home. Because we often have freezing temperatures during the winter in Minnesota, indirect solar thermal water systems most commonly use glycol.



Typically installed on roofs, solar thermal collectors are available as either flat-plate or evacuated tube collectors. Flat plate collectors are mounted in a weatherproof box with an absorber plate to collect solar radiation. The absorber plate transfers heat into the fluid-filled pipes underneath it. The fluid then flows to the heat exchanger. Evacuated tube collectors utilize glass tubes to absorb and transfer heat. Each tube has an inner and outer tube. Air between the tubes is removed to prevent heat loss through conduction and convection. The inner tube is usually coated or made of a different material to absorb solar radiation. The heat is then transferred to a heat exchanger.

Because this system is dependent on the sun's heat, solar thermal water systems are usually connected to a standard water heating system that acts as a back-up hot water supply on cloudy days when sunshine cannot be captured. [Learn More](#)⁴⁷.

44) <https://mn.gov/commerce/industries/energy/solar/mim/>
45) <http://www.cleanenergyauthority.com/solar-rebates-and-incentives/minnesota/>
46) programs.dsireusa.org/system/program?state=MN
47) energy.gov/energysaver/solar-water-heaters

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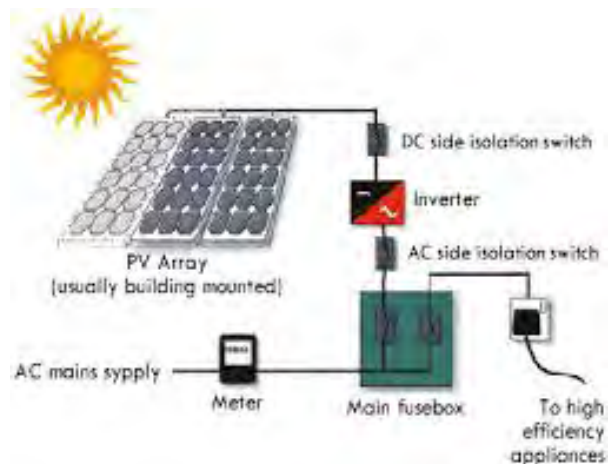
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Solar Electric Photovoltaic

Solar electric photovoltaics (PV) have the longest pay-back timeframe of the common solar technologies. PV panels are used to convert solar radiation into electrical energy. Typically installed on roofs or tracks, the panels are made of PV cells that are connected to a converter, which is, in turn, connected to your home. Panels installed on tracks can be programmed to follow the sun to collect as much solar radiation as possible throughout the day. If you're considering re-roofing your home, consider using PV integrated roof shingles to generate power for your home. PV panels are suitable for year-round use and are low maintenance. Many panels operate for 30 to 50 years! PV technology is constantly evolving, and panel efficiency is increasing.



Resources from Minnesota Renewable Energy Society <http://mnrenewables.org/explore>

YARDS AND LANDSCAPING

Landscaping not only provides your home with aesthetic benefits, but it can help with water management, seasonal heating and cooling needs, maintenance and irrigation requirements, and even wildlife attraction. Whether you do the work yourself or hire a landscape professional, the Minnesota Department of Natural Resources recommends starting with the following steps:

- 1. Describe Your Yard:** Include the location of your house, neighbors, structures, sidewalks, utility lines, mature trees, gardens, shrubbery, sun exposure, topography, soil pH, fertility, and texture, and water drainage.
- 2. Think About Your Preferences:** How will the site be used? How long do you plan to stay in this house? What wildlife species would you like to attract? Do you have time to garden? What kinds of vegetation do you desire? Consider colors and appearances at different times of the year.
- 3. Determine How Much Money You Want to Spend**
- 4. Develop a Design:** Consult references, visit gardens and landscapes that you are attracted to, and start drawing out your ideas.
- 5. Prepare garden/landscape site** according to your design and specifications.

[Learn More from MN DNR](#)⁴⁸



Home Exteriors

Choosing Plants

Deciding which plants to use in your landscape design depends on both your location and the goals you want your landscaping to achieve. First off you'll want to ensure that the plants are suited to your climate. [Northern Gardening](#)⁴⁹ has a detailed list of cold-climate plants that are well-suited to Minnesota. This can be done using the [Plant Hardiness Zone Map](#)⁵⁰. The map divides the country into zones based on average minimum temperatures for that region. Central and Southern Minnesota fall into zones 4A and 4B with average minimum temperatures between -20 and -30 degrees F. To find your exact hardiness zone, simply type your zip code into the interactive map. When searching for plants to use, be sure that their hardiness zone matches yours. That way you know that your plants will have a good chance of surviving the winter.

As you look at the different types of plants, you'll want to consider many factors such as sustainability, edibility, and water consumption. For example, are you hoping to grow food to eat or attract birds and butterflies or are you hoping to spend as little time as possible tending to your yard? Are you concerned about how much water and fertilizer your yard will need? Depending on your overall goals, you may consider a wide variety of plants, including fragrant plants, edible plants, native plants, ground covers, pollinators, nitrogen fixers, and pest deterrents.

Landscape with Native and Adaptive Plant Species

Native (indigenous) plants grow naturally in our region and typically require little water and care. Adaptive plants are those that grow successfully in our region and do not invade native ecosystems. Using native and adaptive plant species in your landscaping plan can be beautiful, cost-effective, and require less maintenance all while promoting biodiversity.

Water quality: The extensive root systems of native plants help to hold soil thereby reducing erosion and slowing runoff. Native plants also have the ability to absorb chemicals, such as nitrogen and phosphorous, which can reduce water contamination. Because they are better adapted to the climate and soil, native plants also require less chemical treatment.

Biodiversity: Native plant species provide food and shelter for wildlife, including beneficial insects, pollinators, and native birds.

Reduced Maintenance: Native plants are typically very low in maintenance because they are already well-adapted to the environment. Grass is a good example of this. Almost all grass lawns are planted with non-native species that require significant maintenance and irrigation. Landscaping with drought-tolerant plants or establishing a low-maintenance lawn can erase watering needs completely as described in this article on [Cool Season Grass Selection](#)⁵¹. The article also provides a table that categorizes grass varieties based on maintenance level, watering needs, mowing frequency, and fertilizer requirements. Before reseeding or sodding your lawn with these species though be sure to check your city's ordinances on lawn length and other landscape regulations. Here are more resources you may find helpful:

- [Learn About](#)⁵² native plants and their use in creating sustainable landscapes.
- Explore native and recommended plant species at www.minnesotawildflowers.info and <http://www.morningskygreenery.com/>.
- Purchase native plants from local growers. Find a local nursery [here](#)⁵³.

49) www.northerngardening.com

50) planthardiness.ars.usda.gov/PHZMWeb/InteractiveMap.aspx

51) www.extension.umn.edu/garden/landscaping/maint/coolseas.htm

52) www.extension.umn.edu/garden/yard-garden/landscaping/native-plants-for-sustainable-landscapes/

53) www.dnr.state.mn.us/gardens/nativeplants/suppliers.html

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Planting for Pollinators

Pollination happens when wind, water, or wildlife carry pollen from the male part of a flower to the female part. Almost 90% of the world's flowering plant species rely on animal pollinators. Pollinators provide food—nutritious fruits, vegetables, and nuts—to both humans and other wildlife, they create stable environments by pollinating plants that stabilize soil and prevent erosion, and they can help sequester carbon and other chemicals. These plants can also add aesthetic value to your landscape plan. Find out more about Minnesota's pollinators [here](#)⁵⁴.

Butterflies: Butterfly gardens use a combination of colorful flora and ornamental rocks to attract, feed, and provide shelter for butterflies, including endangered monarchs. To learn more about creating a beautiful landscape feature that benefits nature visit [Monarch Watch Website](#)⁵⁵. You can also find a list of native plants that attract butterflies [here](#)⁵⁶.

Bees: To help attract honeybees (we depend on them to pollinate much of our food) consider planting native flowers in larger swaths of color. This will help combat Colony Collapse, a disorder that has led to a large decline in the honeybee population. Learn more about gardening to attract bees [here](#)⁵⁷ and find a list of native plants that attract bees [here](#)⁵⁸.

Birds: Use shrubs, fruit and seed-bearing trees, and a variety of native flowers to attract songbirds and hummingbirds right to your back window! Trees and shrubs will provide shelter, while their fruit, seeds, and sweet nectar will provide food to keep the birds coming back. Trees offer a great alternative to traditional feeders, which have been shown to disrupt migration patterns due to overfeeding in the winter months. Find a list of native plants that attract birds [here](#)⁵⁹.

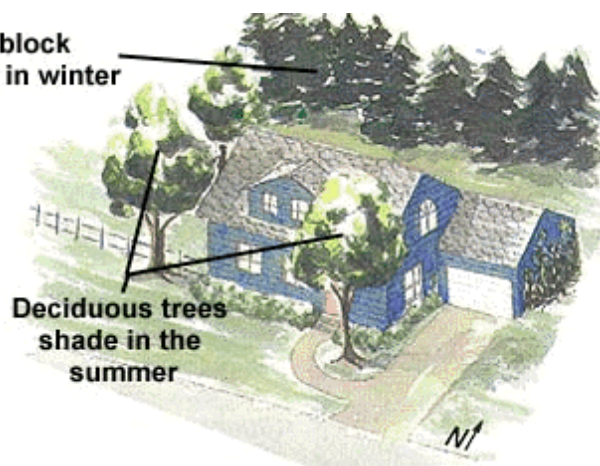
Check out the [Pollinator Partnership](#)⁶⁰ to find more information on pollinators, pollinator plants, and how to plant them.

Locating Plants

Situating your plants is just as important as choosing them. Your landscape plan should be both aesthetically pleasing but also contribute to proper drainage, climate control, and productivity. For example, you can use deciduous trees and shrubs to block the hot summer sun on the south and southwest sides of your home to reduce cooling costs. Evergreens on the west and north sides of your home will help block the cold prevailing winter winds to reduce heating costs. Be careful not to plant large trees too close to your home, utilities, sidewalks, or other trees. AND always call Gopher State One Call

(1-800-252-1166) **48 hours before you dig or do any yard excavation** to locate underground utilities such as electric, gas, and telephone. Visit Gopher State's [Website](#)⁶¹ for more information.

Evergreens block
north winds in winter



Deciduous trees
shade in the
summer

54) www.dnr.state.mn.us/pollinators/index.html

55) www.monarchwatch.org/garden/

56) www.morningskygreenery.com/index.php?cPath=47_49

57) www.ecologicalgardening.net/2013/07/flowering-plants-that-native-bees-love.html

58) www.morningskygreenery.com/index.php?cPath=47_55

59) www.morningskygreenery.com/index.php?cPath=47_50

60) pollinator.org/guides.htm

61) www.gopherstateonecall.org/

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Home Exteriors

Permaculture

Permaculture is a design strategy in which multiple plants of differing characteristics are grown close together in *polycultures* so they benefit each other. For example, a nitrogen fixer might be grown close to a pest confuser – the nitrogen fixer would improve the fertility of the soil and the pest confuser would deter harmful pests. Permaculture also allows for increased productivity and plant variety, it can reduce maintenance needs, it can lessen the impact of pests, and it can even alleviate worries about weeds.

Permaculture is especially useful when it comes to edible landscaping. Edible landscaping, especially when paired with organic gardening practices, can enhance your yard, garden, or landscape. Vegetable gardens can easily be integrated into your landscape to provide a safe and nutritious food source for your family.

For information on permaculture design, landscaping, and choosing the right plants for your specific climate, sun, soil, aesthetic, and functional requirements, check out the [Natural Capital Plant Database](#)⁶². You can also [Learn more](#)⁶³ about Permaculture at the Permaculture Institute.

Irrigation and Water Management

The design of your yard or landscape has a large impact on water management. The plants you choose may reduce irrigation needs as well as help to reduce erosion, runoff, and water contamination. Water collection, absorption, and diversion systems can also help manage stormwater and keep it from polluting water systems.

Irrigation

If you can't avoid watering, it's important to properly manage your water use. There are many ways to conserve water in your yard but you can start by choosing the right plants and using the right type of irrigation system.

Choosing the right plants. Native plants can significantly reduce the need for fertilization and irrigation so choosing the right vegetation is important. For tips on planting to conserve water, check out the [WaterSense Website](#)⁶⁴.

Timing. For a healthier lawn and to save on water bills, avoid watering until around Memorial Day unless your yard shows signs of stress due to lack of rain or abnormally high temperatures in May. Automatic timers will also help you optimize your irrigation. Watering during mid-day results in greater water loss due to evaporation so it's best to irrigate between 4 am and 8 am or between 4 pm and 9 pm. WaterSense also offers irrigation controllers and rainfall shutoff devices designed to use local weather data to determine when and how much to water. [Learn More](#)⁶⁵ about Irrigation Controllers.

Sprinkler Heads. Certain types of sprinkler heads apply water more efficiently than others. Rotary spray heads deliver water in a thicker stream than mist spray heads, which means more water reaches your plants and less is lost to evaporation and wind.

62) permacultureplantdata.com/

63) pricoldclimate.org/

64) www3.epa.gov/watersense/outdoor/what_to_plant.html

65) www3.epa.gov/watersense/products/controltech.html

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Home Exteriors

Micro/Drip Irrigation. Drip irrigation is more efficient than conventional sprinklers because it requires less water and delivers the water directly to your plants' roots. These systems use 20 to 50% less water than conventional sprinkler systems and can save up to 30,000 gallons per year. Because they apply the water directly to the plant roots, loss to wind, runoff, and evaporation is minimized. [Learn More](#)⁶⁶.

Work with an EPA [WaterSense Certified Professional](#)⁶⁷ to design and install an efficient irrigation system.

Stormwater Management

Your landscape can also be designed to help manage stormwater and runoff from and around your home. By making sure the ground slopes away from your home and that the landscaping is the proper distance from the foundation, you can prevent basement leaks and flooding. Here are more tips and strategies to manage rainfall in a beneficial way.

Use a Rain Barrel and/or Cistern to collect and store the rainwater that comes off your roof. They are used to either slow runoff water or to collect and store rainwater for irrigation purposes and can be purchased ready-made at home and garden stores or you can make something yourself.

Rain Barrels: A rain barrel is usually put on up cinder blocks or on a stand to increase water pressure. Direct your downspout into the barrel to collect water for your use. Barrels have a spigot for water usage near the base and an overflow valve ideally draining to a rain garden or existing storm sewer system. [Learn More](#)⁶⁸. Learn how to build your own Rain Barrel [here](#)⁶⁹.

Cisterns: Cisterns are large tanks that store rainwater collected from impervious surfaces (most commonly rooftops) for domestic uses or consumption. They can help manage stormwater by reducing peak runoff volumes because instead of entering stormwater sewer systems, the water is collected for home use. This lowers the cost, energy, and resources associated with cleaning and treating stormwater.

Domestic uses of cistern water include flushing toilets, watering gardens, or doing laundry. The water collected in cisterns can also be used as drinking water. However, the design must ensure that the water is safe and free of contaminants.

Careful consideration must be taken for cisterns that contain drinking water. The roof must be made of galvanized steel or aluminum to prevent build-up of organic solids. Also, the area must be devoid of trees to prevent leaves, twigs, insects, and bird feces from landing on the roof. The water should be filtered before entering the cistern.

Many cisterns are situated above ground and positioned to collect runoff from the roof. Some cisterns though are concealed underground to mitigate the effects of temperature changing and limit the access of insects and animals. When designing or installing a cistern there are several things to consider. First, be sure there is an overflow pipe to prevent the cistern from overflowing. Also, you'll want your cistern to be cylindrical in shape and lined with a plastic membrane to prevent any part of the tank structure from fracturing and dissolving in the water. Some models will be equipped with a pump for delivering the water to where it is needed. [Learn More](#)⁷⁰.

66) www3.epa.gov/watersense/outdoor/tech.html

67) www3.epa.gov/watersense/findapro/

68) www.marc.org/Environment/Water-Resources/Landscaping-and-Lawn-Care/Rain-Barrels

69) www.marc.org/Environment/Water-Resources/Landscaping-and-Lawn-Care/Rain-Barrels/How-to-build-a-rain-barrel

70) www.esf.edu/ere/endreny/GI-Calculator/CisternsIntro.html

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Home Exteriors

Be aware that your roofing materials may affect the quality and safety of the water that flows into your water collection system. Chemicals used in or to preserve roofing can leach into rainwater, which is not an issue if used on trees or flower gardens, but may present problems in vegetable gardens. Roofs made from lead-free metal or clay tile have little to no impact on quality of water collection, however, wood shakes and shingles, fiber cement shingles, rubber and plastic shingles, and asphalt shingles all may leach chemicals into runoff water.

Rain gardens are shallow, planted depressions that collect rainwater runoff and allow it to infiltrate soil and disperse more slowly, which can help combat erosion and filter out toxins. Traditional designs typically encourage rainwater to leave your yard quickly, running off grassy lawns into ditches and culverts, but when water moves quickly, it takes with it soil particles, valuable nutrients, and toxins detrimental to streams and larger bodies of water. Also, since the rain gardens drain water rather than hold it, standing water is not an issue during an average rainfall.

As you plan where to put your rain garden, look for a naturally low point in your yard or the place that was designed to collect runoff from your driveway or roof. Next, test your soil infiltration rate to make sure the spot you have chosen will drain properly. Once you have the site and have dug the garden, select a variety of native plant species that can tolerate and thrive in moist soils. You'll notice that many of these native plant species are the same ones that attract birds and butterflies!

Here are a few useful resources for creating rain gardens:

- [Guidelines and restrictions](#)⁷¹
- [List](#)⁷² of rain garden plants and their characteristics from the University of MN Extension
- [Blue Thumb](#)⁷³ Website
- [Maplewood Design Guide](#)⁷⁴
- [Mid-America Regional Council](#)⁷⁵ rain gardens
- To see previous designs, check out the City of Maplewood, [MN Rain Garden Designs](#)⁷⁶

Drain tiling is an underground drain system that is often used behind retaining walls or near foundations to absorb and distribute excess groundwater. This type of system uses a perforated pipe buried beneath layers of different size rock to collect water and direct it to rain gardens, bio-swales, or culverts, which can be designed to appear as a dry streambed or an edging rock garden.

Shoreline and Erosion Control For homes near lakes and streams, shoreline and erosion control are important landscaping strategies necessary to preserve the quality of Minnesota's many water bodies. Since shoreline restoration involves dealing with complex and sensitive ecosystems, it's important to consult a professional before doing any shoreline work. Learn more at the Minnesota Department of Natural Resources' interactive [Restore Your Shore](#)⁷⁷ website.

71) www.extension.umn.edu/environment/shoreland/lake-home-and-cabin-kit/docs/raingarden.pdf

72) www.extension.umn.edu/garden/yard-garden/landscaping/best-plants-for-tough-sites/docs/08464-rain-garden.pdf

73) www.bluthumb.org/raingardens/

74) www.ci.maplewood.mn.us/DocumentCenter/View/247

75) www.marc.org/Environment/Water-Resources/Landscaping-and-Lawn-Care/Rain-Gardens

76) www.ci.maplewood.mn.us/1035/Designs

77) www.dnr.state.mn.us/restoreyourshore/index.html

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Home Exteriors

Lighting

When lighting your yard, there are many factors to consider, including your intention for lighting, where to put your lights, the energy efficiency and cost of the lights, and how the lights will be installed. For an intensive look at lighting options, check out this design guide on [How to Illuminate Your Yard with Landscape Lighting](#)⁷⁸.

Paving Solutions

Individual hardscapes, roofs, and roadways are big contributors to the “heat-island effect” (the warming of surfaces by the sun in urban areas), which then contributes to raised air temperatures and higher energy demands. The heat-island effect has also been shown to raise the temperature 5 to 8 degrees Fahrenheit above outlying areas, and, according to NASA-sponsored studies, is causing more rainfall and thunderstorms.

Choose the Right Material Because large areas of black asphalt pavement contribute greatly to the heat-island effect, select hardscapes that use a lighter color as these have a higher Solar-Reflectance-Index, which means the surface will absorb less of the sun’s energy on a hot day and help reduce contributions to the regional heat-island effect. [Learn More](#)⁷⁹.

If you’re repaving your driveway, adding sidewalks, or installing an outdoor living space, carefully consider your paving selection. The impervious materials typically used (asphalt and concrete) contribute significantly to both the quality and quantity of stormwater runoff. When planted areas are replaced with hard surfaces, the amount of space available to absorb rainwater is also reduced. Consider using a pervious paving solution, which is designed to allow for the percolation or infiltration of water into the soil below the pavement. They have many benefits including reducing stormwater runoff, replenishing groundwater, reducing flooding, and reducing water contamination. Pervious pavement materials (usually made from asphalt, concrete, or recycled materials) can be used for driveways, parking lots, sidewalks, decks, and patios. There are also a variety of patterns in which they can be laid. [Learn More](#)⁸⁰.

When pervious paving isn’t an option, consider recycled asphalt and concrete. Recycled paving materials require less dependency on raw materials harvested from vital ecosystems and consume fewer natural resources.

If you have landscape or pervious paver questions as you develop and implement your project, go to the [Minnesota Nursery and Landscape Association](#)⁸¹ to find a certified landscape professional who can answer your questions.

78) www.hgtv.com/design/outdoor-design/landscaping-and-hardscaping/how-to-illuminate-your-yard-with-landscape-lighting

79) www2.epa.gov/heat-islands

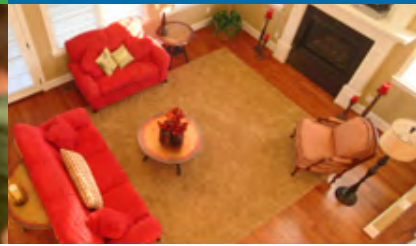
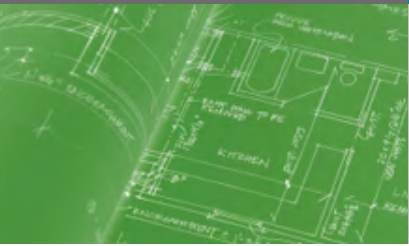
80) www.lakesuperiorstreams.org/stormwater/toolkit/paving.html

81) www.mnla.biz/

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Interior Of Your Home: Materials, Energy Use, and Appliances

The healthiness of the indoor environments where you spend most of your time is critical to your well-being. From wall and floor finishes to surfaces to energy use, there are many ways to make your home a healthier space for your family. In addition to having a healthier lifestyle and enjoying long-term savings, you'll also be helping our planet.

This section offers best practices for both small modifications to your home's interior as well as moderate improvements that may require a bit more effort but will be worth your while.

MATERIAL SELECTION

Green products are getting more attention and becoming more affordable. It is now fairly easy to remodel your home's interior using green techniques and materials.

Before you throw yourself into an interior remodeling project, one of the best things you can do for the environment and your family is to focus on eco-friendly materials and supplies. Not only are these materials better for the environment, but they also don't have various chemicals and additives that are commonly used during the manufacturing process. This can help improve the environment inside your home and help protect the environment outside your home. Fortunately, finding eco-friendly building materials is becoming easier all the time.

Reduce, Reuse, Recycle

Selecting interior finishes is often a very exciting step in a remodeling project since it's the material colors and textures that add character to a space and transform a house into a home. Interior finishes, however, can quickly become costly and some can pose health hazards or have unseen environmental impacts. Before you run to the home supply store for finish samples, take some time to look at what you can reuse or refurbish. The less you have to replace, the less you have to spend. Plus, by using fewer new materials and by diverting unnecessary waste from the landfill, you can reduce the environmental impact of your remodel. Consider reclaiming and re-purposing products from other locations in your home or salvage stores. For example, old wood floors could be refinished or re-purposed to become accent walls or a work surface!

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Only after you've exhausted all of your repairing, reusing, and re-purposing resources is it time to look at purchasing new materials. To find products that help you maintain a healthy indoor environment and reduce environmental impacts, it's important to educate yourself about the manufacturing process, durability, performance, and recyclability of interior finish products. Also look for items that can be recycled at the end of their life.

If you do find that your project will require you to remove and dispose of materials, be sure to identify proper disposal methods¹. If you hire a construction waste hauler, choose one that sorts and recycles waste. Be aware of city ordinances that mandate where and how certain waste is disposed. Separate recyclable, hazardous, yard, and landfill waste. Most counties have annual pick-up and drop-off points for appliances, organics, and hazardous waste products. Learn More².

A Healthy Home

Whether it's home, school, or work, Americans spend nearly 90% of their time indoors, but did you know that indoor pollutant levels can be two-to-five times higher than that of the outdoors? To avoid negative health impacts, we must be aware of our indoor environmental quality and do what we can to make it as healthy as possible. For example, a healthy home should not expose occupants to lead dust, fiberglass, or asbestos particles. Health problems can also come from exposure to radon, carbon monoxide (CO), or mold. In addition to mitigating specific issues like radon or lead, good indoor air quality can be attained by ensuring adequate ventilation and filtration, managing the moisture levels, and avoiding materials that off-gas Volatile Organic Compounds³ (VOCs).

Following is a list of things to be aware of in your home:

Asbestos is a mineral fiber that occurs in rock and soil used in construction and is used for its strength and heat resistance. It can be found in:

- Roofing shingles
- Ceiling and floor tiles
- Attic and wall insulation containing vermiculite
- Vinyl flooring
- Walls and floors around wood-burning stoves protected with asbestos paper millboard, or cement sheets
- Textured paint and patching compounds used on wall and ceilings
- Hot water and steam pipes coated with asbestos material or covered with an asbestos blanket or tape
- Asbestos can cause lung disease and cancer. The best course of action is to avoid disturbing these materials during remodeling, but if they must be disturbed, engage expert help to avoid risk of accidental exposure. Learn More⁴.

1) www.cityofroseville.com/436/Recycling
2) ramseyatoz.co.ramsey.mn.us/pages/default.aspx
3) www.epa.gov/indoor-air-quality-iaq/volatile-organic-compounds-impact-indoor-air-quality
4) www.lung.org/our-initiatives/healthy-air/indoor/indoor-air-pollutants/asbestos.html



Interior Of Your Home: Materials, Energy Use, and Appliances

Carbon Monoxide (CO) is an odorless, colorless gas formed by the incomplete combustion of fuels. When people are exposed to CO gas, the CO molecules will displace the oxygen in their bodies and lead to poisoning. Common sources of CO in the home include furnaces or boilers, gas stoves and ovens, fireplaces, water heaters, clothes dryers, wood stoves, power generators, motor vehicles, power tools and lawn equipment, and tobacco smoke. Because CO has no odor, color, or taste, it cannot be detected by our senses and can build up in the home without detection. If exposure goes unnoticed, CO poisoning can lead to death. To prevent poisoning, be sure to install a CO alarm and properly maintain fuel burning appliances. [Learn More](#).⁵



Mold is a type of fungus that is present in our natural environment. Excess moisture is the critical factor in any indoor mold problem. Eventually, mold left unaddressed will damage what it is growing on and exacerbate respiratory health issues like allergies and asthma. Though it is most frequently found in finished basements, it may be found elsewhere in homes with poor moisture management or insulation problems. The key to preventing mold growth is to prevent moisture problems through proper insulation and ventilation. [Learn More](#).⁶

Lead is a toxic metal that was once regularly used in the manufacturing of common household products. The most common source of lead air pollution in homes is paints used before 1978. Exposure to lead is extremely dangerous and interferes with cognitive functions and brain development, especially in children. [Learn More](#).⁷

Radon is a colorless, tasteless, and odorless gas that forms when uranium breaks down to radium and then to radon. As it decays, radon releases radioactive byproducts that are inhaled and can cause lung cancer. Radon is emitted from the ground and enters a home through cracks in walls, basement floors, foundations and other openings. The best way to mitigate radon contamination is by ensuring your home is properly sealed. You may also need to install a radon ventilation system to remove high levels. [Learn More](#).⁸

5) www.health.state.mn.us/divs/eh/indoorair/co/

6) www.health.state.mn.us/divs/eh/indoorair/mold/

7) www.lung.org/our-initiatives/healthy-air/indoor/indoor-air-pollutants/lead.html

8) www.lung.org/our-initiatives/healthy-air/indoor/indoor-air-pollutants/radon.html

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Interior Of Your Home: Materials, Energy Use, and Appliances

VOCs (Volatile Organic Compounds) are pollutant gases that can be released from building materials over the entire lifetime of the product including during application, storage, and removal. VOCs are found in paints and coatings, adhesives, furniture, composite wood products, carpet, flooring, and other products. Exposure to VOCs can irritate eyes, nose, throat, and skin, cause allergies, or aggravate asthma. Respiratory problems, headaches, nausea, and organ and central nervous system damage are side effects of excessive exposure to VOCs. Tobacco smoke, moisture, and mold are hazardous to indoor air quality. To prevent VOC exposure, look for products labeled “No VOCs” or “Low VOCs.” Also, be sure to keep your home properly ventilated. [Learn More](#)⁹.

Use the [Minnesota Green Communities](#)¹⁰ “[Choosing a Healthy Home Checklist](#)”¹¹ to identify and assess the exterior and interior of your home.

*Integrated Pest Management
Cockroaches, dust mites, rodents, and other pests are living in or trying to get into your home for food, water and warmth. Rather than use pesticides that are harmful to both human and environmental health, you can prevent infestations by sealing around cracks, crevices, and openings around wall/ floor/roof penetrations. Use materials such as caulk or expanding foam insulation to seal smaller openings. For larger openings, use copper mesh (not steel wool) to plug holes. Boric acid is recommended as low-toxicity insecticide; use only in areas that cannot be accessed by pets or children such as wall cavities, behind counters, and under cabinets. The [Natural Resources Defense Council](#) website provides more information on integrated pest solutions.*

Paints, Coatings, Adhesives

There are a variety of paint, wood coating, and adhesive products available. Look for Green Seal or MPI products, and choose products with the lowest VOC levels possible. Whenever possible, use water-based or latex paints; plant-based paints can also be a good option. While some plant-based paints contain terpenes, which is a VOC derived from plants, these paints will not contain toxic pigment products or use herbicides or fungicides during production. By using the following chart, you can verify that the product you have chosen contains less than the maximum grams per liter of VOCs. Products that meet these standards use fewer toxic solvents and have less potential to off-gas harmful chemicals into your home.

Product	Maximum VOC limit (grams per liter)
Paints (including pigments)	50 g/L
Floor sealants	100 g/L
Anti-corrosive coatings	250 g/L
General adhesives (for indoor use)	50 g/L

9) www.lung.org/our-initiatives/healthy-air/indoor/indoor-air-pollutants/volatile-organic-compounds.html

10) www.mngreencommunities.org/resources/index.htm

11) mngreencommunities.org/publications/download/HealthyHome_checklist.pdf

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Interior Of Your Home: Materials, Energy Use, and Appliances

Navigating Product Labels

When purchasing paints and coatings, look for the Green Seal¹² logo or the GreenGuard¹³ Indoor Air Quality Certified logo to ensure your product meets emissions standards. These third-party organizations set and verify standards for finish products. Measured in grams per liter (g/L), maximum VOC limits are set by paint finish type.

Many rating programs and standards exist for determining safe VOC limits for sealants and adhesives used in and around our home during construction practices. The USGBC's LEED 2009 Rating System¹⁴ recognizes multiple program standards to form their acceptable maximum VOC values:

Architectural Applications	VOC Limit (g/L less water)	Specialty Applications	VOC Limit (g/L less water)
Indoor carpet adhesives	50	PVC welding	510
Carpet pad adhesives	50	CPVC welding	490
Wood flooring adhesives	100	ABS welding	325
Rubber floor adhesives	60	Plastic cement welding	250
Subfloor adhesives	50	Adhesive primer for plastic	550
Ceramic tile adhesives	65	Contact adhesive	80
VCT and asphalt adhesives	50	Special purpose contact adhesive	250
Drywall and panel adhesives	50	Structural wood member adhesive	140
Cove base adhesives	50	Sheet applied rubber lining operations	850
Multipurpose construction adhesives	70	Top and trim adhesive	250
Structural glazing adhesives	100		
Substrate Specific Applications	VOC Limit (g/L less water)	Sealants	VOC Limit (g/L less water)
Metal to metal	30	Architectural	250
Plastic foams	50	Nonmembrane roof	300
Porous material (except wood)	50	Roadway	250
Wood	30	Single-ply roof membrane	450
Fiberglass	80	Other	420
Sealant Primers	VOC Limit (g/L less water)		
Architectural, nonporous	250		
Architectural, porous	775		
Other	750		



Notice: If you find something labeled "natural" or "organic," use caution when purchasing. "Natural" is an unregulated term that can be applied to anything and "organic" applies to food and agriculture practices only.

Always use proper caution and protection when applying finishes. Follow manufacturer recommendations, allow proper drying time, and wear protective clothing.

If you cannot find a certified product, read the label for VOC quantity (which is the VOC for the base paint). Also, be aware that added colorants can increase VOC levels so be sure to ask the paint dealer what the total VOCs will be after the pigment is added. If mixing your own colors, choose the lowest VOC content possible for your base and confirm the VOC impact of adding colorants. Consumers can ask a paint dealer to show them paint that remains low VOC once the pigment is added. There are also manufacturers that are converting to a no-VOC pigment system.

12) www.greenseal.org/Home.aspx

13) greenguard.org/en/CertificationPrograms/CertificationPrograms_indoorAirQuality.aspx

14) www.usgbc.org/resources/adhesives-sealants-and-sealant-primers-voc-limits-ieqc41

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Interior Of Your Home: Materials, Energy Use, and Appliances

Floor Finishes

When considering flooring options, you'll want a product that will create the aesthetic you desire, will withstand the wear from everyday use, and will contribute to an overall healthy indoor environment. Regardless of the product, all flooring will impact your home's indoor air quality both during installation and throughout the life of the product. For example, hard-surface floors like wood or tile are finished or sealed with materials that may emit or "off-gas" unsafe vapors. Carpeting off-gasses too, but it also collects household particles like dust mites, pollen, pet dander, moisture, and dirt, which can lead to allergies. Carpeting can be particularly problematic when used in bedrooms of people with asthma.

REDUCING YOUR CARPETING

One of the easiest things to do to improve your indoor environmental quality is to minimize the amount of carpet in your home. While they may seem harmless, carpet fibers collect household particles like dust mite offal, pollen, pet dander, moisture, and dirt, which can lead to allergies. Explore a variety of solutions that provide alternatives to carpeting.

To ensure a healthier home, when replacing or refinishing flooring, choose products with third-party certification labeling. These programs ensure products bearing their label meet low-emission standards. For carpeting, the Carpet and Rug Institute's Green Label Plus¹⁵ logo is a good guide. For finishes, grouts, and sealants, use the Green Seal¹⁶ label and standards. The certifications will consider the following attributes:

- Waste reduction: reuse of materials that would have otherwise ended up in landfills
- **Recycled content**: reclaimed wood or recycled plastic
- Durability: increases a product's lifespan and significantly reduces the amount of resources needed to produce such products
- Locally-sourced
- Environmentally-friendly production: FSC-certified wood, low impact on the environment
- Third-party certified: FSC-certified wood, GreenGuard Indoor Air Quality, **SCS Recycled content**
- Healthy: low-VOC emissions, toxins, or pollutants
- Recyclable or compostable

In addition, look for products with multiple green attributes then the compare the number of green attributes each product has before making your final choice. For example, a polished concrete floor that contains **recycled content** has three green attributes (uses **recycled content** + reduces waste by being made in a form on site + eliminates the need for additional flooring materials), while porcelain or ceramic flooring has one attribute (durability).

Carpet

Though thousands of rolls of carpet are installed each year, carpet has one of the shortest lifespans of all flooring types because it wears poorly and needs to be replaced frequently. In fact, the immense, four-billion-pound waste stream from carpet disposal consumes nearly 2% of solid landfill waste space, and if carpet is burned, it releases dioxin and other chemicals into our air. Before installing carpet, be sure to first consider other options. If you do decide to go with carpeting, consider the composition, type of fiber, and the effect of the **off-gassing**.

15) www.carpet-rug.org/CRI-Testing-Programs/Green-Label-Plus.aspx

16) www.greenseal.org/GreenLiving.aspx



Interior Of Your Home: Materials, Energy Use, and Appliances

Carpet Composition and Type

Carpet itself is composed of two parts: the carpet fiber (either pile or loom to form various textures and patterns) and the backing material. A third component of carpeting is the separate layer of padding that is installed beneath carpet to add cushion and to extend the life of the carpet. A fourth element is the stain guard, which may contain carcinogens that could have adverse health effects. Each one of these four components can also off-gas VOCs into your home. VOC levels are typically higher at the time of installation and can vary based on the type of carpet.¹⁷

One way to reduce the amount of carpet you have in your home is to use carpet tiles or area rugs rather than traditional wall-to-wall carpet. Carpet tiles have several advantages: they are easier to clean, the individual tiles can be replaced, and the variety of installation patterns and textures can also disguise what would be visible in wall-to-wall rolled carpet. Area rugs also offer the comfort of carpet but can be cleaned and replaced much more easily. Learn More.¹⁸

Natural Fibers and Recycled Content

Carpets made from natural fibers such as wool and jute off-gas less, however, there is ongoing discussion about whether they have a lower environmental impact when compared to man-made fiber because of the heavy metals used in some wool dyes and the washing process required to clean wool. One clear advantage, though, is that both the backing and carpet fiber made from natural fibers are compostable at the end of the carpet's life.

If you do install carpet, look for carpets that contain **recycled content** and can be recycled at the end of their life. Carpets that contain **recycled content**, especially post-consumer content (like plastic bottles), help provide markets for various materials that would otherwise be wasted and saves natural resources from being used to make carpets. Companies are also beginning to offer programs to recycle old, worn-out carpet. These carpet reclamation programs can help prevent some of the four billion pounds of carpet waste generated annually in the U.S. from ending up in the landfills. Learn More¹⁹ about reducing carpet waste.

In 2008, an estimated 1.285 million tons of carpet was buried in California landfills. Some carpets are made from fiber that is more readily recycled than others. One can look at today's carpet recycling industry to better understand if your carpet will be recyclable when it is time to replace it. Currently nylon fibers have the highest economic value in the recycling process and are highly desired for this reason.

Indoor Air Quality

While it may seem harmless, carpet fibers collect household particles like dust mites, pollen, pet dander, moisture and dirt, which can result in poor indoor air quality and lead to allergies. This is especially true in bedrooms of people who have asthma. To reduce the chance of developing poor indoor air quality, avoid using carpet in spaces like bathrooms, kitchens, dining rooms, or entry areas that are prone to moisture. Also avoid basements and concrete slabs on grade where carpet and carpet padding can trap moisture wicking up through the slab and cause condensation under the carpet, which can lead to mold and bacteria growth.

17) www.carpet-rug.org/carpet-for-the-home/selecting-the-right-carpet/carpet-and-rug-construction.aspx

18) www.nchh.org/Portals/0/Contents/CarpetsHealthyHomes.pdf

19) www.calrecycle.ca.gov/Carpet/PreventWaste.htm

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Interior Of Your Home: Materials, Energy Use, and Appliances

If you do choose to install wall-to-wall carpeting, make sure it is Green Label/Green Label Plus certified. Products with the Carpet and Rug Institute's Green Label and Green Label Plus²⁰ logo have met low emission standards for carpets, adhesives, and cushions (carpet padding). Also carefully consider stain protection products applied to your carpet. And don't forget to count the product's green attributes before making your final decision. The possible attributes are these: **recycled content**, locally-sourced, environmentally-friendly production, third-party certified, healthy, recyclable or compostable.

Wood and Wood-based Flooring

Local Sourcing

Because of its durability, many people think that wood flooring is always the best choice and many times it is. But before choosing a wood flooring product, you'll want to look at where the material came from and how the forest it was taken from is managed.

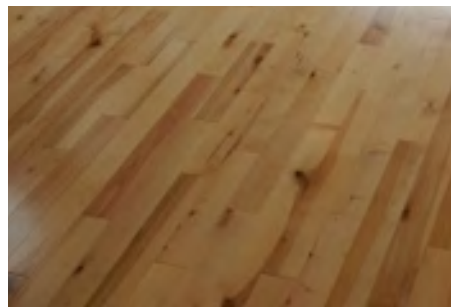
Buying a product that is harvested from near where you will be using is often ideal because local sourcing supports the local economy and lessens the environmental impacts of product transportation. But local sourcing isn't the only consideration. You should also be aware of the renewability of the material, the harvesting practice, and the manufacturing process.

Renewable materials are resources that can be naturally grown and harvested in a period of ten years or less. This is important because it reduces the demand for products made from limited supplies of raw materials, like mining or quarries. Responsible forestry management is also important in order to maintain our wood resources and lessen the ecological impact caused by over harvesting. Using products that require long-term growth and are harvested before they can mature and reproduce can have damaging environmental impacts such as loss of biodiversity, erosion, and flooding.

Whenever you are in the market for wood products – not just floors but doors and windows too – be sure to purchase FSC certified wood products.

Solid Wood

Many people like wood floors because of their durability, ease of cleaning, and the aesthetic appeal. Although wood floors are often the right choice for many parts of your home, there are places (bathrooms, basements, or on concrete slabs) where a wood floor is not the best option because of its susceptibility to shrinkage and expansion.



Most solid wood floors are made entirely of milled lumber planks, however, some solid wood floors are made of reclaimed wood, which can include things like old timber, siding, flooring, or logs. Reclaimed wood products can be just the right choice if you want to add character to your home, and using reclaimed wood has the added benefit of reducing the depletion of natural resources. Rather than sending the wood to the landfill, some manufacturers “rescue” the wood products and remanufacture them into wood flooring and other home finish products.



Interior Of Your Home: Materials, Energy Use, and Appliances

Perhaps the biggest advantage to a solid wood floor is its durability because the flooring itself won't wear out for decades if finished properly. The only part of the floor that may need attention is the finish, which can be redone when needed. With normal wear, a wood floor will typically need to be refinished every 15 to 20 years. The initial installation can also be more advantageous when compared to other flooring options since solid wood can be installed using just nails. If an adhesive is necessary to secure the flooring to the **subfloor**, be sure to pay attention to the VOCs to reduce the potential for **off-gassing**.

Regardless of which wood flooring option you choose, many finishing products release VOCs that can negatively impact your health. For this reason, it's important to use Green Seal certified water-based finishes.

As with other options, be sure to evaluate the possible green attributes, which are waste reduction, **recycled content**, durability, locally-sourced, environmentally-friendly production, third-party certified, healthy, recyclable and compostable.

Engineered Wood

Thin layers (plies) of wood are glued together to compose engineered wood flooring. The layering process of gluing hardwoods together – sometimes as many as 10 plies—contributes to greater strength than solid wood. Engineered wood is less susceptible to shrinkage and expansion, which allows it to be used in moisture-prone areas such as bathrooms and raised flooring in basements.

As a layered product, some engineered wood can be refinished while some can only be recoated, depending on manufacturer and stated warranty.

If you are thinking about using engineered wood, consider the VOC of the glues used during manufacturing and installation.

Engineered wood has several potential green attributes including waste reduction, **recycled content**, durability, locally-sourced, environmentally-friendly production, third-party certified, and healthy.

Other Wood-based Flooring

Renewable materials such as cork, bamboo, and poplar wood are also being used in flooring products and have many advantages. Cork flooring is appreciated because it is easily cleanable, has very low **off-gassing**, and it is durable. Bamboo is liked because it is extremely durable but it's also very lightweight. The biggest drawback to cork and bamboo, however, is that they are typically shipped from overseas so the energy used to transport the materials impacts the environment and can add to the cost. One option that avoids those drawbacks is fast-growing hybrid poplar trees, which are grown all across the U.S. Many people also like poplar because it has the look of traditional hardwood flooring and it is often used in wood fiber products such as OSB and fiberboard.



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Laminate Flooring

Although laminate flooring is meant to look like real wood, stone, or other natural flooring materials, it is actually a photographic image that has been printed and layered into the flooring material. Laminate floors have a finish or wear coat, an image layer to get the look of a desired flooring material, a laminate layer made mostly of resins, and typically a backing layer that acts as a moisture barrier. Because the inner layer is a resinous, pressure-treated laminate product, VOC **off-gassing** can be an issue and because the glue used to apply the laminate to the **subfloor** may off-gas, be sure to look for low or no-VOC adhesive products to minimize the impact of the VOCs.



As with other flooring materials, laminate is not the perfect choice for some areas of your home such as high-traffic areas because the finish or wear coat can't always be refinished or repaired. Before deciding on laminate flooring, it's best to read the care instructions and the manufacturer's warranty. Despite its limitations, laminate flooring does have the following potential green attributes: locally-sourced, third-party certified, and healthy.

Porcelain and Ceramic Flooring

Made from fired clays and available in a seemingly infinite selection of colors and textures, ceramic tile is a great flooring option in terms of cost. While the manufacturing process is energy-intensive, it's a very durable product.

Consider **recycled content** when selecting a ceramic tile. Recycled glass is often added to tiles to create flecks of color, and sometimes tiles are made entirely of glass. Kaolin, a form of weathered feldspar and a byproduct of mining, is also a common source of **recycled content** in ceramic tiles. Many manufacturers have been using **recycled content** in their products for years. **Recycled content** tiles are also competitively priced. The higher the **recycled content**, the better. This means more waste is diverted from landfills and less virgin material is extracted to make a new product. Ceramic tile can also be recycled at the end of its life. It is often ground up and used as fill material.



Adhesives, grouts, and sealants used to apply and protect tile installations can contain VOCs so look for Green Seal, Green Guard or Scientific Certification Systems²¹ certifications on these products to ensure they are Low- or No-VOC. Make sure that adhesives, sealants, and grouts are applied properly and maintained to prolong the life of your tile installation. Over time, grout can soften and crack. Optimize the life of your grout by re-grouting any cracks or chips and resealing every two or three years (if not using epoxy grout). Clean regularly but avoid the use of abrasive or acid-based cleaning products such as bleach or ammonia.



These floors have several potential green attributes including waste reduction, **recycled content**, durability, locally-sourced, and healthy.

21) www.scsglobalservices.com/certified-green-products-guide?scscertified=1

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Interior Of Your Home: Materials, Energy Use, and Appliances

Linoleum and Rolled Flooring

Historically, the term linoleum referred to an environmentally friendly resilient flooring option made from linseed oil, wood flour, cork dust, and resins applied over a jute, burlap, or canvas backing. Over time, the name linoleum also came to refer to vinyl sheet flooring. Here, we reserve linoleum for non-vinyl products. Linoleum has several qualities that make it very desirable as a flooring option. It is extremely flexible, which makes it easy to cut and inlay, which can create a variety of patterns and color combinations. It also comes in a wide variety of colors, and because the color goes through the entire thickness of the product, linoleum hides gouges and scratches well.



When well maintained, linoleum can last nearly 40 years, but it does require regular application of a sealer or topcoat to maintain wear strength. Refinishing products can contain VOCs so look for products that have been Green Seal certified to protect your health. As an added benefit, linoleum flooring is naturally anti-bacterial and it's biodegradable at the end of its lifecycle. Look for Floor Score²² labeled products for improved indoor air quality.

Linoleum, though sometimes hard to find, has several potential green attributes: waste reduction, durability, locally-sourced, environmentally-friendly production, third-party certified, healthy, recyclable and compostable.

Vinyl

A popular competitor to linoleum flooring is vinyl flooring. Like linoleum, vinyl is available in tile or sheet form but unlike linoleum its manufacturing involves chlorides (hence PVC) and petroleum-based resources. It also releases dioxin -- a potent and damaging greenhouse gas -- during the manufacturing process through the life of the product and if it is incinerated in at the end of its lifecycle. Sheet vinyl also tends to crack and dry as it ages over time and its color and pattern are on just a top layer so it is not as durable as linoleum. One other drawback is that the installation of vinyl requires adhesives and sealants that can release VOCs.

Although a vinyl floor is nearly maintenance free, its highly toxic manufacturing and disposal process, extreme flammability, and relatively fast degradation mean it is a poor choice in terms of sustainability.

Composition Tile (VCT/MCT/LCT)

Popular for its durability and low-cost, VCT (vinyl composition tile), is made of vinyl chips melted together; but, like vinyl tiles or sheet flooring, the manufacture of VCT releases dioxins into the atmosphere and VCT off gasses over its lifetime. In recent years, two new materials -- LCT (limestone composition tile) and MCT (marmoleum composition tile) -- have been developed that provide cost effective, environmentally friendly alternatives to VCT. LCT is made of 85% limestone and recycled vinyl chips and MCT is made only of natural linoleum. All three products are low maintenance and very durable when used in homes but all require adhesives be used during installation so be sure to look for low-VOC adhesives and Green Seal certified sealants when selecting these products.



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Surfaces

Whether you're looking for kitchen countertops, bathroom vanities, island worktops, or shelving solutions, you'll want the work surface to withstand the wear from everyday use. But you'll also want to choose a product that has as many green attributes as possible. Consider this example: a locally quarried granite countertop made from remnant scrap has three green attributes (local + durable + reused content) whereas a new slab of local granite has two green attributes (local + durable).

Look for products with multiple green attributes such as these:

- Waste reduction: reuse of materials that would have otherwise ended up in landfills
- **Recycled content**: reclaimed wood or recycled plastic
- Durability: increases a product's lifespan and significantly reduces the amount of resources needed to produce such products
- Locally-sourced
- Environmentally-friendly production: FSC-certified wood, low impact on the environment
- Third-party certified: FSC-certified wood, GreenGuard Indoor Air Quality, **SCS Recycled content**
- Healthy: low-VOC emissions, toxins, or pollutants
- Recyclable or compostable

Wood

Wood, especially local wood and FSC-certified wood, is a beautiful countertop option. Countertops can be made of any species. Many durable options, such as maple and walnut, can be sourced locally and can be refinished on site. Wood surface products should be FSC-certified to ensure they were produced using sustainable forestry practices and their finishes should be non-VOC and food-safe for use in kitchens. Refinishing or routine treatment with mineral oil or other recommended products may be required to prevent drying, warping, and staining of the wood. Wood products have many possible green attributes including these: durability, recycled, locally sourced, environmentally-friendly production, third-party certified, healthy, and compostable.

Linoleum

Another option is to seek out a natural linoleum countertop, which proved its worth as a countertop material prior to laminate being created. Historically, the term linoleum referred to an environmentally friendly resilient flooring material made from linseed oil, wood flour, cork dust, and resins applied over a jute, burlap, or canvas backing. Over time, the name linoleum also came to refer to vinyl sheet flooring. Here, we reserve linoleum for non-vinyl products.

Linoleum has several qualities that make it a good countertop material. It is extremely flexible, which makes it easy to cut and inlay, creating a variety of patterns and color combinations. It also comes in a wide variety of colors, and because the color goes through the entire thickness of the product, linoleum hides gouges and scratches well. When well maintained, linoleum can last nearly 40 years. It does require regular application of a sealer or topcoat to maintain wear strength. Refinishing products can contain VOCs so look for products that have been Green Seal certified to protect your health. As an added benefit, linoleum is naturally anti-bacterial and biodegradable at the end of its lifecycle. Linoleum's potential green attributes include durability, healthy, environmentally-friendly production, third-party certified, and compostable.

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Interior Of Your Home: Materials, Energy Use, and Appliances

Plastic Laminate

Plastic laminate products, which are made of a layer of decorative plastic glued over a plywood or composite base, are popular because of their affordability but their durability is limited, and there are concerns with VOC's from the glue in the composite wood as well as emissions from plastic production. A careful shopper, though, can find some good, cost-effective laminate products that have **recycled content** as well as FSC papers in the laminates. Many of these products are also GreenGuard-certified for low emissions. If you do decide on laminate, one adhered to a bio-based substrate or FSC paper that uses a low-VOC adhesive is a good, green option. Though not as good as other options, plastic laminates do have the following potential green attributes: low-emissions, environmentally-friendly production, and third-party certified.

Local and Remnant Stone

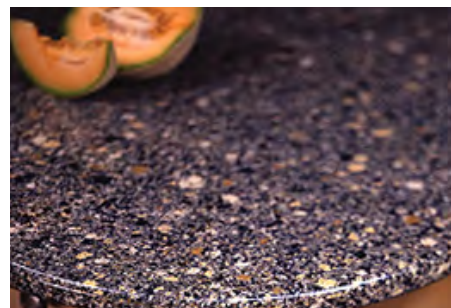
Stone work surfaces such as marble and granite are often desirable for their natural appearance and durability but they can be very costly and are subject to staining. If you choose natural stone for your countertops, research a variety of manufacturers and suppliers before you make your purchase and consider the effects of mining practices used to harvest the stone. Also try to find locally-sourced stone to reduce the environmental impact of transporting it. Depending on the size of your countertop, a remnant might be the way to go. Many fabricators (the companies that actually cut, polish, and install the product) have lots of remnant pieces that are often sold at a discounted rate making remnant a more cost effective option. When calculating the green attributes, consider the following: waste reduction, durability, locally sourced, healthy, and recyclable (recycling is currently an uncommon practice).

Concrete

Concrete countertops may sound like an odd concept for a kitchen counter – especially if you are imagining something similar to your basement floor -- but concrete can be stained, polished, or even combined with glass flecks to create a wide array of colors and finishes. This type of countertop can be either precast or formed and poured on-site. Known for durability, the overall performance of a concrete countertop relies on the finish used to seal it. Scratches, stains, and even the level of bacteria resistance will depend on the strength and porosity of the sealers. Although you'll want a high-quality seal, you'll also want to find a sealer that minimizes the VOCs released. As always, talk to your installer about using low- or no-VOC finishes whenever possible. Concrete countertops have the following potential green attributes: waste reduction, **recycled content**, durability, third-party certified, healthy, and recyclable.

Solid Surface Material

Solid surface materials and quartz, also known as engineered stone, are manufactured surfaces that resemble natural stone. Solid surface materials are made of a blend of processed clay material, alumina trihydrate, acrylics, and resins, which are cured in molds to a desired shape then often finished with a gloss. The glosses used can contain VOCs, so be sure to talk to your installer about your options. The same is true for some of the acrylics and resins used during manufacturing. Polishes can be subject to scratching over time, which can require refinishing. Solid surface countertops have several advantages over other products – they are less porous than laminates and often have additives to resist bacteria growth. They also can be refinished, and the material color and texture is through-body so it hides scratches and wears well.



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Quartz counter tops are made from quartz crystals that are combined with resins then cured in a mold to form the desired size and shape. The surface is then polished to form an extremely durable, scratch- and stain-resistant work surface. Quartz is non-porous and requires no refinishing. Its colors and textures resemble natural stone patterns. Quartz and solid surface products sometimes incorporate small quantities of recycled glass. Both types can be refinished on-site.

Both solid surface and quartz countertops have a number of potential green attributes including waste reduction (if cast to specification), **recycled content**, durability, third-party certified, and healthy.

Wood and Agrifiber Composites

Agrifiber surfaces are composite products made from processed fibrous raw material such as sunflower seeds, wheat, coconut shells, bamboo, and sorghum stalks. Although they are not appropriate for wet applications such as kitchen countertops, they can be a nice choice for cabinetry, other kitchen work surfaces, and for finish carpentry. Wood composites, which are more lightweight and competitively priced, are also becoming more readily available. If you do choose this type of product, spend time researching product reviews and warranties for durability. And as with any composite, look at the adhesives used to bind the material together – it should be low VOC or have no VOCs and have no added urea-formaldehyde. These products have the following potential green attributes: waste reduction, locally sourced, third-party certified, healthy, and compostable.



ENERGY USE AND APPLIANCES

Greener energy supplies may provide the cleanest electricity, but the first step to take is to minimize the energy you need before selecting an energy source. Reducing the amount of energy you use (conservation) is usually the smartest, most economical, and most environmentally-friendly action you can take. Whenever you save energy, you not only save money, you preserve clean air to breathe and you also reduce the demand for such fossil fuels as coal, oil, and natural gas. Less burning of fossil fuels also means lower emissions of carbon dioxide (CO₂), the primary contributor to global warming, and other pollutants.

To get started, take a look at your monthly electricity bill to see how much energy you are using, then determine if you can turn off any appliances or set them to automatically go into standby or hibernate mode when not in use. Also be aware of how you use lighting in your home – many times lights are left on for extended periods when they aren't needed. You can also install a programmable thermostat that you can adjust to best suit your comings and goings. If you are replacing appliances, be sure to purchase Energy Star® certified (high efficiency) appliances.



Interior Of Your Home: Materials, Energy Use, and Appliances

Insulation

With rising energy costs and a growing concern for our environment, it is important to address and correct all the ways our homes use or conserve energy. This will result in substantial savings and reduced environmental impact. One of the best ways to conserve energy in your home is to ensure that you have appropriate insulation in your walls, floors, and roof.

The natural tendency of heat is to move from areas of hot to areas of cold. In the winter, this can become a problem because all of the heat we are paying for to warm our homes wants to leach back into the cold outdoors. Insulation, however, is designed to keep that hot air from moving, thereby reducing the amount of energy required for comfort. Insulation is measured in **R-value**, or resistance to heat flow. The higher the **R-value**, the better the material is at keeping heat from leaving your home. You may also run into U-value when looking at insulation, which measures conductivity for an insulation assembly. This is basically the opposite of **R-value**. Low U-value = better insulator and high U-value = poor insulator. The more layers of insulation material you have, the better the insulation. Popular materials for insulation include fiberglass, wool-fiber, polystyrene, extruded polystyrene, and expanded polystyrene. For a comparative chart of insulation materials, see Chapter 3: Insulation Materials.

Understanding Utility Bills

There are simple things you can do to be more energy efficient and keep your energy costs down. Start by seeing how much energy you use by reviewing utility bills. Then begin monitoring how you use lighting, appliances, thermostats, and electronics to see where you are using the most energy. To estimate the amount of energy a specific electronic device uses, check out the [Appliance Energy Calculator](#)²³. You can also learn about what goes into determining your rates and get tips on how to improve energy conservation under the “[My Account](#)”²⁴ option for Xcel Energy or CenterPoint Energy’s “[Manage Your Account](#)”²⁵. Once you have all this information, you might want to set an energy savings goal that will reduce your utility bill!



Utility Rebates

Costs of upgrading your mechanical and utility systems can be offset by rebates available through government organizations, utility companies, and even product manufacturers. The [Database of State Incentives for Renewables and Efficiency](#)²⁶ (DSIRE) allows you to view available rebates and incentives from a variety of sources. The site links you to corresponding sites to guide you through the rebate process. [Contact Xcel](#)²⁷ or [CenterPoint](#)²⁸ to learn more about what rebate programs or tax credits might be available for your area.

23) energy.gov/energysaver/estimating-appliance-and-home-electronic-energy-use

24) myaccount.xcelenergy.com/oam/index.jsp

25) www.centerpointenergy.com/en-us/residential/customer-service/manage-your-account?sa=mn

26) programs.dsireusa.org/system/program?state=MN

27) www.xcelenergy.com/Energy_Solutions/Residential_Solutions/Rebates_&_Energy_Savings

28) www.centerpointenergy.com/en-us/residential/save-energy-money/efficiency-programs-rebates?sa=mn

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Interior Of Your Home: Materials, Energy Use, and Appliances

Appliances

If you're making the investment to upgrade or purchase new appliances with your remodel, look for appliances bearing the Energy Star® logo. These appliances have been designed to use less energy than traditional models, using energy more efficiently and reducing **phantom loads**. Refrigerators, dishwashers, washers, air conditioners, and most home and office electronics (televisions and computers) can be Energy Star® certified.



Visit the Energy Star® [website](#)²⁹ to search for qualified products. If you want to go even further, the non-profit Consortium for Energy Efficiency works with the EPA to create higher efficiency standards than Energy Star®, and their [website](#)³⁰ has easy-to-search product databases that will help you find and compare products.

Home Office and Entertainment

If you are creating a home office or entertainment center, an important consideration beyond material selection is energy use. These spaces tend to have energy-hungry equipment, and most office and entertainment appliances have Energy Star® options available. The most effective way to save energy is to be aware of what the equipment uses when left on but not in use. Ideally, set equipment to power off or automatically go into standby or hibernate mode. [Learn](#)³¹ about best practices to incorporate when designing and furnishing your new office or entertainment center. [Compare](#)³² average consumption of appliances. [Search](#)²⁹ for Energy Star® office products.

Thermostat

Purchase, install, and program an Energy Star® certified programmable thermostat. One of the most cost-effective energy improvements available, programmable thermostats help you to easily manage your home comfort while using less energy. Programmable thermostats typically have anywhere from two to six temperature settings daily, allowing you to design your own settings based on your schedule. Lowering heat settings 10 to 15 degrees while you're gone during the day and while you sleep can lower utility costs as much as 15% a year! Programming the furnace or air conditioning to kick on just an hour before you get home or wake up allows your home to reach comfortable levels without wasting energy. Try the Energy Star®'s [Interactive Programmable Thermostat](#)³³ online to see how different temperature settings can make a difference.



It's good to remember that having a programmable thermostat saves energy only if you use it properly. Some are easier to program than others, so if yours is confusing, return it and get one that is easier to use so you'll actually use it. Also, set the programmed temperatures to be comfortable to everyone in your home, since using the override feature frequently can result in saving less energy than if the temperature were a degree or two warmer.

29) www.energystar.gov/products/certified-products

30) www.cee.l.org/content/cee-program-resources

31) www.myenergysolution.com/energy-saving-products/homeoffice.html

32) aceee.org/home-electronics

33) www.energystar.gov/index.cfm?c=thermostats.progThermostat

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Interior Of Your Home: Materials, Energy Use, and Appliances

The location of your thermostat is also important when thinking about energy efficiency. To prevent “ghost readings,” locate your thermostat away from windows, doors, direct sunlight, vents, or drafty areas. This can cause unwanted cycling of your heating and cooling appliances. For best results, locate thermostats on interior walls and program two or more zones with multiple thermostats to focus heating and cooling where you need it. This helps maintain the comfort for a group of rooms based on their use. For example, program a thermostat near your busy living spaces to be warmer. Have another to control upstairs bedrooms that are used only for sleeping. To learn more about different types of programmable thermostats and which thermostats work best with your heating system, visit the U.S. Department of Energy’s Thermostat and Control Systems [web page](#)³⁴.

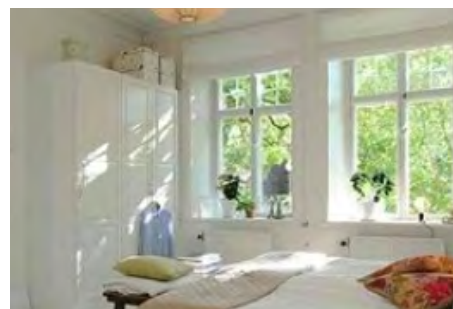
Lighting

Updating your light fixtures during your remodeling project can also reduce the amount of energy you use. When choosing new fixtures, look for Energy Star® certified fixtures and ceiling fans and design your lighting to provide the right level of lighting for each room’s use. For example, use dedicated compact fluorescent fixtures for lights that are used more than two hours at a time and use compact fluorescent lamps (CFL bulbs) in other incandescent fixtures to reduce energy use. As an alternative to CFLs, [LED bulbs](#)³⁵ are becoming more commonly available, and while the initial cost seems high, they have an exceptionally long life and significantly lower energy use than either CFLs or incandescent bulbs.

For ambient lighting, locate fixtures to distribute light evenly and use the right level of lighting for the task being done in the room. In some cases, individual task lighting may better serve certain spaces. You can also maximize the effects of natural light by selecting lighter colored paints that better reflect the light. [Learn More](#)³⁶.

TASK LIGHTING

Task lighting reduces the demand on larger lighting sources and focuses light where and when we need it. Fixture type and efficiency is very important depending on the frequency of use. For task lighting used for longer periods of time, fluorescent and LED fixtures are best.



Natural Lighting Techniques

Natural daylight not only reduces demands on artificial lighting sources, but it also improves indoor environmental quality. It’s understandable that privacy concerns and room location don’t always allow direct window access to the outdoors or the ability to leave blinds or curtains open. Consider techniques such as obscure glazing, solar light tubes, or light shelves to bring natural light deeper into a space to overcome some of the obstacles to using natural light.



34) energy.gov/energysaver/thermostats

35) www.nrdc.org/energy/energyefficientlightbulbs/75-watt-lightbulbs.asp

36) energy.gov/energysaver/lighting-choices-save-you-money

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Interior Of Your Home: Materials, Energy Use, and Appliances

Obscure glazing is achieved through the use of windows or glass blocks that allow light to pass through but limit or distort visibility. This works great for spaces where levels of privacy are desired, such as bathrooms or basements. Glass blocks, window tinting, and glass “frosting” are available in a wide variety of patterns to achieve different levels of privacy. Note that glass blocks have very poor thermal performance compared to double-glazed windows. Windows located above eye level, such as transom windows over doors or other windows, are also great ways to allow daylight into a room without sacrificing privacy. Operable transoms can also add cross ventilation to naturally ventilate spaces.

Solar light tubes are hollow tubes of reflective material that penetrate the roof and transport light into a space. A dome lens on the roof side captures and bends light down the tube and into the space. These tubes are different than skylights in that they are installed to be used as a lighting source rather than as a source of supplemental daylight. Condensation and air leakage is much less of an issue with these because the tubes are often evacuated, which means that the air has been drawn out and the tube has been sealed to prevent heat loss through conduction.



Light shelves are both interior and exterior elements installed on windows to project light deeper into a space. Just like it sounds, a horizontal “shelf” with a reflective top surface is installed above eye level to reflect light. The system works best when you have both an interior and exterior shelf working together. Different light levels will be delivered into the space throughout the day and year depending on the position of the sun in the sky. The light shelf can also help block unwanted light and glare. At certain times of the day, light shelves will shade the area below the shelf near the window. The depth of the light shelf is determined by which times of day you are trying to project or block the most light.



Additional Resources:

[Whole Building Design Guide](http://www.wbdg.org/resources/daylighting.php)³⁷

[Home Tips.com](http://www.hometips.com/buying-guides/daylighting-techniques.html)³⁸

37) www.wbdg.org/resources/daylighting.php

38) www.hometips.com/buying-guides/daylighting-techniques.html

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Interior Of Your Home: Materials, Energy Use, and Appliances

Gas vs. Electric Appliances

Like many things in your home, appliances have two costs: the initial purchase investment and the operating/maintenance costs. Stoves, clothes dryers, and water heaters are the most common appliances that are available as either gas or electric, and energy efficiency will vary by the type and model. Most gas vs. electric decisions are made based on the type of utility connection you have available. If you have both, it is inherently more efficient to burn gas to create heat than to turn electricity into heat. In most cases, gas will also be more affordable to operate.

Energy Star®

When choosing appliances, look for the Energy Star® label. Be aware, however, that Energy Star® does not certify clothes dryers and stove/range/ovens.

Laundry

Washing Machines

With the average American family doing more than 400 loads of laundry annually, improving energy and water efficiency in your laundry room can be a big cost and energy-saver. Energy Star® labeled washers reduce electrical use by nearly 37% and water use by more than 50%. If your current machine is more than 10 years old, Energy Star® recommends upgrading to a more efficient model. When shopping for your next machine, take time to compare the yellow EnergyGuide labels to determine annual usage. Also be sure to choose a size that fits both your space and family size. Something too small will result in more loads of laundry and something too large will waste water and energy. The Energy Star® Buying Guidance³⁹ is a good resource for choosing the right machine.

Dryers

Because most dryer models use similar amounts of energy, Energy Star® does not certify these products. Connection type and operating costs are going to be the driving factors in deciding what to purchase. Gas dryers are more efficient and typically more affordable to operate. Installing a gas connection with proper ventilation in a home set up with electric is an option but may be costly depending on location of the appliance. Be sure to talk with your utility provider and a contractor before purchasing gas appliances if you do not already have a gas hook-up.

To reduce your energy use, select a model with an automatic moisture sensor option. This will allow the dryer to stop when the clothes have finished drying. You can also save energy by drying multiple loads consecutively. You don't have to heat the dryer from a cold start for the second or third load being dried. Remember, the most energy efficient method of drying clothes is using the clothes line or a drying rack. Air dry whenever possible! Learn more⁴⁰

Don't Forget about Clotheslines!

The most efficient clothes dryer you can purchase also happens to be the cheapest—a clothesline! While it's obvious that drying your clothes outside saves energy and money, it isn't practical for year-round use in our climate. When the weather outside doesn't co-operate, consider using drying racks indoors.

39) www.xcelenergy.com/Energy_Solutions/Residential_Solutions/Rebates_&_Energy_Savings

40) www.energystar.gov/products/appliances/clothes_dryers

Key

Glossary Terms: *Italicized*

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Interior Of Your Home: Materials, Energy Use, and Appliances

Venting Dryers

Dryer vents should exhaust directly to the outdoors and be independent of any other ventilation system. Venting heated dryer exhaust into the home can cause air quality issues, moisture issues, and even carbon monoxide issues. Proper installation of dryer vents is also key to maximizing energy efficiency. The vent should be equipped with a damper at the exterior side to prevent air infiltration and the place where it enters the house should be well-sealed and insulated to prevent air leakage. Your dryer vent pipe should be UL-rated material, typically a rigid metal or foil pipe and metal foil tape should be used to seal around connections in the pipe; air leakage at these points reduces the efficiency of the vent. Avoid sharp bends or sags in the pipe as these points become places for lint and moisture to accumulate. You'll also want to remember to clean your vent regularly to remove lint build up and reduce potential fire hazards.

[Learn More](#)⁴¹ about washers and dryers.

Kitchen

Purchasing Energy Star® appliances can help you save big bucks in your kitchen. Depending on the model you're replacing, you can save \$100-\$200 on your annual utility bills! Smaller refrigerators use less energy than larger ones, so begin by considering whether you can live with a smaller unit then compare the actual energy use numbers on the yellow Energy Guide Label⁴² for the different models you're considering. Note that the ranges shown on the tags vary by style of appliance. For example, side-by-side refrigerators are less efficient than similarly sized top-mounted freezers.

Energy Star® certified refrigerators are required to use 20% less energy than those that do not bear the certification logo.

If you are in the market for a dishwasher, remember that newer models use both less water and less energy. They also have built-in heating units to raise the water temperature of only the water it's using, which will reduce the demand on your larger water heating systems.

Take a look at the U.S. Dept. of Energy's "Guide to Kitchen Appliances"⁴³ to help make energy efficient appliance replacements.

41) aceee.org/node/3072

42) www.consumer.ftc.gov/articles/0072-shopping-home-appliances-use-energyguide-label

43) energy.gov/energysaver/tips-kitchen-appliances

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Interior Of Your Home: Materials, Energy Use, and Appliances

Stove/Range/Ovens

Energy Star® does not certify stove/oven/ranges because there isn't much variability in their efficiency. Based on operating costs alone, gas stoves tend to cost half as much as electric stoves. Gas stoves also have electric ignitions to avoid energy used by pilot lights. The following table (from Consumer Guide to Home Energy Savings) compares the operating costs of different ovens, assuming gas prices are \$.60 a therm, and electricity is \$.08 a kWh:

Appliance	Temperature	Time	Energy	Cost
Electric Oven	350	1 hour	2.0 kWh	\$.16
Electric Convection Oven	325	45 minutes	1.39 kWh	\$.11
Gas Oven	350	1 hour	.112 therm	\$.07
Electric Frying Pan	420	1 hour	.9 kWh	\$.07
Toaster Oven	425	50 minutes	.95 kWh	\$.08
Electric Crockpot	200	7 hour	.7 kWh	\$.06
Microwave Oven	"High"	15 minutes	.36 kWh	\$.03

Things like insulation, oven door gaskets, and reduced use of the “self-clean” setting can also improve the efficiency and operating costs of ovens. [Learn More](#)⁴⁴.

Range Hoods

Why are range hoods so important? Without a range hood, moisture and particulates are left to contaminate the air in your home. Excess moisture can get into wall and ceiling cavities and affect structural components of your home. It also can degrade finishes by causing peeling, swelling, and staining. Cooking on a gas stove will also create carbon dioxide, carbon monoxide, smoke, and other particulates that may trigger asthma in children and exacerbate it in adults. A range hood helps provide cleaner, fresher air for you to breathe in your home. This reduces possible health problems caused by poor indoor air quality.

SHHHHHH ...

Install quiet, low-sones (rated 2.0 sonos or less) range hoods to save energy and reduce excess noise. Look for models that are Home Ventilating Institute (HVI) Certified. For a list of certified ventilation products, go here: www.hvi.org/proddirectory/CPD%20Files/Sec1.pdf

Range hoods that exhaust air directly to the outdoors are the best option to remove gases, particulates, and smoke that can affect respiratory health. To get the most benefit, they should be equipped with a damper to stop infiltration of outdoor air. Another type of hood is also available – recirculating range hoods – however the benefit of this type of hood is limited to odor removal. They don't help address moisture issues or the quality of indoor air.



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Kitchen range hoods equipped with multiple speed settings allow low-level, quiet ventilation for light cooking with the ability for higher rates when needed. Recommended ventilation standards will vary based on the location of the range and the width of the hood against the wall. If your range is wider than standard, it may require a higher cfm (ventilation measurement). Also a commercial-style kitchen range can create a lot of heat that can melt internal components of the range hood if the heat is not exhausted properly. Check with the range manufacturer or range hood manufacturer for cfm requirements and warranty limitations. Go to the [HVI page](#)⁴⁵ for more detailed specifications.

When adding a range hood, you may need to provide make-up air to your home. Envision that each cfm of air that leaves the house is like one basketball of air leaving the house per minute. If the range hood is 150 cfm, that is similar to 150 basketballs of air leaving the home per minute. If air isn't brought in to replace the air that leaves, other combustion appliances may be compromised, which can result in potential carbon monoxide and poisonous gas issues. Check with a building performance professional to avoid CO issues before purchasing and installing range hoods.

Typically kitchen range hoods should vent 100 cfm, or meet the specifications set by the Home Ventilating Institute (HVI) and described in the [HVI Range Hood Brochure](#)⁴⁶. For optimal performance, look for a range hood with multiple fan settings and make sure your fan is sized and located properly for your home. To test whether your current kitchen exhaust is adequate or needs to be upgraded, use toilet paper to see how many cfm are being moved. It takes about 25 cfm to hold up one piece of toilet paper, so if your range hood fan can hold four pieces, it is providing enough ventilation.

Faucets and GPM (Gallons per Minute)

For information on bathroom faucet standards, check out the [WaterSense® website](#)⁴⁷. Here you will find all bathroom faucet requirements and specifications, but finding the right faucet for your kitchen sink is just as important. Between cooking, washing dishes, and cleaning, 11% of a household's total indoor water use happens in the kitchen. Try to reduce this number by installing a kitchen faucet with a low gallons-per-minute (GPM) rating, which will help you conserve water. The 2011 Enterprise Green Community Criteria requires kitchen faucets use a maximum of 2.0 GPM, and recommends 1.5 GPM. Unlike bathroom fixtures, the WaterSense® label program does not exist for kitchen faucets because of their different uses. When choosing a faucet, be aware of GPM and look for a fixture that has a rinse-spray valve. This is an easy way to use less water when cleaning up around the kitchen.

Bathrooms

You care about the environment. You also happen to have a bathroom badly in need of remodeling. How do you get the job done with minimal impact on both our fragile planet and your precious budget? Thankfully, the growth of the green building movement has given rise to many eco-responsible products and resources that allow you to create the water-conserving, healthy, energy-wise bath you've always wanted – all without busting your bottom line. Green bathroom remodels should focus on improving energy efficiency, managing moisture, and using recycled materials.

45) www.hvi.org/publications/HowMuchVent.cfm

46) www.hvi.org/publications/pdfs/HVIRangeHood_4Feb08.pdf

47) www3.epa.gov/watersense/pubs/faq_bs.html

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Interior Of Your Home: Materials, Energy Use, and Appliances

Replacing Fixtures

Whether you're updating your bathroom or not, consider replacing your fixtures with low-flow, EPA-approved WaterSense® fixtures to save money and improve the water efficiency in your home. Fixtures that use less water pay for themselves quickly and help conserve the diminishing fresh water supply we depend on for drinking, cooking, bathing, and more. Look for EPA certified WaterSense® fixtures and appliances [Here](#)⁴⁸.

Toilets

Flush rate, measured in gallons per flush (GPF), is the primary way to measure efficiency of a toilet. New high-efficiency toilets (HET) and **dual-flush toilets** use 1.3 gallons or less per flush while older, standard model toilets use 3.5 gallons to 7 gallons of water per flush. In addition to low GPF values, consider the Maximum Performance (MaP) score to measure the ability of the toilet to remove solid waste (measured in grams). Many of today's high-efficiency toilets perform very well, but not all low-flow toilets work equally well. Flushing twice negates any benefits of a low-flow toilet!

For selecting and comparing WaterSense® approved toilets that perform well, use the [WaterSense-certified HETs w/ MaP Test Results](#)⁴⁹ document created by water efficiency and plumbing specialists in the U.S. and Canada. As a general recommendation for replacing toilets, look for WaterSense®-approved fixtures with 1.28 GPF or less and MaP values of 500g or greater. Dual-flush retrofit devices do exist if you're not ready to replace your toilet. These devices claim to reduce the amount water used to flush liquid waste but have not been verified by independent research parties. Because all toilets are different and designed around certain GPF values, retrofits may not remove all waste in some instances, thus requiring a second flush and negating any water savings. [The Alliance for Water Efficiency](#)⁵⁰ provides more information on dual-flush retrofit devices for dual-flush retrofit device awareness.

Learn More from [WaterSense](#)⁵¹.

Showerheads and Faucets

Efficiency in showerheads and faucets is measured by how many gallons per minute (GPM) the fixture uses – the lower GPM, the better. Low GPM fixtures, however, must still provide enough water pressure to get the job done. WaterSense®-approved showerhead criteria –which includes flow rate over a range of pressures, spray force, and spray coverage – will help you find the best one for your needs. Showerheads must have a GPM of 2.0 or less to bear the label.

[Learn More](#)⁵² about showerheads.

48) <http://www3.epa.gov/watersense/products/index.html>

49) www.allianceforwaterefficiency.org/uploadedFiles/Resource_Center/Library/products/MaP/MaP_16/2010-12-15-WaterSense-Listing.pdf

50) www.allianceforwaterefficiency.org/Toilet_Retrofit_Devices.aspx?terms=dual+flush%5d%20and%20a%20cautionary%20statement%20%5bhttp://www.allianceforwaterefficiency.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=3662

51) www3.epa.gov/watersense/products/toilets.html

52) www3.epa.gov/watersense/products/showerheads.html

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Bathroom faucets and faucet aerators are also WaterSense®-approved at flow rates of 1.5 GPM or less. Aerators attached to faucet nozzles add air to reduce water flow to as little as .5 GPM. This is adequate for bathroom uses like washing hands and brushing teeth. Like showerheads, water pressure conditions are included when determining acceptable faucet GPM values.

[Learn More](#)⁵³ about faucets.

Moisture Control

Moisture trapped in your bathroom can cause problems that negatively impact your indoor environmental quality and damage materials in your home. Moisture can cause dangerous mold growth, rot in wood products, and warping and failure in floor, wall, and ceiling finish products. In order to manage moisture in your bathroom, you'll need a bathroom fan that exhausts to the outside. For more info, visit the Minnesota Sustainable Housing Initiative [website](#)⁵⁴ on bathroom fan recommendations.

Fan Specifications

Energy Star® compliant, low-sone (quiet) fans should be installed to save energy and reduce excess noise. In order to function properly, bathroom fans should be sized for the room they are exhausting. Ventilation standards are shifting, and the most recent standard by ASHRAE, the national engineering society leading the field in setting standards, has lowered the recommended ventilation rates. Bathroom fans should draw 50 cfm, which you can test by holding toilet paper up to the fan while running -- if it holds up two pieces, it is drawing 50 cfm of air. Check out the [Home Ventilating Institute Bathroom Ventilation Guidelines](#)⁵⁵.

Locations and Performance

Fans can be vented through the ceiling or wall, but should be exhausted directly to the outdoors. If a vent needs to pass through an attic space, it should be insulated to prevent condensation. It's important to note that fans should never vent into the attic itself. Also, in both wall and ceiling vents, seal around the penetration to reduce air leakage to unconditioned spaces and install dampers at the exterior side of the vent to prevent cold outside air from entering the house.

One problem that can occur with venting is back drafting, which is caused when fans draw so much air that they do not permit combustion appliances like hot water heaters or boilers to draft through chimneys. This can result in the build-up of carbon monoxide, which is a dangerous toxic gas. If you add ventilation to your home, you can affect whole-house ventilation so be sure to hire someone to verify that use of fans does not create back drafting conditions.

Greywater Systems

Greywater is waste water generated around the home – not including toilet waste water, which is considered “black” water. Common **greywater** sources include water used in sinks, the laundry, and when showering. When biodegradable soaps and cleaning products are used, **greywater** can be collected and reused to flush toilets, provide irrigation, and reduce demand on potable water supplies and lower utility bills.

*Before You Start a **Greywater** Project*
Current Minnesota building codes have significant restrictions on **greywater** systems.

53) www3.epa.gov/watersense/products/bathroom_sink_faucets.html

54) www.mnshi.umn.edu/kb/scale/bathfans.html

55) www.hvi.org/publications/bathroom_ventilation.cfm

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Interior Of Your Home: Materials, Energy Use, and Appliances

Small-Scale Greywater Systems

Localized or small-scale **greywater** systems are those that can be easily installed during bathroom remodels, they do not require the infrastructure of whole-house systems, and they are not regulated by code. For example, water used at a bathroom sink can be collected in a storage tank below the vanity to be filtered and treated before being pumped into the toilet tank to be used for flushing.

Tips for planning a greywater system⁵⁶.

Learn More⁵⁷.

Large-Scale Greywater Systems

In a home-scaled **greywater** system, waste water is collected and stored from all **greywater** supplies in your home. The first step to installing a **greywater** system is coordinating with both state codes and city ordinances. The current state code and city ordinances may restrict the use of **greywater** systems for health and sanitation concerns. If **greywater** systems are allowed, design, storage, and supply products are regulated by plumbing codes. **Greywater** systems require the installation of specific supply and drainage plumbing lines to prevent crossing of water supplies. A storage, filtration, and pump system is also required to distribute the **greywater** supply in the home. All components of the **greywater** system should be labeled "**Greywater - Do Not Drink**." Because **greywater** is not treated to potable water quality standards, it is recommended that **greywater** supplies in both small-scale and home-scale **greywater** systems be used within 24 hours.

MN Regulations Regarding Greywater:

"Use of alternative systems is allowed only in areas where a standard system cannot be installed or is not the most suitable treatment.

...A toilet waste treatment device must be used in conjunction with a greywater system. Accordingly, toilets wastes shall be discharged only to toilet waste treatment devices. Greywater or garbage shall not be discharged to the device, except as specifically recommended by a manufacturer. Septic systems are required for greywater systems.

There shall be no openings or connections to the drainage system, including floor drains, larger than two inches in diameter. For repair or replacement of an existing system, the existing drainage system may be used. Toilets or urinals of any kind shall not be connected to the drainage system. Toilet waste or garbage shall not be discharged to the drainage system. Garbage grinders shall not be connected to the drainage system.

...the liquid capacity of a greywater septic tank serving a dwelling shall be based on the number of bedrooms existing and anticipated in the dwelling served and shall be at least as large as the following given capacities: 2 bedrooms, 300 gallon capacity; 3 or 4 rooms, 500 gallons; 5 or 6 rooms, 750 gallons; 7, 8 or 9 rooms, 1 000 gallons" (State Regulations Site⁵⁸).

56) www.greywater.com/planning.htm

57) www.greenandsave.com/utility_savings/water/greywater_small_

58) www.greywater-systems.com/regs.htm

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