green home

healthy homes for a healthy environment

lighting

green

What is a green home?

It's an approach to design, construction and home improvements with the goal of not only making your home look better, but work better for both you and the environment. A green home can be healthier. It can also provide lower utility bills, reduced maintenance costs and a cleaner planet!

Our Green Home Remodel Guide series covers common remodeling topics and gives helpful hints on materials and strategies to create a home that's healthy, saves money, and is easy on the environment.

The other guides in the series include:

- Remodel Overview
- Bath & Laundry
- Kitchen
- Painting
- Landscape Materials
- Roofing
- Hiring a Pro
- Salvage & Reuse
- Do-It-Yourself Home Energy Audit Guide
- Green Home Buyer's Guide

Available at
www.seattle.gov/dpd/greenbuilding

lighting

What is efficient lighting?

Lighting is a crucial component of a comfortable, safe, attractive and efficient home. Yet all too often, even in "green" homes, little consideration is given to lighting design. Misconceptions regarding the inferiority of efficient lighting are still common.

We've entered a new era. As you'll learn in this guide, efficient lighting comes in a diversity of styles and functionalities which helps to create flexibility for the discerning designer and homeowner.

According to the ENERGY STAR® program, if all of America's homes replaced their five most used lights with ENERGY STAR qualified lamps, we could collectively save eight billion dollars a year in energy costs and prevent greenhouse gas emissions equivalent to removing ten million cars from the road each year.

At the individual home level, lighting accounts for between 5 – 10% of a home's energy use. Lighting chosen for its durability, efficiency and appeal will last 6 – 20 times longer (depending on the lamp type) and cost less to operate and maintain.

how

How can I use this guide?

Whether you are just changing lamps, replacing existing fixtures, or considering an integrated lighting design, this guide will give you the tools to select the best products and technologies for your needs. It will also:

- Introduce you to the technology and art of efficient lighting design.
- Give you the knowledge to talk intelligently with design and lighting professionals.
- Serve as a launching point for you to create a beautiful and efficient lighting plan that benefits you, your family and the environment.

Cover photo: Tom Woltjer
Top photo: Lithonia Lighting

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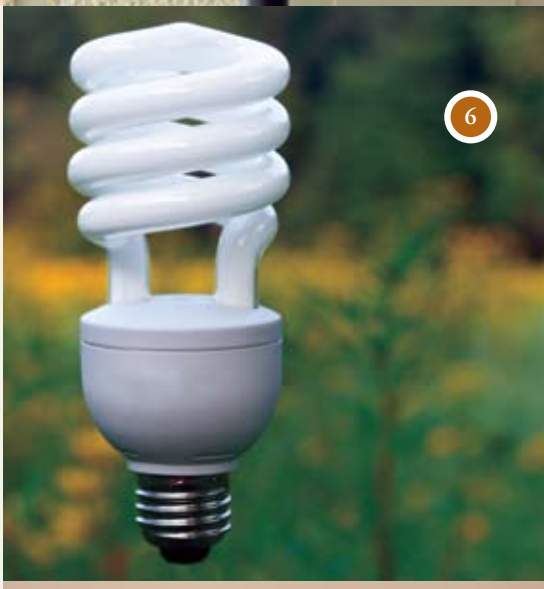
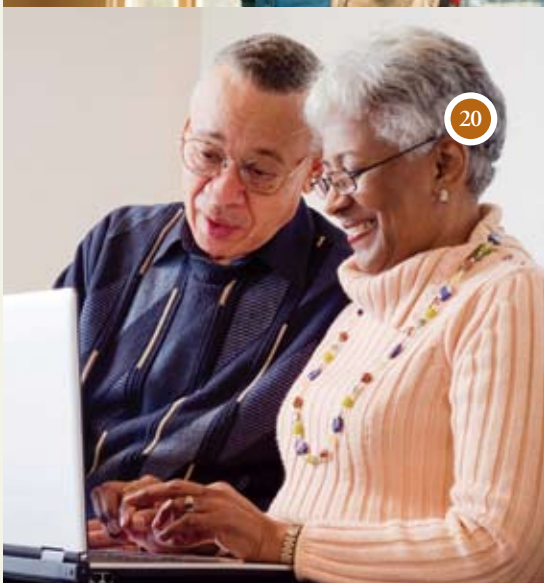




introduction

Gone are the days when a round ceiling fixture with two 60-watt incandescent light bulbs was the preferred lighting option for most of the rooms in a home. Now there are an overwhelming number of light bulbs and fixtures from which to choose. As you will learn in this guide, you can choose bulbs that vary in color temperature, beam spread, light intensity, power consumption and longevity to name a few. And besides all the aesthetic choices, there are a myriad of fixture types that include wall sconces, pendants, chandeliers, ceiling fixtures, recessed cans and vanity strips. To help you get started in sorting out all these choices, you will find on the next page a list of important features to consider when replacing or adding new lighting.

Let this guide serve as a starting point for your research. Remember, every decision you make regarding your lighting project can help improve your home's performance – for you, your family and the environment.

FIRST, A WORD ABOUT TERMINOLOGY:
Most homeowners use the term "light bulb" or "bulb" when referring to a light source; and the term "lamp" when referring to a light fixture. However, the lighting industry uses the term "lamp" when referring to the light source and the term "luminaire" when referring to the actual housing of the light source. Throughout this guide we will use the term "lamp" when referring to a light source but use the more colloquial term of "fixture" when referring to the housing.

Photo top left: Lithonia Lighting
Photo top right: Nuvo Lighting a Satco Product
Photo left: Lighting for Tomorrow and American Fluorescent (2008 winner)
Photos right middle and bottom: Seagull Lighting

Decide What You Want

When considering any type of new lighting, the first step is to identify and prioritize the goals of your project.

Functionality	Your lighting should put light where it's needed, in sufficient amounts, while consuming the least amount of power (watts). It should allow for comfortable performance of daily tasks. Think about where the activities usually occur in each room. These areas will need adequate task lighting. In other areas, ambient lighting may be enough. (See page 9 for more information.) Your lighting controls should provide maximum flexibility for a variety of light levels and ease of use.
Efficiency/Cost	Look for the ENERGY STAR label when choosing new lamps and fixtures. Make sure your choices include automated energy-saving features where appropriate, such as occupancy sensors or timers. Select lamps that have a long life for maximum savings and minimal replacements.
Beauty/Aesthetics	Check that your lighting choices allow for a diversity of effects and applications, such as color temperatures, beam spreads, and direction light is focused. Consider highlighting interesting architectural elements, special artwork or décor.
Ecological Benefits	Select energy efficient lamps for minimal toxic content. Plan for proper disposal when lamps burn out. Outside lighting should minimize "light trespass" into neighboring properties and the night sky.
Safety & Security	Your outdoor lighting should allow for safe movement by identifying uneven surfaces and other hazards. It should provide soft, non-glaring light to help you discern between wanted and unwanted visitors, and help identify your home for guests and emergency personnel. Indoors, the design should help identify transition areas such as counter edges and floor height changes. Avoid unshielded light sources that can cause glare.

Expand Your Definition of Cost

Consumer decisions are often driven by the initial price tag on an item, with little regard for the long term costs. With the uncertainty of future energy costs, consumers have begun to consider the ongoing energy costs of their purchases. The initial price of an incandescent lamp, for example, is usually less than the price of a compact fluorescent lamp (CFL). But when you consider that a CFL lasts 6 – 10 times longer and take energy prices into account, the true dollar cost becomes clear.

Do Your Homework

Thorough research helps you ask the right questions of retailers, designers and contractors and avoid costly mistakes. It pays to start your research early, looking for manufacturers and retailers that offer the products that meet your needs and desires. You may wish to keep an electronic or paper file of contact names and businesses, and magazine and newspaper clippings that show products and design strategies you like.

Consider hiring a design professional. With the recent increase of high quality efficient lighting options, many forward-thinking designers are now specializing in high quality designs that incorporate energy-efficient lighting choices. Good lighting professionals can help you accomplish the priorities you identified in the *Decide What You Want* section.

Identifying all the items for your new lighting scheme – down to the fixture and lamp types – will help you determine cost and availability and reduce the need for expensive, last minute decisions. Factor into your schedule how long it takes to receive special-order items. When visiting lighting showrooms, ask to see samples of ENERGY STAR-

Photo left middle: Seagull Lighting
Photo left bottom: Tacoma Power

qualified lamps and fixtures, and advice on how to best use them. (Keep in mind that some showroom sales staff may still have outdated ideas about efficient lighting and will direct you away from efficient choices.) The Internet is also a great place to search for information and products, but be aware of biases in information sources. The line between a sales pitch and factual information can be quite blurry. See *Resources* at the end of this guide for recommended places to begin.

Universal Design

Universal Design is a concept that reinvents the basic assumptions we have made in designing the spaces where we live and work and the products we use. The result is more flexible, adaptable spaces and products useful to a wide range of ages, sizes, or physical abilities. These principles can help homeowners *age in place* and reduce the need for costly and wasteful tear-out and remodeling activity down the road.

Lighting strategies that put light where needed and allow for the increased lighting needs of elders help create welcoming and safer spaces for all. Rocker switches (also known as "Decora style") allow for easier on-off function than do small toggle switches. Switches located between 36 and 42 inches above the floor, measured to the center of the switch, allow access from various heights. Switches located both at the top and bottom of a set of stairs allows for safe passage in both directions. Visit the AARP website at www.aarp.org/families/home_design for more tips on Universal Design strategies you can incorporate into your home.

technology

Understanding the technology and terminology behind lighting will help you navigate the potentially confusing territory of design and product selection.

Light Sources

There are numerous light sources available; the two most popular for residential applications are incandescent and fluorescent.

Incandescent

Incandescent light sources generate light from heat. Any object heated to a suitably high temperature will emit light. We've all seen how hot stove burners glow red. The filament of an incandescent lamp must be heated to an even higher temperature (about 4400 degrees Fahrenheit!) to produce the warm yellowish color of light typical in residential lighting.

Standard – Standard incandescent lamps used today are much like those invented by Thomas Edison in 1879! Unfortunately, these lamps convert only 5% – 10% of the electrical energy they consume into light. The rest of the consumed energy is emitted as heat, which is usually wasted energy, especially in the summer when still more energy may be used to run ventilation or air conditioning to dissipate heat.

Halogen – Halogen lamps are incandescent lamps in which the tungsten filament is sealed into a quartz capsule containing a small amount of halogen gas. This design allows the lamps to burn hotter and more efficiently, while producing a whiter color of light. Halogen lamps last significantly longer than standard incandescent lights. The tiny size of the halogen capsule enables even small lamps to produce highly focused light, suitable for task and accent lighting.

Halogen IR – The most efficient type of incandescent lamp is halogen IR (infrared). The quartz capsules of these lamps feature a special infrared-reflective coating that redirects the heat back to the filament, reducing the amount of electricity needed to maintain the required operating temperature. Since halogen IR lamps produce more light with less energy than conventional halogen lamps (up to 30%), it is often possible to save energy by using a lower wattage halogen IR lamp to replace a standard halogen lamp.

Fluorescent

Fluorescent lamps, which were first mass-produced by GE in the 1940's, produce light by passing an electric current through a glass tube containing tiny amounts of mercury gas. A phosphor coating on the inside of the glass converts the energy to visible light. A ballast is needed to start the lamp and to ensure a precise flow of electrical current.

Older fluorescent lamps used a single type of phosphor which produced greenish light, and magnetic ballasts which caused humming and flickering. Today's lamps incorporate electronic ballasts which eliminate flicker and hum. They use multiple high quality phosphors to generate light of excellent color and quality. Depending on the style, a fluorescent lamp can last from 6,000 to over 24,000 hours and provide 3 – 10 times the light output per watt than an incandescent lamp.

Fluorescent lighting used for residential and decorative lighting is characterized by warm color tones and excellent color rendering. High color rendering enhances skin tones and makes the color of interior furnishings look natural. Manufacturers have accomplished this by much more precise mixing of several different phosphors to achieve more natural color. In addition to more accurate color rendering, you can now find fluorescent lighting in a variety of color temperatures. (see page 7 for more information).

One drawback of fluorescent light sources is that they contain a small amount of mercury and should never be thrown into the trash. See the *Health and Safety* section on page 16 for more information about mercury and proper disposal options.

Linear Fluorescent – Linear fluorescent lamps refer to the tube type, of which the 4-foot length is the most common. Older style tubes were 1½ inches in diameter, or 12/8 of an inch, commonly referred to as a T12. The new standard diameter for 4-foot tubes is 1 inch, commonly referred to as a T8. Linear fluorescent lamps now provide excellent color rendering, long life (up to 36,000 hours) and beautiful, even light. Fluorescent tubes are now being made in smaller sizes such as T5, T4 and T2 in a variety of lengths which make them perfect for vanity, under cabinet and cove lighting. As tube diameters shrink, efficiency increases and fixtures become more stream-lined.

Compact Fluorescent – Compact fluorescent lamps (CFLs) refer to the group of fluorescent lamps designed to replace standard incandescent lamps. The use of CFLs in the home is rising due to four major factors: improved performance, smaller sizes, huge increase in variety of styles and lower costs.

CFLs last 6 – 10 times longer and use 75% less energy compared to standard incandescent lamps. Their longevity and energy savings are their two most important qualities.

Until recently, two-piece CFLs have been the standard in ENERGY STAR fixtures to ensure that inefficient incandescent replacement lamps could not be used. Unfortunately, having the ballast as a permanent part of the fixture meant that the replacement lamp had to be identical to the original in wattage and pin configuration. Many customers had difficulty finding the correct replacement. And, these inflexible fixtures would not allow customers to brighten or dim the light by switching lamps or using a dimmer switch.

Recently, fixture and lamp manufacturers have worked together to create new one-piece CFLs with an integrated ballast and an industry standard GU-24 pin configuration (see photo on page 19). New ENERGY STAR fixtures with a GU-24 socket give customers the ability to choose a replacement CFL that has different light outputs, color temperatures and dimming capabilities. A wide variety of CFLs with the GU-24 base are now available at local and online retailers.

A major barrier to wide-spread use of CFLs is their inability to work well with lighting controls such as dimmers, photocells, motion sensors and electronic timers. The electronic components found in most controls are not compatible with the electronics contained in fluorescent lamp ballasts. For instance, you need a CFL made specifically for use with dimmer switches for it to work properly with most existing in-home dimmers. Although dimmable CFLs are improving, they do not perform exactly like incandescent lamps in that when dimmed, they may not dim as far and the color may not become warmer.

Another small annoyance with CFLs is that they can take anywhere from 15 – 30 seconds to come up to full brightness. Reflector types tend to take a little longer. This is a deliberate feature that actually extends the life of each lamp. And it can be a benefit when turning on bathroom or bedroom light in the middle of the night!

For many general or ambient lighting applications, fluorescent lamps are an excellent choice. They provide a high volume of light while using a fraction of the electricity that incandescent sources use and they last 6 – 10 times longer. Fluorescent lamps can also work well for task lighting providing bright, even lighting and excellent color rendering.

For warm inviting light: choose a fluorescent lamp that states "warm white" or "soft white" on the package. (Color temperature will be in the 2700 – 3000K range.)

For a crisper whiter light: choose a fluorescent lamp that states "bright white" on the package. (Color temperature will be in the 3500 – 4200K range.)

For cool white light: choose a fluorescent lamp that states "cool white" or "daylight" on the package. (Color temperature will be in the 5000 – 6500K range.)

Light Emitting Diodes (LED)

An LED is a semiconductor diode that emits light when an electrical current is applied. The effect is a form of electroluminescence. The first known report of a light emitting diode was made in 1907 and the first visible spectrum LED (red) was developed in 1962. LEDs have been used for many years in exit signs, indicator lights and in home appliances.

Now, brighter LEDs are showing up in high-end flashlights and holiday lights. Very recently, the emergence of attractive warm white LEDs has resulted in a few high quality LED fixtures for home use such as under cabinet lighting, cove lighting and recessed can retrofits.

The future of LED lighting is extremely exciting! LEDs are very durable, compact, energy efficient, and free of toxic content. Life ratings of up to 50,000 hours allow arrays of LEDs to be integrated directly into fixtures without provision for replacement, allowing for radically new designs. As of this writing, the majority of LED lights on the market can best be described as special-purpose or novelty products. Products designed for residential lighting are expensive and hard to find. When reading LED product labels, look especially for indications of light output indicated by lumens and color temperature indicated by degrees Kelvin or "K". If this information is missing, the product is probably not acceptable for general lighting.

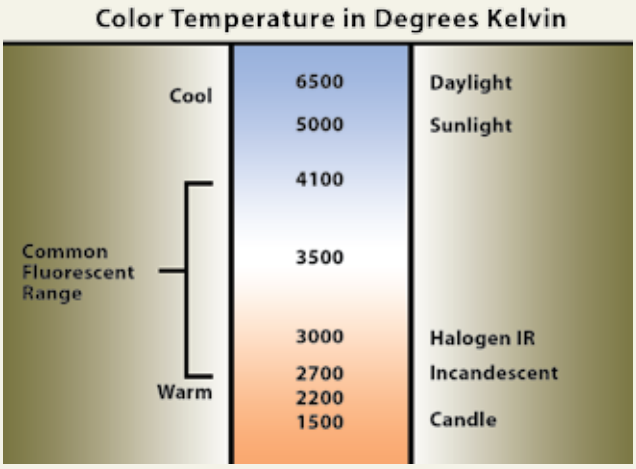
The Color of Light

Two ratings are used to describe the color of white light sources. Color temperature describes the shade of white light emitted, while Color Rendering Index (CRI) rates the ability of the light to accurately portray colors in the area being lit.

Color Temperature

If you've ever tried to match white paint, you know that there are actually many different shades of white. A similar issue emerges with white light. While incandescent, fluorescent, LED, and other light sources all emit "white" light, they can look very different from one another. This color appearance of light sources is described by the lighting industry in terms of color temperature and is measured in terms of degrees Kelvin or "K".

The higher the color temperature, the "cooler" or more blue the light source appears. Light sources that most observers would consider "warm", (more yellow/orange) such as incandescent lamps, have color temperatures of around 2700K. Halogen light, often characterized as "crisp white", is around 3000K.



No matter what color temperature light you choose, if it has a low Color Rendering Index (CRI), nothing will look good under it.

Fluorescent lamps are available in a full range of color temperatures from 2700K for home use to over 6500K for certain commercial and industrial applications. Lamps can achieve these different temperatures by the careful mixing of phosphors – the white coating on the inside of the glass tubes. Commonly available fluorescent color temperatures are 2700K (warm), 3000 – 3500K (bright white), 4100K (cool) and 5000 – 6500K (daylight). ENERGY STAR requires labeling of color temperatures.

Many homeowners prefer warm colors, but cooler colors have benefits as well. Bright and daylight fluorescent light appears more like daylight and excels at revealing certain colors. For example, using a 5000K fluorescent lamp with a CRI of 90 in a closet can

enable you to easily distinguish between black and navy sports jackets or brown and green socks. Studies have even shown that light color affects our daily sleep cycles. Cooler colors promote wakefulness and productivity, while warmer colors tend to promote relaxation.

Color Rendering Index (CRI)

A major hurdle to consumers embracing fluorescent lighting is their experience of fluorescent technology in the past. Many early fluorescent lamps had poor color rendering. Modern fluorescent lamps have solved the issue of color rendering through advances in phosphor technology.

The measurement of light's ability to properly render colors is called the Color Rendering Index or CRI. It involves measuring the extent to which a series of eight standardized color samples differ in appearance when illuminated under a given light source. The highest possible score is 100, defined as the CRI of standard incandescent lamps and the sun.

For high-quality fluorescent lighting applications, look for lamps which are labeled with a CRI of 80 or greater. To make shopping for fluorescent lamps easy, look for the ENERGY STAR label, since ENERGY STAR qualification is granted only to lighting products with a CRI of 80 or greater. While no two lighting sources are identical, a fluorescent light source with a CRI rating of 80 or greater will result in object coloration largely indistinguishable from that produced by an incandescent light.

NOTE: When purchasing linear fluorescent tubes, beware of the "warm white" (WW) or "cool white" (CW) designation on the package or the tube itself. These terms were created well before advances in phosphor technology that now make excellent color rendering possible. Tubes with a "WW" or "CW" mark may not suitable for in-home applications where good color rendering is important.

Reading Lamp Labels

On most lamp packages, both incandescent and fluorescent, you will find three prominent numbers: light output (lumens), energy used (watts) and life (hours). These numbers can easily be used to calculate the lamp's efficacy (lumens per watt) and total cost of operation (see below).

Two lamp labels shown on the right side of this page illustrate the significant differences between a standard 100-watt incandescent lamp and an equivalent ENERGY STAR CFL.

Light Output – The total quantity of light emitted by a lamp is measured in lumens. Notice that the 100-watt incandescent lamp consumes more than 4 times the energy and produces *less* light than the 23-watt ENERGY STAR CFL.

Energy Used – The electrical energy used by the lamp is measured in watts. While wattage is not a unit of brightness, CFL packages are often labeled with claims such as "100-watt replacement" as an aid to customers who are replacing existing incandescent lamps.

Life – Lamp life is determined through a standardized that test manufacturers are required to perform. All lamps are turned on for one hour, then off for one hour, then on for three more hours and so on until one-half of the total number of lamps have failed. The rated lamp life is the number of hours at which half the lamps have failed. While individual lamp life varies considerably, the ENERGY STAR CFL with a rated life of 12,000 hours may last 16 times as long as the value-brand incandescent lamp with a rated life of 750 hours.

Efficacy – In lighting, this term refers to the lumens of light output for every watt of input power. It is the number you get when you divide the light output by the energy used. As illustrated, the 100-watt incandescent lamp producing 1605 lumens has an efficacy of **16** lumens per watt, while the 23-watt CFL producing 1640 lumens has an efficacy of **71** lumens per watt!

Cost of Operation – The total cost of operating a lamp for a fixed number of hours (1,000 hours) is its purchase cost plus its energy cost. The 1,000-hour purchase cost of a lamp is its price divided by 1,000 hours of rated life. For example, if the 750-hour incandescent lamp shown at right costs 20¢, its 1,000-hour purchase cost is 26¢ ($.20 divided by .75). If the 12,000-hour CFL shown right costs $5, its 1,000-hour purchase cost is 41¢ ($5 divided by 12). Adding the cost of energy priced at 8¢ per kWh, the total 1,000-hour cost of operation is **$8.26** for the incandescent lamp compared to only **$2.25** for the CFL. To minimize cost, choose lamps with long life and low energy use.

Did you know that if you dim an incandescent lamp (standard, halogen or halogen IR) just 10%, you double the lamp life? And if you dim it 20%, you quadruple the lamp life! (More reason to enjoy those softly lit romantic dinners.) For a halogen lamp, be sure to turn the dimmer up to full brightness for 5 minutes every few weeks to get the longest life. Higher temperatures at full light output allow the chemical reactions inside the capsule to fully interact which extends the life of the filament.

CFL Label

Incandescent Label

choosing the right light

Lighting should be planned to complement your lifestyle. Look at the activities that occur in each room, the atmosphere you want to create and the decorative elements you wish to emphasize. Keep in mind that light can be absorbed and even wasted in dark-colored rooms, or reflected and used as additional illumination in light-colored rooms. Also take note of those areas that serve more than a single purpose and those that will require more than one type of lighting.

Basic Lighting Types

There are three basic types of lighting that work together to light your home. A good lighting plan combines all three types (know as "layering") to light an area, according to function and style.

- *Ambient (top left)* – Provides overall, general lighting which radiates a comfortable level of brightness. Ambient lighting can be accomplished by chandeliers, ceiling or wall-mounted fixtures, recessed or track lights, or with lanterns mounted on the outside of a home. Having a central source of ambient light in all rooms is fundamental to a good lighting plan.
- *Task (middle left)* – Helps you perform specific tasks such as reading, sewing, cooking, homework, hobbies, crafts, games or balancing your checkbook. It can be provided by recessed and track lighting, pendant lighting, under cabinet lighting and even certain chandeliers, as well as by portable floor and desk lamps. Task lighting should be free of distracting glare and shadows but bright enough to prevent eyestrain.
- *Accent (bottom left)* – Adds drama to a room by creating visual interest. As part of a decorating scheme, it is used to emphasize paintings, house plants, sculptures and collectables; or to highlight the texture of a wall, drapery or outdoor landscaping. To be effective, accent lighting requires at least three times as much light on the focal point as the general lighting around it. This usually is provided by track, recessed or wall-mounted fixtures for indoor lighting and floodlights for outdoor lighting.

Fixture Types

Once you've selected where and what you want to illuminate, you'll have to decide how it is best accomplish it. Lighting showrooms are an excellent place to view the many different styles, sizes and shapes of fixtures to deliver the ambient, task and accent lighting you need. Make sure you view the fixture from many angles to check for glare.

Answer these questions before you choose your fixture:

- Does it have the ENERGY STAR label?
- Will it accommodate a variety of different lamps, including efficient styles, a variety of lumen outputs or different beam spreads, i.e., SP (spot), NFL (narrow flood), FL (flood) and WFL (wide flood)?
- Will the fixtures blend in with the architecture or make some sort of statement with light or structure?
- Will the fixture itself be highly decorative, or does it also have to function as a task light, such as a chandelier over a dining room table?
- What is the availability of the fixture, i.e., does it need to be special-ordered?
- Will I be able to easily find and replace the lamp when it burns out?

Remember the concept of "layering". Not only does layering give more options for how the space is lit, but different fixtures are more suited to ambient, task or accent lighting. For example, recessed or track lights work well for accent lighting, linear fluorescents for under cabinets, in coves or on each side of a bathroom mirror are excellent for task lighting and decorative fixtures with CFLs work well for ambient light. Often a fixture may do double duty; the accent lighting may provide task light, the task lights may provide enough ambient light, or the architectural coffer lighting may provide ambient light. This layering strategy is critical to creating a rich visual environment.

Choose fixtures that have the ENERGY STAR® label. Products with this label have met strict energy efficiency guidelines set by the EPA and US Department of Energy.

CHANGE A LIGHT CHANGE THE WORLD ENERGY STAR

COMMON FIXTURE TYPES

Wall Sconce
Used mostly for ambient light

Ceiling Fixture
Used for ambient light

Chandelier
Used for ambient light; as a decorative fixture as part of the overall ambiance in halls, foyers, dining rooms or bathrooms; or even as a task light when installed over a dining room table

Vanity
Typically used over or on either side of a bathroom mirror

Cove
Used to create ambience in a formal space

Under Cabinet/ Under Shelf
Used for task and accent light primarily in kitchens

Pendant
Can be used in kitchens over islands, or over an eating area

Track and Rail
Used primarily for accent lighting; but can also be used for ambient lighting

Recessed
Used for ambient or accent lighting

Portable Table/Floor
Used for task and ambient lighting

Utility
Serves as ambient and task lighting in garages, shops or laundry areas

A note about recessed downlights: In many new homes, recessed downlights are often overused by builders because they are easy and relatively inexpensive to install. But more is not necessarily better. Recessed downlighting can be an excellent choice for ambient and accent lighting, but it usually does not work well for task lighting. Recessed downlighting can cause shadows on your task and are difficult to move once installed. Also, each installed recessed fixture requires a hole in your ceiling. If installed in the ceiling just below your roof, there is an opportunity for significant heat loss if the hole is not sealed properly. (This type of work usually requires a permit. Check with your local municipality.) *If you are changing out existing fixtures for recessed downlights, make sure you understand all the options before you make that cut. Often, changing the type of lamp within an existing fixture solves the problem.*

Photo left bottom: Seagull Lighting
Photos above and to the right: Seagull Lighting

lamping options

The performance of any light fixture depends very much on the type of lamp used. Here is a very basic guide of different types. NOTE: Because there are numerous common styles of lamps within each lamp type, we did not include illustrations of them in the chart below. Please refer to our webpage at www.betterhomelighting.com to see photos of all the different types, sizes and styles of lamps within each category.

LAMP TYPE	DESCRIPTION	BENEFITS	DRAWBACKS
Incandescent – Standard	A tungsten wire filament is placed inside a glass bulb. An electric current is passed through the filament and the resistance in the filament causes it to heat and "incandesce" or glow.	■ Low initial purchase price ■ Available in many wattages, shapes and sizes ■ Easily dimmable ■ Many options for directional source	■ High overall costs due to high energy use ■ Short lamp life ■ Not very energy-efficient
Incandescent – Halogen	A halogen lamp is an incandescent source. But halogen lamps contain halogen gas which slows down the deterioration of the tungsten filament and extends the lamp life.	■ Whiter light than standard incandescent ■ Available in many wattages, shapes, sizes and bases ■ Increased lamp life over standard incandescent ■ Fairly easy to dim ■ More energy-efficient than standard incandescent ■ Excellent as a directional source of light	■ More costly than a standard incandescent ■ Less energy-efficient than fluorescent ■ Shorter lamp life than fluorescent
Incandescent – Halogen IR	Halogen IR (infrared) lamps feature a special infrared-reflective coating that redirects the heat back to the filament reducing the amount of electricity needed to maintain the required operating temperature.	■ Whiter light than incandescent ■ Available in many wattages ■ Increased lamp life over regular halogen ■ Up to 30% more efficient than standard halogen	■ More costly than regular halogen ■ Shapes and sizes are limited ■ Less energy-efficient than fluorescent ■ Shorter lamp life than fluorescent
Fluorescent	A lamp that uses chemical phosphors to convert electrical energy into visible light. The types of phosphors used will determine the color temperature of the light.	■ Very energy-efficient ■ Long life ■ Available in many wattages, shapes and sizes ■ Lowest overall operating cost ■ Produces less heat than incandescent	■ Requires a ballast to operate ■ Special dimmable products can be expensive ■ Higher initial cost than standard incandescent ■ Contains trace amounts of mercury and should be disposed of properly ■ Not a good source for directional light
Light Emitting Diodes (LEDs)	LEDs contain a semiconductor diode that emits light when an electrical current is applied. The effect is a form of electroluminescence.	■ Very energy-efficient ■ Very long life ■ Small ■ Dynamic colors	■ Very high in initial cost ■ Very few high quality residential fixtures currently available ■ May not be able to find replacement parts due to rapidly changing technology

R or PAR? Choosing between R and PAR lamps can be confusing. Both R and PAR lamps have reflective coatings inside the lamp that directs the light in one direction providing better beam control than standard lamps. But whereas R lamps have a frosted smooth glass top that provides soft light, PAR lamps have a harder, prismatic top that tends to focus the light more precisely and sharply. PAR lamps come in a variety of defined beam spreads from narrow spot (10 degrees) to wide flood (60 degrees).

lighting control options

TYPE	DESCRIPTION	BENEFITS	DRAWBACKS
Switch	Turns fixture either ON or OFF.	■ Inexpensive ■ Easy to use	■ Light is either ON or OFF ■ Wastes energy if switch left in ON position when not needed
Dimmer	Gives user the ability to vary the intensity of the light level.	■ Can be inexpensive ■ Fairly easy to install ■ Provides flexible light levels ■ Saves energy/increases incandescent lamp life	■ Must be compatible with lamp type; i.e. low voltage, incandescent, fluorescent, LED ■ Fluorescent dimming can be expensive
Timer	Keeps lights on for the amount of time you select. Once the countdown is complete, the lights turn OFF.	■ Can be inexpensive ■ Mechanical or electronic ■ Electronic versions can be programmable and adjust to daylight ■ Saves energy	■ Do not always work with fluorescent lamps, especially electronic types (read packaging carefully)
Photocell	Senses change in outdoor light levels so exterior lights turn ON at dusk and OFF at dawn.	■ Saves energy ■ Excellent feature when manufactured as an integral part of an exterior fixture ■ Can be integral to fixture, switch or stand alone	■ As a stand-alone component, compatibility with CFLs can be problematic ■ For best operation, must be exposed to bright sunlight
Motion Sensor	Turns lights ON instantly when motion is detected (usually used for outdoor security).	■ Newer models can gradually fade OFF rather than quickly turn OFF after no motion is detected ■ Can be integral to fixture, switch or stand alone	■ If aimed improperly, small animals can trigger false ONs
Occupancy Sensor Switch	Detects when a room becomes occupied and turns ON the lights automatically. If no occupancy is detected for a specified time, the lighting automatically switches OFF.	■ No need to remember to turn the lights OFF ■ Saves energy ■ May be useful if user is physically unable to turn on switch	■ Typically more costly than timer ■ False OFFs can occur by little movement in area ■ Lower user acceptance in occupied spaces with stationary tasks ■ Must be compatible with lamp type ■ Lights stay ON longer than if manually switched OFF by user
Vacancy Sensor Switch	User turns light ON manually, but if user forgets to turn light OFF, it will turn OFF automatically. Lights stay on as long as the detector senses motion.	■ Light will turn off automatically if user forgets ■ Saves energy	■ Typically more costly than timer ■ False OFFs can occur by little movement in area ■ Lower user acceptance in occupied spaces with stationary tasks ■ Must be compatible with lamp type
Scene Controller	Dims all the lighting loads of one room with the touch of a button.	■ Multiple lighting "scenes" can be programmed by owner ■ Smooth transitions between light levels	■ More expensive than dimmers but considerably cheaper than whole house controls
Whole House Controller	Can control one or all the lights in a home.	■ Controls different room "scenes" ■ Can utilize touch screens ■ Extremely flexible ■ Smooth transitions between light levels ■ Can incorporate shade and music controls ■ Engraveable custom plates	■ Expensive ■ High installation costs ■ Programming can be complicated

lighting choices room by room

Once the fixture and lamps have been chosen, the next step is to select the best location so the subject is illuminated in an optimal way. A professional lighting designer can be a great resource for this task. For example, if you are lighting a vanity, you would not want to put the lamp behind where a person would stand; you would place the lamp on the wall by the mirror so that it shines evenly on the person's face. Lighting both sides of the face provides the best light. For lighting above or below kitchen cabinets, a long diffuse source such as linear fluorescent is the best choice.

If you are lighting a workshop, the lamps are often placed directly over the workbenches. Linear fluorescents are good choices. In all of these examples, we are addressing the location and direction of the light from a normal viewing perspective. This is often done unconsciously, but it helps to know the process.

The following is a room-by-room guide to help you place your lighting fixtures.

Kitchen

The kitchen is primarily a work area, but it is also a gathering place for family and friends. The variety of functions requires lighting solutions that are both functional and comfortable.

Good kitchen lighting incorporates both ambient and task. A large ceiling fixture equipped with linear fluorescent lamps with high CRI and 3000 – 3500K will supply well-diffused ambient lighting. As the only source, however, it will create shadows when you are working at the counters. You will need supplemental task lighting where you will be chopping vegetables and washing dishes. Under-counter linear fluorescent lighting with high CRI is an excellent choice. Not only is linear fluorescent lighting extremely efficient and long lasting, it provides soft, comfortable and even light.

You can also use it above your cabinets for ambient lighting. It lights the ceiling and bounces the light around the room making everything seem brighter. With today's color

Photo left bottom: Seagull Lighting

temperature options and high color rendering, linear fluorescents are an excellent option in the kitchen.

Stylish, shiny granite counters with incandescent point source lighting can cause uncomfortable glare in the kitchen. Be careful with downlights or recessed cans, since they can put the light behind you, creating shadows in your task areas. They also provide no light on the ceiling, making it appear darker.

Consider placing the recessed cans 12 inches in front of the upper cabinets. This allows the upper cabinets to be highlighted when closed but provides light into the cabinets when opened. At the sink area, an ENERGY STAR-qualified recessed light fixture works well as long as the fixture is not installed directly above you, but placed 12 inches from the wall. (For existing downlights, 3000 – 3500K fluorescent R lamps work very well.)

Dinettes, nooks and island counters can be illuminated with decorative pendants. When used with dimmer controls, these ceiling-hung fixtures will provide you with adequate task lighting for homework, hobbies or family paperwork. The dimmer will allow you to adjust the light for alternate activities such as dining or entertaining. For an existing fixture, consider a dimmable CFL. Although CFLs don't dim exactly like an incandescents, it may meet your needs.

Bathroom

In the bathroom, it is important to provide a good source of illumination on both sides of the mirror for grooming and applying makeup. Linear fluorescent bath bars with high CRI lamps are an excellent choice. Soft, diffuse light on either side of the mirror eliminates harsh shadows under the eyes and nose. Sometimes the light around the bathroom mirror provides both ambient and task lighting. If you have a large bathroom, you may want to add additional light such as an ENERGY STAR-qualified ceiling-mounted fixture in the middle of the room. For wet areas such as the shower, make sure the fixture is rated for that application.

Photo right middle and bottom: Seagull Lighting

Living/Family Room

These rooms may require the most flexibility in the lighting system, especially if you like to rearrange your furniture. Layering your lighting is especially important here. (See page 9 for the 3 basic types of lighting needed to achieve a layered effect.) When using fluorescent sources, most people find lamps with warm tones (2700K) most pleasing. Here is an example of four different layers of light:

1. Table and floor lamps. These work great with CFLs and provide both ambient and task lighting.
2. Wall sconces. These can provide low level ambient lighting suitable for TV viewing.
3. Linear fluorescent. This an excellent choice for placing over bookshelves or behind curtain valances and coves. The light sources is hidden (no glare) and the up-lighting bouncing off the ceiling produces a soft and diffuse light.
4. Recessed directional downlights. These work well to highlight art, architectural features such as fireplaces or to just wash a wall with diffuse light. Point-source lamps (rather than fluorescent) work best for these applications.

Try to avoid using recessed downlighting over seating areas as these cast unappealing shadows on people's faces and cause uncomfortable glare.

Dining Room

Dining room lighting should be both decorative and functional. Having several layers of light can establish the mood for a variety of functions; including dining, homework or crafts. When using fluorescent sources, most people find lamps with warm tones (2700K) most pleasing. Here is an example of three light layers that can be used all together or in different combinations:

1. A chandelier above the dining table (placed 30 inches above the table). Consider if you want a fixture that just shines light down on the table, one that can shine both down and up, or one that provides light all around.
2. Wall sconces with CFLs (regular and dimmable) placed on the wall on either side of a buffet or sideboard. Again, think about directionality – some sconces shine light up, down, in both directions or just glow softly.
3. Recessed directional downlights with point-source lamps to highlight art on the wall or to highlight objects on a buffet or sideboard.

Bedroom

Ideal bedroom lighting should provide a mixture of soft, ambient lighting along with task lighting for reading and dressing. Warm color temperatures (2700K) are usually preferred. General ambient lighting can be provided by ceiling fixtures, chandeliers, fan lights or wall sconces. Task lighting can be provided by portable wall, table or floor fixtures. Accent lighting can include track lighting or recessed spot lights. Here is an example of three light layers:

1. Swing-arm wall fixtures on either side of the bed with 2700K CFLs.
2. Low-voltage track lighting along one wall to highlight art or bounce light off the wall.
3. Recessed downlights to light the dresser. Fluorescent R lamps can work well in this application.
4. Portable table lamp with 2700K CFL on the vanity or dresser.

Exterior Lighting

Soft, even light by entry ways, paths and outbuildings is the best night-time strategy for visibility since it avoids creation of harsh shadows and high contrast areas. A photocell will automatically turn the light on at dusk and off at dawn. A motion sensor will turn the light on only when it senses movement. The sensor can be set to stay on for varying numbers of minutes. CFLs are best used in manually controlled fixtures since electronic controls may interfere with the electronic components in the ballast. Also, make sure the CFL you choose is rated to operate at low temperatures. If you want to connect a timer to a fixture with a CFL, you'll have better luck with a manual one rather than an electronic timer due to competing electronic components found in the timer and the CFL.

Photo left middle: Lighting for Tomorrow and Lightolier (2008 winner)
Photo left bottom: Tom Woltjer
Logo right bottom: Total Reclaim, a hazardous waste recycling company located in Seattle.

health & safety

Electrical Safety – Caution should always be observed when installing, removing or operating any electrical product. Before installing or replacing a fixture, power should be turned off at the electric panel. Use only products that have been approved by Underwriters Laboratories (UL) and show the UL label.

Portable plug-in fixtures should have grounded plugs and be plugged into ground fault interrupters (GFIs) when they are used around water (bathrooms, kitchens, and outdoors). Do not plug portable fixtures into loose outlets or use any switch that has a broken wall plate. Do not run fixture cords under rugs, and replace frayed cords.

Especially in older homes, you may encounter hazards created by previous design and product decisions. Exercise extreme caution whenever dealing with electricity. Old wiring may be frayed or improperly installed. Consult with an electrician if there's any doubt about your existing wiring.

Mercury – A small amount of mercury is necessary to energize any kind of fluorescent lamp. Most lamps contain between 2 and 5 milligrams of mercury sealed within the glass tubing. By comparison, mercury thermometers contain 500 milligrams of mercury. Fluorescent lights are safe to use in your home and no mercury is released when in use. If you break a CFL in your home, unhealthy exposure to mercury is extremely rare. Visit the EPA's website at www.epa.gov/mercury for complete clean-up instructions. Many jurisdictions, including King County have banned the disposal of CFLs into the trash. (See *Disposal* below.)

PCB's – Polychlorinated biphenyls (PCB's) are chemicals which were used for their insulating qualities but have been found to be very hazardous to the environment and all life. Ballasts manufactured after 1978 are often marked "non-PCB". Older fluorescent or mercury vapor lamps may contain PCBs and should be disposed of at a hazardous waste facility. Magnetic ballasts may contain a PCB alternative, DEHB, which itself has been linked to cancer. Contact your local solid waste or hazardous waste management program to learn about proper disposal of these items (See *Resources* section.)

Disposal – Treat all fluorescent products as hazardous waste – the same as batteries, motor oil or lead-based paint. Visit www.betterhomelighting.com for more information on disposal rules, FAQs, plus a comprehensive list of locations where fluorescent products can be recycled in the Puget Sound area. Seattle and King County residents can also visit www.takeitbacknetwork.org for a list of locations in King County.

glossary

Angle – Term used when referring to reflector lamps and how the light comes out of the lamp. Narrow beam and wide beam are common residential terms.

- *Beam Angle* – refers to the smaller area of the lamp's beam where the candlepower is greater than 50 percent of the candlepower measured at the center of the beam.
- *Field Angle* – refers to the larger area of the lamp's beam where the candlepower is greater than 10 percent of the candlepower measured at the center of the beam.

Ballast, electronic – Electronic ballasts use electronic components to transform current to a lower level needed to operate fluorescent lamps, and because they operate at a very high 24,000 cycles per second, flickering is completely eliminated.

Ballast, magnetic – Magnetic ballasts use a core and coil assembly to transform electric current to start and operate fluorescent lamps. Flickering and humming are usually associated with magnetic ballasts.

Color Rendering Index (CRI) – Represents how closely a light source depicts an object's true color. A CRI of 100 is the highest with the sun as the reference. ENERGY STAR-qualified CFLs must have a CRI of 80 or greater.

Color Temperature – The numerical measurement of the color appearance of the light that comes from a light source. Color temperature is measured in degrees Kelvin or "K". The higher the color temperature, the cooler or more bluish white the light appears. 2700K is a common value for warm-colored incandescent lighting. "Daylight" lamps are nothing more than lamps with very high kelvins, often 5000 – 6500K.

ENERGY STAR® – A joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. Products earning the ENERGY STAR have met strict energy efficiency guidelines. Visit www.energystar.gov for more information and lists of qualified products.

Daylight – Fluorescent products described as "daylight" have a color temperature between 5000 – 6500K and a CRI over 80. This color approximates the color of a sunny day at noon on a clear day. Daylight lamps can appear to be a bit blue in interior lighting situations.

Footcandle – A term commonly used by lighting professionals when describing the amount of light that reaches a surface (illuminance). Footcandles are an expression of lumens per square foot.

Full Spectrum – When used to describe light quality in lamps, this is a marketing term some lighting manufacturers use as a selling feature. In lighting, the term "full-spectrum" refers to light that contains all colors in the rainbow: violet, blue, green, orange, yellow and red. It is a common misconception that only "full-spectrum" lighting contains a full spectrum of colors, but that is not the case. Most household lighting, including CFLs, contain all visible colors of light. Lamp manufacturers often refer to their lamps as full-spectrum because they put out light similar in color to the midday northern sun ("daylight"). These lamps have a high color temperature, usually in the 5000 – 6500K range and a CRI of 90 or greater. Depending on the light source's spectral power distribution curve, the same objects may appear to be a different shade or color under different light sources.

Although research has shown that some people claim to feel better and are more productive in a "daylight" atmosphere, full spectrum lamps are about 100 times less intense than true sunlight.

Glare – Uncomfortable brightness caused by the light source shining directly in the eyes of the occupants of the space.

Kelvin (K) – The unit of measure used to designate the color temperature of a light source. The higher the kelvins, the cooler (bluer) the color; and the lower the number, the warmer (more yellow/orange) the color. (See Color Temperature above.) Common kelvins are 2700K (warm), 3000 – 3500K (bright) and 5500K (daylight).

Photos of ENERGY STAR-qualifed fixtures on page 17 and 18 courtesy of: American Fluorescent, Designer's Fountain, ENERGY STAR, Lightolier, Lithonia, Nuvo Lighting a Satco Product, Progress Lighting, Royce Lighting and Seagull Lighting. For product catalogs, please see websites listed in our Resources *section on page 20.*

CFL with GU-24 base

Light Pollution/Trespass – Light that intrudes on other property (trespass) and/or into the sky (pollution). Light pollution inhibits night viewing of stars, affects sleep patterns of humans, and can disrupt the migratory patterns of birds. See the International Dark Sky Association's website at www.darksky.org for more information on reducing light pollution.

Linear Fluorescent – Used to describe long, tubular fluorescent lamps that come in a variety of lengths anywhere from 6 inches to 8 feet. Linear fluorescent lamps have 2 pins on either end that are fitted into a fixture made to hold a specific length of linear lamps.

Lumens – A measurement term that refers to the amount of light produced by the lamp -- the higher the lumens, the brighter the light.

Lumens Per Watt (LPW) – Lumens divided by watts in order to determine a lamp's efficacy. The higher the number, the more efficacious the lamp. CFLs are in the range of 50 – 60 LPW, while incandescent lamps are only 12 – 18 LPW.

Light Source – Two different types:

- *Point Source* – a lamp that has the potential to direct a concentrated beam of light on a specific surface or object; i.e., incandescent PAR lamps.
- *Diffuse Source* – a lamp that spreads light over a wide area; i.e., fluorescent lamps.

Seasonal Affective Disorder (SAD) – Usually diagnosed by a medical professional, SAD is a depression that afflicts up to 10 percent of people in the northern latitudes, primarily during the fall and winter months due to shorter days. Getting 15 minutes of daylight before 10 am is a well known treatment for SAD. Even in winter on a cloudy day, the light outside can be 100 times brighter than the amount of light in our buildings.

Universal Design – Is a design approach whereby products, services and environments are usable by as many people as possible regardless of their age, ability or circumstances. In lighting, for example, light switches with large flat panels rather than small toggle switches are easier to operate. CFLs are an especially good option as they last 6 – 10 times longer than incandescent lamps so need much less frequent changing.

Photos of energy-efficient lamps on page 19 and 20 courtesy of: ENERGY STAR, Lighting for Tomorrow, Lithonia, Seagull Lighting, OSRAM SYLVANIA, Technical Consumers Products, and WATT-MAN Lighting.

resources

This section provides resources to assist home builders, designers and consumers in selecting and using ENERGY STAR-qualified lighting in the home.

www.betterhomelighting.com

The expanded online version of this guide provides additional articles and updated information.

American Lighting Association

The ALA website, www.amercianlightingassoc.com, provides links to lighting showrooms, designers, and fixture manufacturers. The site also contains a lighting guide with information on lighting design for specific rooms and applications, and a special section on energy-efficient lighting.

Consortium for Energy Efficiency (CEE)

CEE, www.cee1.org, is a consortium of efficiency program managers from utilities, industries, trade associations, and government agencies across the U.S. and Canada who work together on common approaches to advancing energy efficiency. CEE, along with the ALA and the U.S. Dept. of Energy (represented by Pacific Northwest National Laboratory) organizes the yearly *Lighting for Tomorrow* design competition for fixture manufacturers. The contest is designed to stimulate the market for attractive ENERGY STAR fixtures. See the winning manufacturers and their fixtures at www.lightingfortomorrow.com

ENERGY STAR®

Visit the ENERGY STAR website at www.energystar.gov to access lists of products that qualify for the ENERGY STAR label, technical specifications, participating manufacturers, and new specifications in development.

ENERGY STAR® Fixture Manufacturer Websites

The ENERGY STAR website at www.energystar.gov currently lists over 130 manufacturers who sell ENERGY STAR-qualified fixtures. Here are a just a few:

American Fluorescent – www.americanfluorescent.com
Access Lighting – www.accesslighting.com
Brownlee – www.brownlee.com
CREE Lighting – www.creelighting.com
Designer's Fountain – www.designersftn.com
Dolan Design – www.dolandesign.com
Juno – www.junolighting.com
Lightolier – www.lightolier.com
Lithonia – www.lithonia.com
Maxlite – www.maxlite.com
Nuvo/Satco Lighting – www.nuvolighing.com
Royce Lighting – www.roycelighting.com
Progress Lighting – www.progresslighting.com
Philips Lighting – www.philipslighting.com
Savoy House Lighting – www.savoyhouse.com
Seagull Lighting – www.seagulllighting.com
Technical Consumer Products – www.tcpi.com

www.lightingplans.com

This site provides home builders with actual lighting plans incorporating energy-efficient fixtures. The site includes multiple plans for kitchens, living rooms, dining rooms, bedrooms, bathrooms, closets/utility rooms, and even garages and exteriors. The lighting plans are supplemented by a fixture schedule of specific fixture types and links to manufacturers.

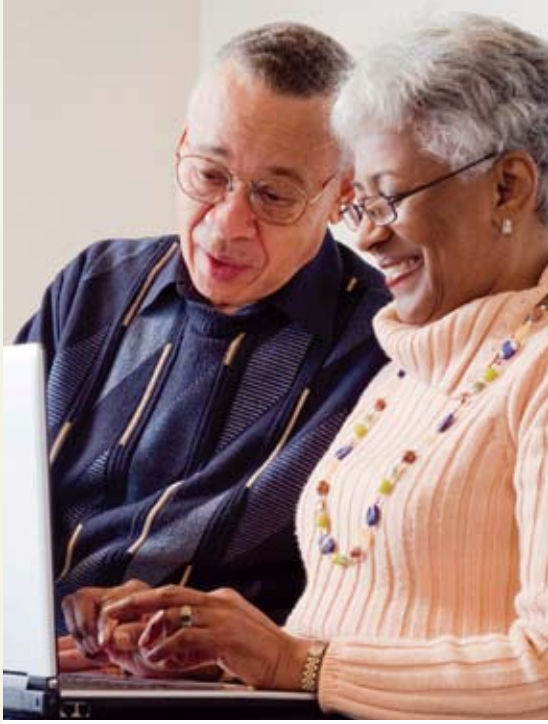
Recycling Information

Take It Back Network – www.takeitbacknetwork.org
Ecolights Northwest – www.ecolights.com
Total Reclaim – www.totalreclaim.com
Enviromental Protection Agency – www.epa.gov/mercury

Utility Websites

Seattle City Light – www.seattle.gov/light/conserve
Puget Sound Energy – www.pse.com
Tacoma Power – www.mytpu.org
Snohomish PUD – www.snohomishPUD.gov
Lighting Design Lab – www.lightingdesignlab.com

This information can be made available on request to accommodate people with disabilities and those who need language assistance.



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The Energy To Do Great Things

city green building
City of Seattle
Department of Planning & Development

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

Seattle Climate Action NOW
SeattleCAN.org

Want to learn more about green building? Visit www.seattle.gov/dpd/greenbuilding

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Thank you!

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