Chapter 9

Water Heating, Appliances and Lighting

Water heating, appliances, and lighting account for a large portion of a home's overall energy consumption. When considering the purchase of this equipment, it is important to consider the energy costs of operating the equipment along with the initial cost of the equipment.

Water Heating

Energy costs for water heating can be as great as those for heating or cooling a house. However, it is easy to cut those bills dramatically with conservation measures and water heating alternatives.

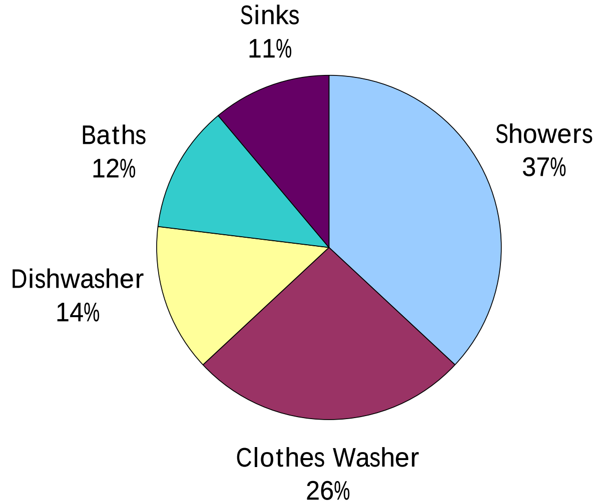
Energy Conservation for Water Heating

No matter what type of energy source is used to heat water, be certain to take advantage of the savings from conservation measures:

- Lower the temperature setting on the water heater to 120°F.
    - Saves energy
    - Reduces the risk of injury from scalding
    - Provides plenty of hot water
    - If hotter temperatures are needed for washing dishes, select a dishwasher with a booster heater
- Wrap the outside of the water heater tank with an insulation jacket. Simple to install – payback is less than 1 year
    - Do not cover the relief or drain valve
    - For gas water heaters, do not block the air inlet to the burner or the flue vent on the top
- Insulate at least four feet of all pipes connected to the unit, but pipe insulation is inexpensive and the slit foam tube type is easy to apply. Therefore, it will pay to insulate as much of the outlet run that is accessible. If the inlet pipes are exposed to cold temperatures, insulate those, too.
- Low-flow showerheads provide a 1-year payback. Well-designed fixtures deliver water at 2.5 gallons per minute or less and still provide plenty of force.
- Heat traps keep heat from escaping from the water heater.
- Low-flow aerators on sink and lavatory faucets.
    - Kitchen sink may need a higher volume flow faucet for filling pots and pans more quickly.

Water heaters come in a range of efficiencies, warranties, and fuel sources. Their efficiencies are measured by a rating known as the *energy factor* (EF).

Figure 9-1
Typical Breakdown of Hot Water Use



Gas Water Heaters

Gas water heaters are typically less efficient, but also cost less to operate than electric water heaters. This is because of the energy loss associated with electrical distribution. Also, with gas-fired power plants providing electricity, any increases in the price of natural gas will be reflected on the price of electricity. One major advantage of gas water heaters is reliability. During hurricanes, natural gas supplies are more reliable than electricity supplies. When a hurricane knocks out electricity for a week or longer it is nice to be able to take a warm shower. A gas water heater can make this possible.

High efficiency gas water heaters can have energy factors above 0.80. In addition to variations in insulation, gas water heater efficiency is also affected by burner design, the shape of the flue baffles which slow the hot exhaust gases down to increase heat transfer to the water, and the amount of surface area between the flue gases and the water.

Higher efficiency gas water heaters have blowers for venting or delivery of combustion air. Most of these units can be vented out of the sidewall of the home rather than the roof because of the forced air blower.

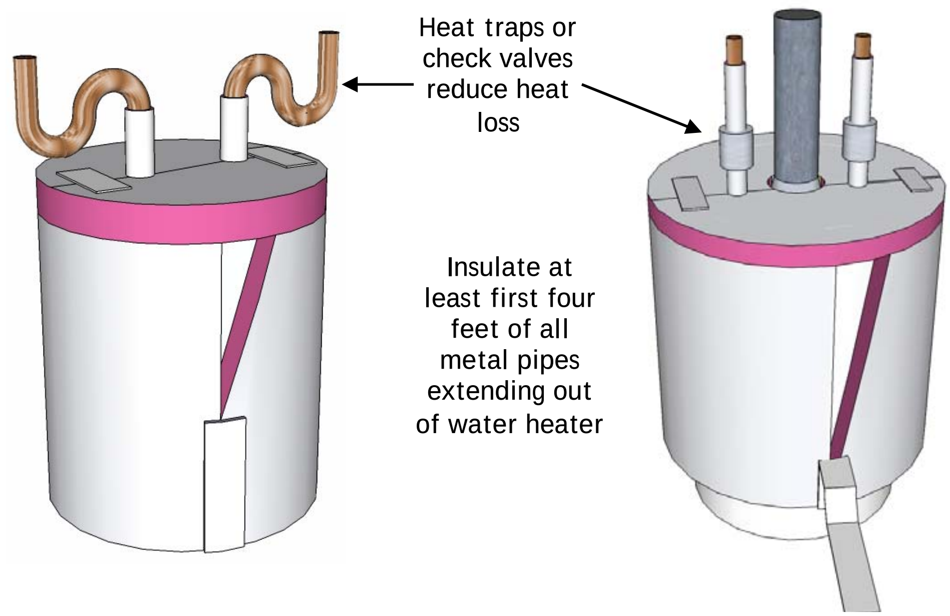
Fuel-fired water heaters should be located in unconditioned spaces that are isolated in terms of pressure and air leakage from the living area. If fuel-fired water heaters are located in the interior spaces, such as interior mechanical rooms connected to conditioned spaces or laundry rooms, they should include provisions for outside combustion air, such as a direct-vent unit. Direct-vent units have a double flue pipe that includes both an intake for combustion air and a flue for exhaust gases.

When shopping for a water heater, use the Energy Guide sticker to compare the estimated annual energy cost for a specific water heater with comparable models. The estimated annual cost shown in bold print on the sticker uses a national average cost of fuel, which could differ significantly in your area.

Electric Water Heaters

For electric water heaters, higher efficiency units have energy factors up to 0.97. Often, the additional cost of a high efficiency unit is quite low compared to the savings. Because of the high cost of electric water heating, more efficient options such as heat recovery units, heat pump water heaters, and solar water heaters should be considered.

Figure 9-2
Insulating Jackets for Electric and Gas Water Heaters



Heat Recovery Units

A *heat recovery unit*, also called a *desuperheater*, recovers excess heat from an air conditioner or heat pump to provide “free” hot water. The heat is captured from the air conditioner’s refrigerant piping between the outlet of the compressor and the inlet of the condenser (outside unit). A heat exchanger on this line extracts heat from the superheated, high pressure refrigerant gas. The refrigerant is hot enough to lose some heat without condensing into a liquid. The refrigerant gas then continues to condenser at a lower temperature. For more information on residential air conditioning, see Chapter 7.

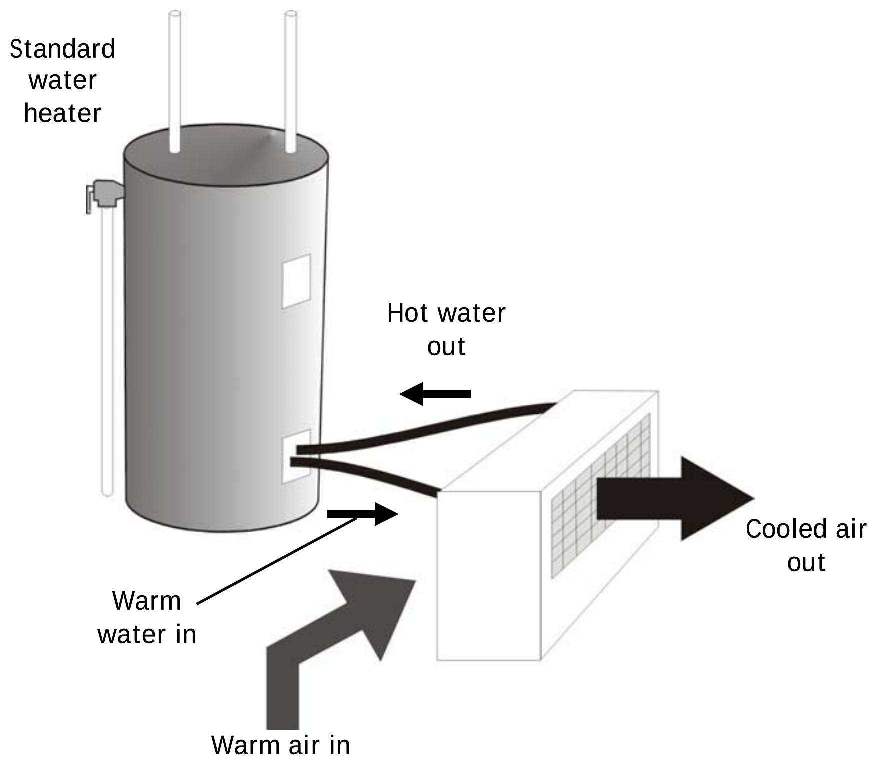
During the summer, the desuperheater can usually provide 100% of the hot water needs of a family while also improving the efficiency of the air conditioner or heat pump. In the spring and fall, with no heating or cooling, the desuperheater is ineffective. In the winter, if connected to a heat pump, the desuperheater will still provide hot water more efficiently than a conventional electric water heater. The energy savings from a desuperheater connected to a central air conditioner depend on how often the air conditioner is used. Savings are typically 20% to 40% of annual water heating costs.

The size and efficiency of the water heater and cooling equipment will affect the performance of the desuperheater. Combining desuperheaters with new, higher efficiency air conditioners or heat pumps, which have lower refrigerant temperatures, can reduce the energy savings. The HVAC system should be at least 2 tons in size to be used effectively with a desuperheater. Before installing a unit, make sure that it will not void warranties on mechanical equipment.

Heat Pump Water Heaters

Heat pump water heaters operate at about twice the efficiency of standard electric water heaters. They use surrounding air as a heat source. As they extract heat from the air, they provide some dehumidification and cooling.

Figure 9-3
Heat Pump Water Heaters



While the cool dry air is an advantage in summer, it is detrimental in winter. It is best to locate the unit in an unconditioned area, such as an unheated basement, where the cooling effect will not cause winter discomfort or higher heating bills. The area must stay above 45°F for the unit to operate properly.

Heat pump water heaters are sold either as separate cabinets which are connected to a conventional water heater or as packages complete with the hot water storage tank. When operating, they are about as loud as an air conditioner, so do not locate them where noise will be a problem.

Solar Water Heaters

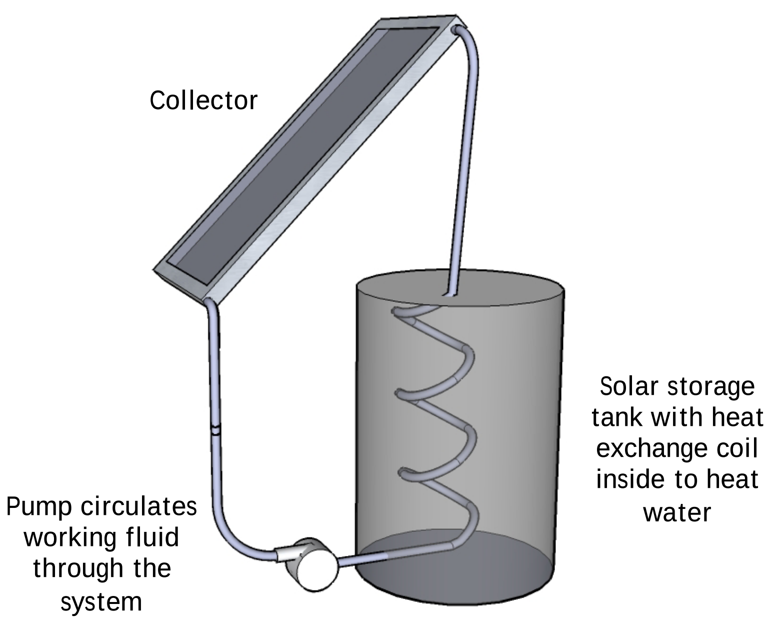
For homes that use a large amount of hot water and receive full sun year-round, solar water heaters may be economical. Most solar water heaters operate by preheating water for a standard water heater. Normally, gas or electric water heaters bring incoming cold water to a desired temperature of about 120°F. A solar water heater uses sunlight to preheat cold water and stores it, often at temperatures well above 120°F.

If the solar-heated water is hot enough, the standard water heater does not need to add more heat. If the water is cooler than needed, the standard water heater will operate as a backup to increase the temperature. Thus, the temperature or availability of hot water is never affected. Of course, even when the solar-heated water is at temperatures below 120°F, the backup unit will use less energy than it would to heat incoming cold water.

A variety of solar water heaters are available commercially, most of which should last 15 years or longer. They are divided into three categories: active, thermosiphon, and batch. In *active* and *thermosiphon* water heaters, solar panels or collectors trap the sun's heat. Water or other fluid running through the collectors absorbs heat and increases in temperature. The liquid then travels to a storage tank where the heat it gains is stored.

Active systems use electric pumps to move the liquid from the collectors to the storage tank. Thermosiphon water heaters require no outside power because they use the natural tendency of water to rise as its temperature increases to push water from the collectors to the storage tank, which must be located higher than the collectors. The hot fluid then passes through a heat exchanger where it heats the domestic water or the incoming water passes through a heat exchanger in the storage tank.

Figure 9-4
Active Solar Water Heating Systems



Some solar water heaters use a single, large storage tank that has a backup source of water heating. Other systems use a standard water heater as a backup and a separate solar storage tank. Active and thermosiphon systems can supply up to 70 percent of a family's annual hot water needs.

The tilt angle of the collector — the angle between the glazing and the horizon — should be within 15 degrees of the latitude. For Louisiana, the tilt angle can be between 18 and 50 degrees. The best tilt angle for a year-round solar device, such as a solar water heater, is 35 to 45 degrees. For solar collectors used only for winter heating, tilt angles can be raised to between 50 and 60 degrees.

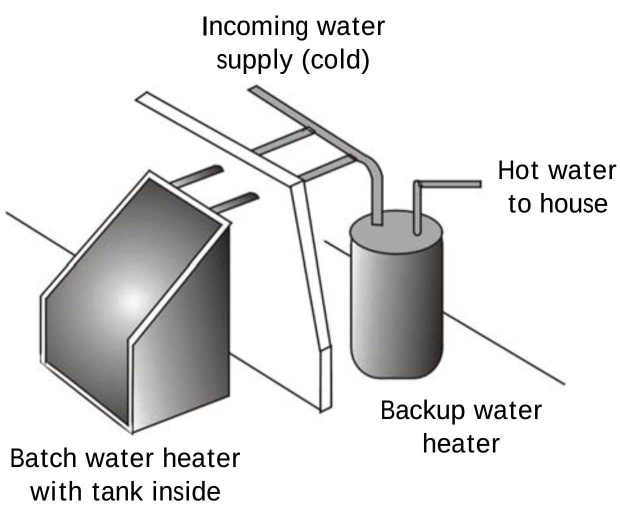
Solar water heaters must be protected from freezing. Active and thermosiphon systems use nonfreezing fluids or automatic drain systems to prevent freezing.

Batch water heaters, also called breadbox water heaters, are simpler than active or thermosiphon systems. However, they provide less hot water, usually about 15 to 40 percent of a family's yearly demand. Batch water heaters combine the collector and storage tank in one box. The box has insulated sides, a clear cover, and one or more tanks inside. In some cases, large tubes are used instead of tanks. A batch water heater can typically store 30 to 60 gallons of hot water.

On a sunny day, sunlight travels through the glazing of the batch unit and strikes the tanks, which are flat black in color. In most cases, the tanks are covered with a special selective surface coating that readily absorbs sunlight, but reduces heat loss from the tank. When the tanks absorb the sun's energy, the water inside the tanks is heated. Local water pressure pushes the solar-heated water into the regular water heater whenever a fixture or appliance, such as a shower or dishwasher, is drawing hot water. Batch heaters are manufactured and sold commercially. However, because of the simplicity of the design, some people build their own.

The collectors for any type of solar water heater should be located as close as possible to the water heater tank to minimize the connecting piping. The glazing should face within 45 degrees of due south. Collectors are usually located on the roof, but they can be attached to supports on the side of a house or on the ground. Because batch water heaters combine collectors, storage tanks, and water, they are heavy. Adequate structural support must be provided when they are located on the roof.

Figure 9-5
Batch Solar Water Heating System



Water inside the tanks of a batch water heater will only freeze on extremely cold nights. However, the water in the pipes that connect the batch heater to the inside can freeze at temperatures around 32°F. A special *freeze prevention drip valve* should be used on a batch water heater.

Solar water heating can provide year round savings. Households that use a large amount of hot water and can adapt the time when hot water is used to match when it is available will benefit the most. Savings will be greatest if laundry, dishes, and bathing are done between noon and early evening - after the sun has heated the water stored in the tank.

Instantaneous Water Heaters

Instantaneous water heaters use higher capacity electric coils or gas burners to heat cold water only when there is a need for hot water. They save energy in two ways: they have no storage tank so there is no need to keep stored water continuously warm, and gas-fired burners on these units usually heat water more efficiently than gas tank-type water heaters. Conventional water heaters keep 30 to 50 gallons of water at a constant temperature - 24 hours a day.

Instantaneous units must be sized carefully for their planned use. A small unit may provide heating for only one faucet or appliance at a time, so a higher capacity model or several units are generally needed to provide hot water for conventional residential uses. By eliminating the standby losses and increasing efficiency, instantaneous water heaters may save 10 to 20 percent of a household's usual water heating bill.

In general, instantaneous water heaters are not particularly cost-effective investments. It is usually more economical to use conservation measures such as low-flow showerheads, insulated tank jackets, reduced thermostat settings to lower standby losses, and to install conventional, high efficiency water heaters.

Appliances

Heating, cooling, and hot water are usually the biggest portion of energy needs in Louisiana homes. However, the cost of operating major appliances is significant. While most new appliances offer a wide variety of features, many models are not designed to be energy efficient. When choosing appliances, it is important to consider their operating costs - how much energy they require to run - as well as the purchase price and the various features and conveniences they offer.

Appliances which operate efficiently may cost more to buy, but the energy savings they provide make them a good investment. For example, running a standard refrigerator over its life of 15 to 20 years costs about three times as much as its purchase price. An energy efficient model can save hundreds of dollars over the life of the appliance. Table 9-1 shows typical annual energy costs for a variety of appliances.

Table 9-1
Typical Energy Costs for Appliances

Appliance	Standard Model ($/yr)*	High Efficiency Model ($/yr)*	10-year Savings
Top Mount Refrigerator	47	38	$90
Side-by-side Refrigerator	68	54	$140
Chest Freezer	39	35	$40
Upright Freezer	76	67	$90
Electric Range	45	36	$90
Gas Range	34	27	$70
Clothes Washer	68	15	$530
Electric Clothes Dryer	48	37	$110
Gas Clothes Dryer	23	19	$40
Dishwasher	47	19	$280

*Analysis assumes cost of electricity to be $0.10 per kWh.

In addition to saving money on operating costs, energy efficient appliances give off less waste heat than standard models. Therefore, they help keep rooms inside the house cooler during warm weather.

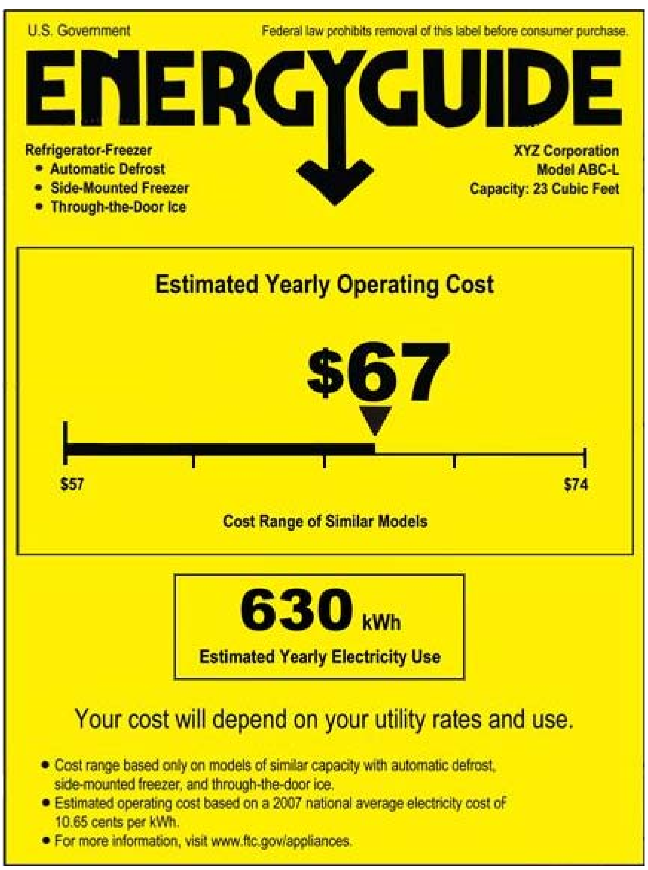
EnergyGuide Label

To compare the energy usage of an appliance, use the EnergyGuide label. Federal law requires that manufacturers display this label on all new refrigerators, freezers, water heaters, dishwashers, clothes washers, and room air conditioners. Energy Guide labels are not currently required on kitchen ranges, microwave ovens, clothes dryers, demand-type water heaters, and portable space heaters.

The large number on the EnergyGuide label tells how much that appliance will cost to operate each year based on an estimate of the amount of energy used and an average national energy costs. The rating for a particular model is shown on a line scale that compares its energy cost against the model with the lowest and highest annual energy costs. Much like the federal miles per gallon ratings for automobiles, the actual amount of energy used and its cost will vary according to local prices and each family's lifestyle.

The EnergyGuide label also provides the name of the manufacturer, model number, type of appliance, and capacity. It has a yearly cost table that shows a range of energy rates and the total annual cost to operate that particular appliance at each rate. Use exact energy rates from local utilities to estimate operating costs for the appliance.

Figure 9-6
EnergyGuide Label



Appliance Shopping Checklist

All Appliances

- Use EnergyGuide label to help select unit. Find the savings in operating costs for more efficient appliances. Divide the savings per year into the extra purchase price to get the payback period. Paybacks of less than five years are generally attractive.

Refrigerators

- The most efficient models are in the 16 to 20-cubic foot range.
- Side-by-side refrigerator/freezers use more energy than similarly sized models with freezers on top.
- Features such as automatic icemakers and through-the-door dispensers add somewhat to energy use.
- Units that are more square, rather than rectangular, also save energy, but may not be as convenient to use.
- Manual defrost units save considerably more than frost-free units, but create more work for the homeowner.
- Look for a power-saving switch that turns off a condensation-prevention heater. Keep this switch off unless the unit experiences significant condensation.
- New generations of refrigerators that do not use chlorofluorocarbons (CFCs) exceed the minimum standards of NAECA by about 30% - the result of the electric utility-funded Super Efficient Refrigerator Program (SERP).
- Try to install the refrigerator in a cooler location - in particular, it should not receive direct sunlight.
- The refrigerator should operate between 36°F and 38°F, and the freezer should be 0°F to 5°F. Adjust temperatures to this range.

Dishwashers

- Water heating accounts for about 80% of energy use.
- Models that use less water also use less energy.
- Models should have light, medium, and heavy cycle options — water use for one dishwasher is 7.5 gallons for a light cycle, 11 gallons for medium, and 13 gallons for heavy.
- Models should have an energy saving "air dry" or "no heat dry" switch.
- Choose a unit that contains a supplemental or booster water heater; then set your water heater to 120°F. Make certain the unit still provides 160°F to the sanitary cycle if desired.
- Minimize pre-rinsing of dishes unless necessary; always rinse in cold water.
- Wash only full loads.

Clothes Washing Machines

- Choose a machine that offers several wash and rinse cycles and several sizes of loads.
- Front-loading models feature faster spin cycles, which dry clothes better, and use less water than top-loading models; in addition, frontloading models usually get clothes cleaner.

Clothes Dryers

- Energy-saving switches and models that detect "dryness" and shut off automatically offer considerable energy savings.
- Some units have moisture sensors in the drum, which save about 15% over standard dryers.

- Others have a temperature sensor in the dryer exhaust, which saves about 10% over standard units.
- If clothes that usually need ironing are removed while slightly damp, they can be hung up to save on dryer and ironing energy use.

Cooking

- Convection ovens are about 1/3 more efficient than standard ovens, but cost much more.
- Electric cooktops with ceramic glass covers are slightly more efficient than coil or disk electric stoves; induction elements, which use electromagnetic energy to heat the pan, are the most efficient, but also cost much more.
- Higher cost models may not save enough energy to make up the cost increase.
- Large kitchen exhaust fans, especially those for side-vented stoves, which can exhaust 400 to 700 cfm should be avoided. They can create considerable negative pressures in tight homes and may cause backdrafting of combustion appliances. The code only requires 100 cfm of ventilation.

Lighting

Standard incandescent bulbs are the most common lighting source for homes. However, incandescent lamps are quite inefficient. They convert only 10 percent of the electricity to lighting; the remainder is waste heat. The lighting industry has responded to the need for energy efficiency with a wide range of excellent products. The most notable of these options are:

- Compact fluorescents that use thin tubes and require less than 1/3 of the electricity to provide as much light as standard incandescent lamps. These products can also provide the same quality of light as incandescent lamps.
- Lower wattage fluorescent tubes, along with efficient electronic ballasts, can reduce the energy needed by a standard 2-lamp, 4-foot fixture from 92 watts to about 60 watts. There are many products available with a high color rendition index (CRI), which measures the ability of a lamp to illuminate colors accurately.
- High pressure sodium and metal halide lamps, mainly intended for exterior use in residences, are four to six times more efficient than standard exterior lamps.

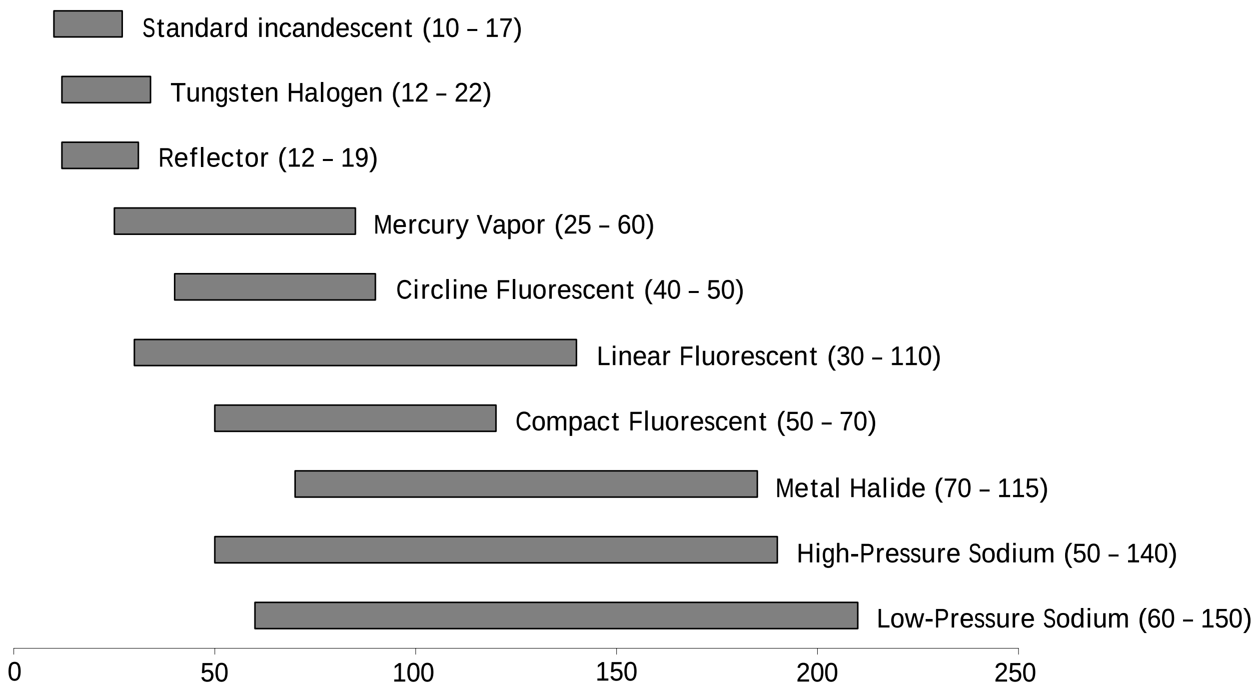
There is great opportunity for originality and ingenuity in residential lighting design. A home combines more functions and needs than most other buildings, yet energy efficient lighting can be achieved at minimal cost. Of course, the needs of each home must be considered individually, but certain conservation measures are applicable to all home designs, including:

- Energy efficient fixtures and lamps for areas of high continuous lighting use, such as the kitchen, sitting areas, and outside the home for safety and security.
- Local task lighting for specific activities such as working at a desk, on a kitchen counter, or in a workshop.
- Accent lighting for areas that need more light enables the overall level of lighting in a room to be reduced.
- Timers and light-sensitive switches for exterior lighting.
- Daylighting – using sunlight as the light source in areas normally occupied during the day.
- Solid-state dimmers and multilevel switches which allow variable lighting levels.

For help in selecting the right bulb, go to: http://www.energystar.gov/index.cfm?c=cfls.pr_cfls

The amount of light a lamp provides is measured in lumens. The electrical energy used to provide that light is measured in watts. The efficiency – called efficacy – of a lamp is measured in lumens of light produced per watt of electricity consumed. Figure 9-7 provides comparative efficacies of different lamp types.

Figure 9-7
Efficacy of Different Lighting Types
(Lumens per Watt)



The lighting level depends on the efficacy of the light source and the ability of the lighting fixture to distribute the light effectively. High efficacy lamps and efficient lighting fixtures reduce wattage requirements while still providing the desired light levels.

In designing a lighting plan, consult knowledgeable professionals about optimum lighting levels and different types of fixtures and lamps. Table 9-2 shows sizing guidelines for tube-type fluorescent lighting systems.

Table 9-2
Fluorescent Lighting Guidelines
(using T-8 lamps and electronic ballasts)

Type of Room	Size of Room	Lighting Needed (Watts)
Living room, bedrooms, family room, or recreation rooms	Under 150 sq. ft.	40 to 60
	150 to 250 sq. ft.	60 to 80
	Over 250 sq. ft.	.33 watt/sq. ft.
Kitchen, laundry, or workshop	Under 75 sq. ft.	55 to 70
	75 to 120 sq. ft.	60 to 80
	Over 120 sq. ft	.75 watt/sq. ft.

Compact Fluorescent Lamps

Table 9-3 shows the purchase and operating costs of incandescent bulbs and compact fluorescent lamps. The options are grouped by comparable lumen output so lamps for similar uses can be compared. The total cost is determined for a period of 10,000 hours, which is the typical life of a compact fluorescent lamp.

For example, a standard 75-watt incandescent lamp costs $54 for electricity and bulb replacements over 10,000 hours of operation. Compare that to a new 19-watt CFL, which has a similar light output. For the same 10,000 hours of operation, the cost of the lamp will be $2.50 and no replacements will be needed.

Table 9-3
Purchase and Operating Costs of Incandescent Lamps and CFLs

	Wattage	Typical Purchase Cost ($)	Lumens	Rated Life (Hours)	Efficacy (Lumens/ Watt)	Electricity Costs for 10,000 Hrs*	Total Cost for 10,000 Hrs
Incandescent and Compact Fluorescent (Cost is for bulbs only)							
Double-life Incandescent	60	$0.50	780	2,000	13	$60	$62.50
Compact Fluorescent	13	$2.00	900	10,000	69	$13	$15.00
Double-life Incandescent	75	$0.50	1,085	1,500	14	$75	$78.33
Compact Fluorescent	19	$2.50	1,200	10,000	63	$19	$21.50
Double-life Incandescent	100	$0.50	1,530	1,500	15	$100	$103.33
Compact Fluorescent	23	$3.00	1,600	10,000	70	$23	$26.00

*Analysis assumes cost of electricity to be $0.10 per kWh.

Concerns about Mercury in Fluorescent Lighting

Some consumers remain concerned about the mercury contained in compact fluorescent lamps. All fluorescent lamps contain very small amounts of mercury. The lamps create light be exciting the mercury molecules with an electric charge. The molecules then emit ultraviolet light, which is converted to visible light by the lamps phosphor coating.

The amount of mercury in the lamp is different for each lamp, but the lamps typically contain only about 5 milligrams of mercury. This mercury is sealed inside of the tube of the lamp and will only escape if the lamp is destroyed. By contrast, using an incandescent bulb requires almost four times the power required by a comparable CFL. The increased electricity use causes a proportional increase in the power plant emissions required to provide that power. One of the emissions produced by coal-fired power plants is mercury.

With coal-fired electricity generation, a 75 watt incandescent bulb will produce approximately 13.2 milligrams of mercury over the standard life of a CFL. During that same period, a comparable CFL will only contribute to the emission of 3.5 milligrams. This means that replacing an incandescent lamp with a CFL can reduce the overall amount of mercury entering the environment, even if all mercury escapes from the CFL.

Economics of Improved Lighting Designs

When choosing lighting fixtures, consider the long-term energy costs of the fixture as well as the purchase price. Energy efficient lighting alternatives reduce waste heat in summer, thereby saving money on cooling costs and increasing comfort levels. In addition, they typically last much longer than standard incandescent lamps.

Table 9-4 shows a sample lighting comparison between a home with standard, incandescent lighting and a home with a variety of efficient lighting technologies. The energy efficient design costs an extra $104, but saves $285 per year on lighting energy bills.

Table 9-4
Sample Improved Lighting Design

Standard Design					Energy Efficient Design				
Room	Type*	Watts	Hrs/ day	kWh/ yr	Type*	Extra Cost	Watts	kWh/ yr	Annual Savings**
Kitchen	I	150	4	438.0	F	$30.00	60	87.6	$13.14
Living	I	150	5	328.5	CFL	$8.28	56	102.2	$17.16
Dining (decorative)	I	75	1	136.9	I	---	75	27.4	$0.00
Bathrooms (2)	I	180	4	262.8	CFL	$4.50	39	56.9	$20.59
Hallway	I	150	4	547.5	F	$30.00	38	55.5	$16.35
Bedrooms (3)	I	225	2	328.5	CFL	$4.50	57	41.6	$12.26
Laundry / Utility	I	100	2	146.0	F	$25.00	30	21.9	$5.11
Closets (5)	I	300	1	109.5	I	---	300	109.5	$0.00
Porch	I	75	4	328.5	CFL	$2.00	19	27.7	$8.18
Exterior Floodlight	H	360	8	1576.8	CFL	$0.00	92	268.6	$78.26
Total Lighting System				4203.0		$104.28		1353.1	$284.99
*I=Incandescent; F=Fluorescent; CFL=Compact Fluorescent									
** Analysis assumes cost of electricity to be $0.10 per kWh.									

Like any component of a home, the selection of lighting system depends on the needs of the occupants and the economics of the systems. Select a lighting system with a low power density and adequate controls. Less efficient systems can be used in rooms which are rarely used, like closets. In rooms that are used frequently, savings associated with a high efficiency lighting system will grow more rapidly, making the system more cost effective. Make sure that the systems selected are economic for the way the system will be used.

Notes: