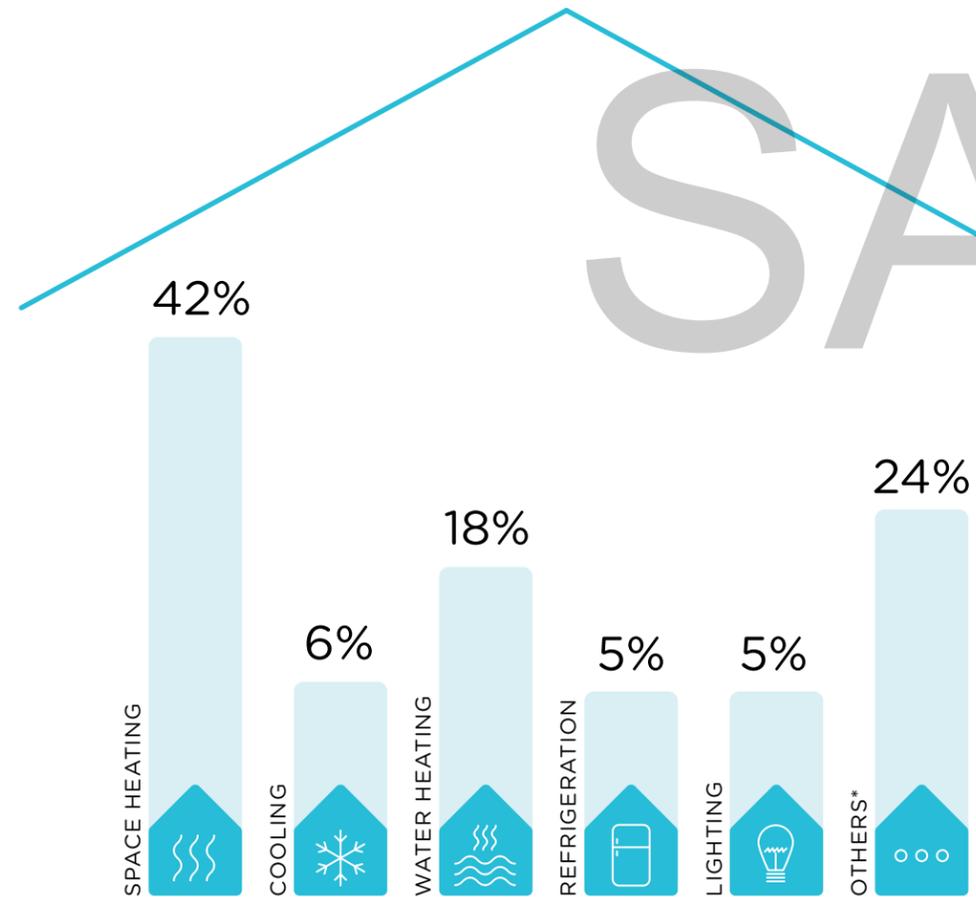


**A GUIDE TO
ENERGY
EFFICIENCY
AT HOME**

ENERGY USE AT HOME

Energy is important and we rely on it every day. We use energy to light and heat our homes, to cook our food, to heat our water for bathing and washing, and even to browse the internet.



*"Others" can represent a variety of household devices, including stoves, ovens, microwaves, and other small appliances like coffee makers.

You have the power to save energy and money too. The more energy you use at home, the more your monthly bill will be. You can reduce your energy use and your monthly bill by making changes to create an energy-efficient home and by conserving energy—using less. While both are important, energy conservation and energy efficiency are different.

WHY SAVE?

Along with saving money, saving energy also reduces the overall demand for the resources (like coal, oil, and natural gas) used to produce a large portion of the energy we use. Coal, oil, and natural gas are known as nonrenewable resources—they are formed naturally over hundreds of millions of years and will eventually become depleted.



WHAT IS ENERGY CONSERVATION?

To conserve energy means simply to use less of it. Energy conservation is any behavior that results in the use of less energy—this can mean turning the lights off when you leave the room or using a fan to cool off instead of the air conditioner.



WHAT IS ENERGY EFFICIENCY?

Energy efficiency means using energy wisely and eliminating ways in which your home wastes energy. Energy efficiency could also mean using technology that requires less energy to perform the same function. For example, replacing an incandescent light bulb with an LED results in using less energy for the same amount of light.

A MORE ENERGY-EFFICIENT HOME IS



A more comfortable home



A safer home



A smart way to save money

How can a more efficient home be more comfortable and safer and also save you money? It's easy to make the connection between using less energy and a lower energy bill, but there are other benefits as well. An efficient home is well insulated and ventilated, which means it won't feel drafty. And the improved air flow will help prevent mold from growing in the house.

ENERGY EFFICIENCY MEANS

Using energy wisely

Using technology that requires less energy to perform the same function

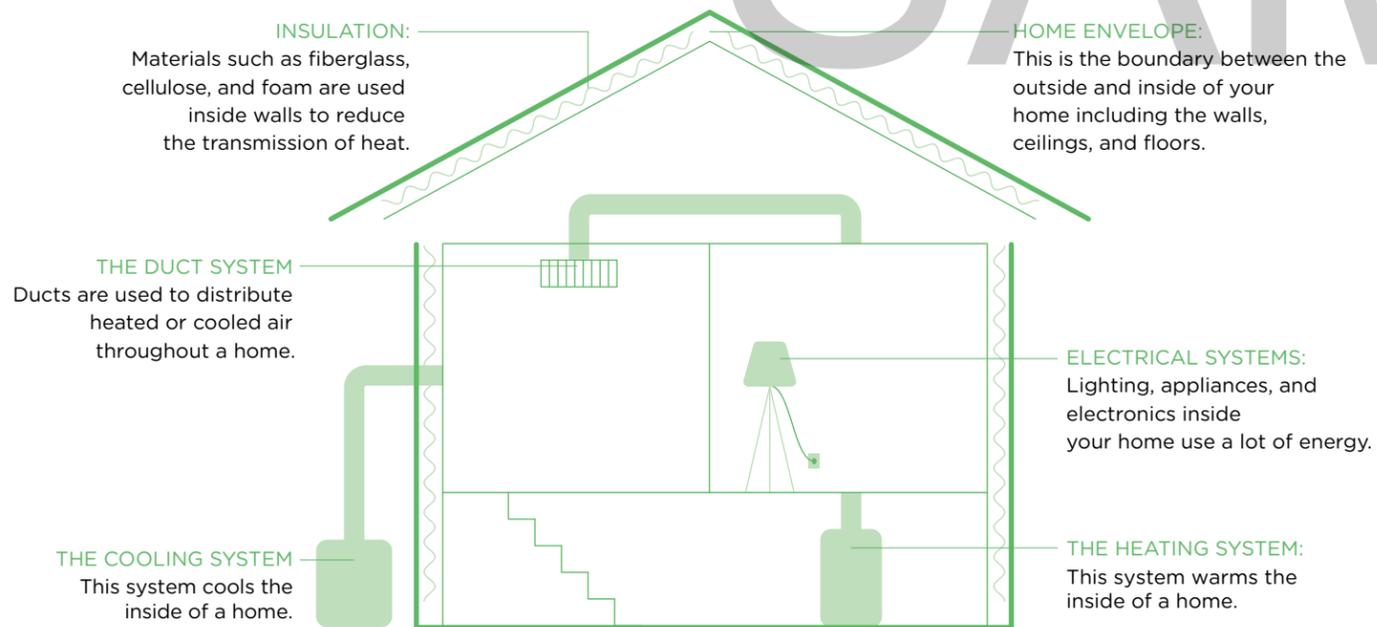
Eliminating ways in which your home wastes energy

Getting the most energy for your money

THE HOME AS A SYSTEM

Energy-efficient homes use energy wisely, keep your family comfortable, and save you money too. An efficient home uses the energy you pay for with as little waste as possible.

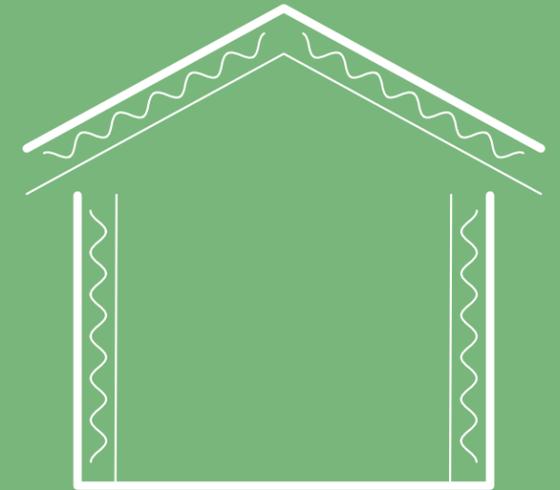
The key to an efficient home is to look at your home as a system of interconnected parts that must all work together well to achieve energy efficiency. Just like your body, when one part is not working well, it affects the entire system. For instance, if you have an upper respiratory infection, it may cause fatigue and congestion too. Similarly, if your home's duct system has many leaks, this may cause problems for your heating and cooling systems. Looking at your home as a system recognizes the connections between your home's components and how making a change to one part will affect how all of the other parts perform. In order to have an energy-efficient home, all of your home's parts must be working well and together as a larger system!



THE HOME AS A SYSTEM

THE HOME ENVELOPE AND THERMAL BARRIER

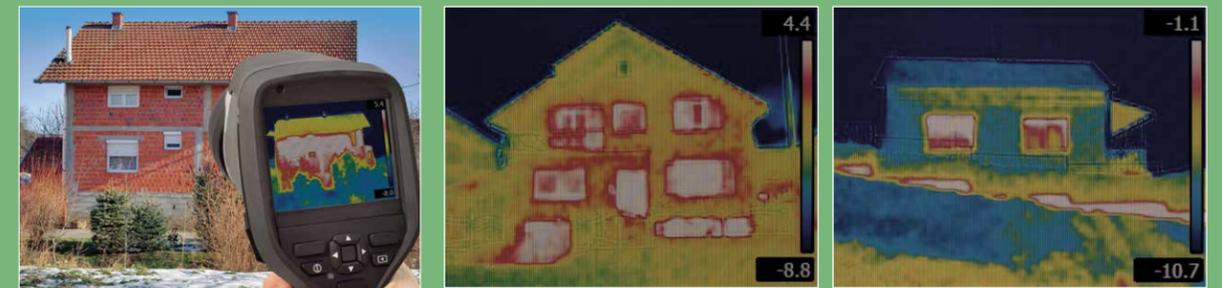
The home envelope is the boundary between the outside world and the inside of your home, including the walls, ceilings, and floors. Creating a thermal barrier in your home envelope prevents heat from moving between the inside and outside of the home. Thermal barriers allow your home's systems to work effectively, can help to save money on heating and cooling costs, and help to keep your indoor spaces more comfortable. Proper insulation, weather stripping, and efficient windows all help to create an effective thermal barrier.



INSPECTING THE THERMAL BARRIER

The best way to test the effectiveness of your thermal barrier is a home energy audit. Energy auditors are professionals who help families make their homes more energy-efficient. Auditors inspect and survey energy use and loss in your home using diagnostic equipment like thermal imagery. They also give tips on how to make your home system more efficient.

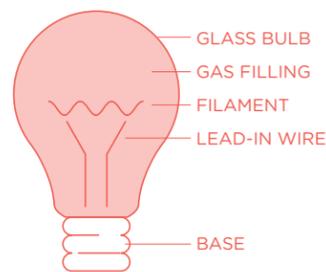
One tool that an energy auditor may use is an infrared camera, which can show where heat is escaping the home. Our eyes have evolved to see only a small section of the electromagnetic spectrum called visible light. You can think of visible light as the colors of the rainbow—red, orange, yellow, green, blue, indigo, and violet. Infrared light has longer wavelengths than visible light. You can think of infrared light as heat. Some creatures, such as snakes, have the ability to detect infrared light, which helps them hunt.



These types of images check the effectiveness of your home's thermal barrier and are usually taken by a professional energy auditor. The image shows the outer layer of your home (the envelope) and where heat is escaping through windows and cracks. This tells the auditor where more insulation, caulking, or sealant is needed.

LIGHTING YOUR HOME: GET OUT OF THE DARK!

Not all electric lighting is the same! More efficient light bulbs can reduce energy used for lighting by 50% to 75%. When lighting your home, it's important to choose a bulb that is both cost- and energy-efficient. There are many types of light bulbs sold, the most energy-efficient kind are called light-emitting diode (LED) light bulbs. These bulbs differ from traditional incandescent light bulbs in how they work, how long they last, and how energy-efficient they are. **Read the following pages to learn more.**



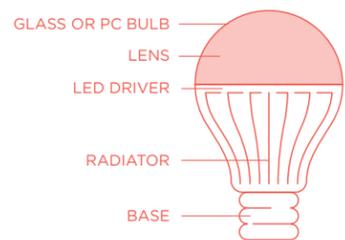
INCANDESCENT BULBS

Incandescent bulbs, an older style of light bulb, are cheap to buy but costly and inefficient in the long run. An electric current passes through a wire inside a glass bulb, causing the wire to heat. The wire, called the filament, gets so hot that it glows and emits light. Incandescent bulbs waste a lot of energy as heat.

PROS: Initially inexpensive

CONS: Very costly in the long run | Waste a lot of energy as heat | They do not last very long—at the most, 1,000 hours | Use significantly more energy than other types of bulbs

Today's incandescent light bulb filaments are made of tungsten. (Tungsten is a chemical element with symbol W and atomic number 74.) At 6,191 °F, Tungsten has the highest melting point of all the metals! That's really hot—for some perspective, the surface of the sun is about 9,941 °F.



LED BULBS

Light-emitting diodes, commonly called LEDs, can last 20,000 to 50,000 hours—that's a lot longer than a standard incandescent bulb. LEDs are semiconductor devices that produce light when an electrical current is passed through them. Inside an LED bulb, the semiconductor consists of two layers—a P-type and an N-type. The N-type layer has extra electrons and a negative charge, while the P-type layer has an overall positive charge and has "holes" that electrons want to fill. The boundary between

these two layers is called a "P-N junction." When an electric current is applied, the electrons move from the negatively charged area to a positively charged area. This process generates energy, which is released as light (photons).

LED light bulbs are highly recommended for home use because they are more efficient. Quality LEDs last longer, are more durable, and offer comparable or better light quality than other types of lighting.

PROS: LED light bulbs are the most energy-efficient type of light bulb available today. They save energy and money!

CONS: The cost per bulb is higher for LEDs than incandescents



In 2014, three Japanese scientists, Isamu Akasaki, Hiroshi Amano and Shuji Nakamura, received the Nobel Prize in Physics for the invention of the blue LED! The blue was the last and most difficult LED bulb to create and was required to create a white LED light. Today, LEDs can be found in all kinds of devices around your home, including digital clocks, remote controls, televisions, and even appliances.

LIGHT AND ENERGY

The amount of light a bulb produces is measured in lumens. LED bulbs are more energy-efficient than incandescent bulbs, meaning they use less energy to produce same amount of light. For example, a 60-watt incandescent light bulb can be replaced by a 9-watt LED.

Compare the lumen output of each type of bulb using this chart. It shows what wattage to look for in an LED bulb to produce the same lumens output as an incandescent bulb.

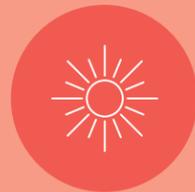
Lumens	Incandescent	LED
450	40W	7W
800	60W	9W
1600	75W	13W
2600	100W	18W

COLOR TEMPERATURE

Light bulbs are available in many different shades of light, from warm whites to cool whites to light that is similar to natural daylight. Light color is measured on the Kelvin (K) temperature scale. A low Kelvin rating means the bulb will emit a warm, yellowish light. A high Kelvin rating indicates the bulb will emit a cool, bluish light, which is closer to natural light. The color of the bulb you choose can affect the mood of the room, so choose carefully!



BRIEF HISTORY OF LIGHTING



SUN

Ancient and modern civilizations have used the sun's light for natural illumination of buildings, homes, and other structures. For example, the Pantheon, an ancient Roman temple, allows sunlight into its interior for natural illumination through a 30-foot hole in the ceiling's center called an oculus.



FIRE

Wood was one of the first fuels used for lighting. In addition to providing light at night, fire enabled us to cook our food and provided heating. There is evidence that widespread fire-making emerged about 125,000 years ago or earlier.



ANCIENT LAMP

Appearing about 72,000 years ago, the first ancient oil lamps were made with hollow rocks, shells, or other natural objects. These containers were filled with a combustible material like moss or dried grass, soaked in animal fat, and ignited for lighting at night.

3000 BC



CANDLE

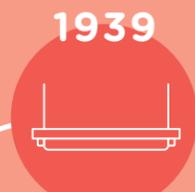
Candles have been used as a light source for thousands of years. Beeswax candles have been found in the tombs of Egyptian pharaohs dating back to 3000 BC—that's about 5,000 years ago!

1790s



GAS LIGHTING

Developed in England in the 1790s, gas lighting technology, powered by whale oil and coal gas, spread quickly. By early in the 19th century, most city streets in the U.S. and Europe were lit by gaslight.



1939

FLUORESCENT LAMPS

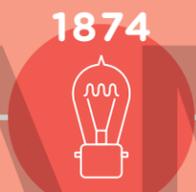
In 1939, General Electric introduced the first fluorescent light and fixture at the New York World's Fair.



1880

COMMERCIAL INCANDESCENT LIGHTING

In 1880, Edison's team tested more than 6,000 materials for their bulb's filament before settling on carbonized bamboo (lasting over 1200 hours!). We still rely on this invention daily.



1874

INCANDESCENT BULB

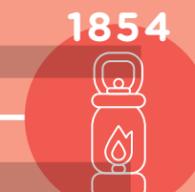
In 1874 Canadian inventors Henry Woodward and Mathew Evans invented and patented an incandescent light bulb housing a carbon filament and nitrogen gas. They did not have enough money to produce and sell the bulbs so they sold the patent to American inventor and businessman Thomas Edison.



1857

GEISSLER TUBE

In 1857 German physicist and glassblower Heinrich Geissler invented the first gas-discharge lamp, called the Geissler tube. Basically, when electrified, glass tubes containing a rarefied gas took on a luminous glow.



1854

KEROSENE LAMP

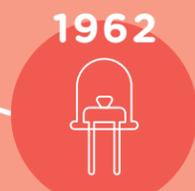
Compared to earlier oil lamps, kerosene lamps burned brighter, cheaper, and cleaner. The advent of kerosene lamps gave the masses access to affordable lighting for the first time.



1800

ARC LAMP

In the early 1800s Humphrey Davy, a British chemist, invented the first practical electric light, called an arc lamp, using a bank of batteries and two charcoal rods. It wasn't until the 1870s that these lights were used commercially. And by 1890 there were 130,000 in the United States, mostly as street lights.



1962

LIGHT-EMITTING DIODES (LEDS)

In 1962 while working for General Electric, Nick Holonyak invented the first visible-spectrum LED (red). Red LEDs were initially used for traffic lights and automobile taillights.



1976

COMPACT FLUORESCENTS (CFLS)

In 1976, Edward Hammer (who also worked for General Electric) created the first compact fluorescent bulb by bending the fluorescent tube into a spiral shape. CFLs became widely available in the mid-1980s and ranged from about \$25 to \$35 a bulb. A CFL bulb today is a lot cheaper—between \$1.50 and \$3.00 a bulb!



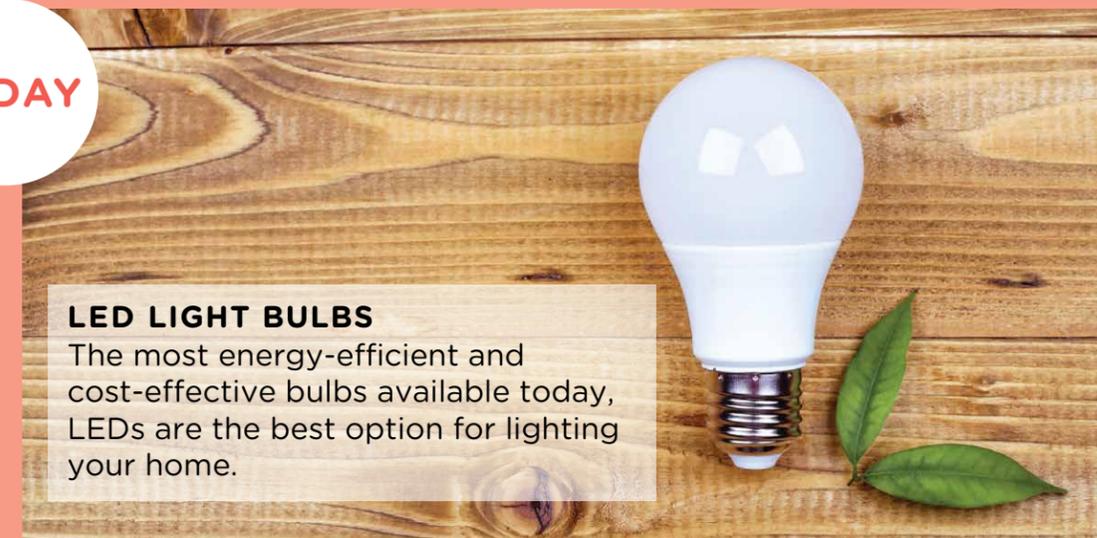
1990s

BLUE THEN WHITE LEDS

In the early 1990s, the blue LED was invented. Soon after, by mixing red, green, and blue light, researchers were able to create the white LED. White LEDs allowed companies to create smartphone and computer screens. They also last the longest and are the most energy-efficient bulbs on the market.



TODAY



LED LIGHT BULBS

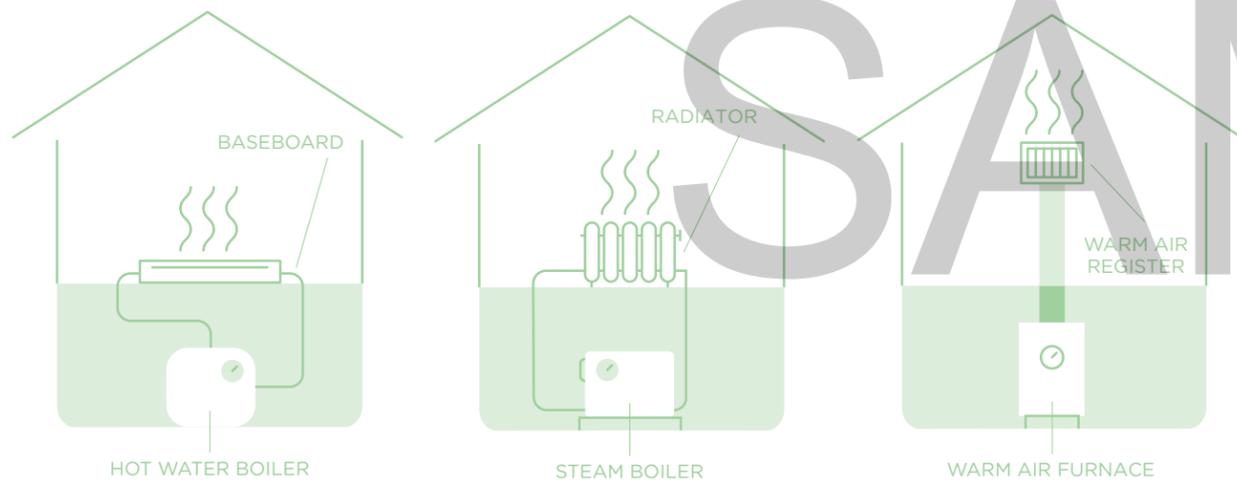
The most energy-efficient and cost-effective bulbs available today, LEDs are the best option for lighting your home.

HEATING & COOLING YOUR HOME

Nearly half the energy used in your home goes toward heating and cooling.

HEATING SYSTEMS

Homes and apartments use a variety of types of heating systems. Some systems use gas or oil, while others use electricity. Central heating systems deliver heat throughout a home by pumping warm air, hot water, or steam generated by a furnace or boiler through a system of ducts or pipes to room radiators or convectors.



HOT WATER BASEBOARD HEATERS use hot water generated by a gas, oil, or electric boiler. The hot water travels through pipes inside the baseboard to warm each room in the house.

STEAM HEATING SYSTEMS use a gas, oil, or electric boiler to heat water, turning it into steam. The steam then travels through pipes to radiators in each room to heat a home.

FORCED-AIR HEATING SYSTEMS deliver heat throughout a home by pumping warm air generated by a gas or electric furnace through a system of ducts and out through vents in each room.

COOLING SYSTEMS

There are many types of air conditioning systems used in homes. These include window, portable, and central air conditioning systems. All of these cooling systems use similar components and direct-expansion refrigeration. When hot air flows over cold, low-pressure evaporator coils, the refrigerant absorbs heat as it changes phase from a liquid to a gaseous state. The resulting gas is then compressed and cooled for conversion back to a liquid state, while any excess heat is released outside.



HEATING AND COOLING EFFICIENTLY

Making informed choices about your home's heating and cooling systems can help your family save significantly on energy costs while improving the comfort of your home. New technologies like programmable and smart thermostats can help you save up to \$180 yearly.



THERMOSTATS

Thermostats allow you to stay comfortable and adjust the temperature of your home to fit your family's schedule.

PROGRAMMABLE THERMOSTATS

If your home has a programmable thermostat, keep the thermostat set as low as is comfortable in the winter and as high as is comfortable in the summer. The recommended settings are 78 °F in the summer months and 68 °F in the winter months. When no one is home or you're sleeping, adjusting temperatures between 5 and 8 degrees (down in winter, up in summer) can help save energy.



SMART THERMOSTATS

Smart thermostats help control the temperature automatically and some even learn from your behavior. They are connected to the internet and accessible through internet-connected devices, such as smartphones and laptops.

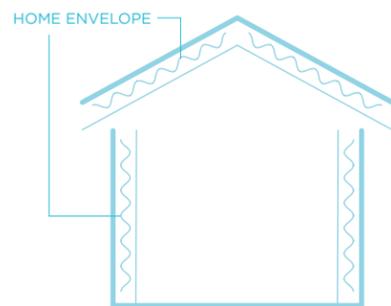
FACT

In the winter, lowering the thermostat as little as **1 °F can reduce a heating bill by 3%.***

*energystar.gov

INSULATING YOUR HOME

The exterior of your home, meaning the outer walls, ceilings, windows, and floor, is called the **home envelope**. Creating a thermal barrier and insulating your home envelope will keep your home warmer in the winter and cooler in the summer. Insulation reduces heat loss.



MOST COMMON TYPES OF MATERIALS USED FOR HOME INSULATION



FIBERGLASS



CELLULOSE



FOAM

Insulation keeps your home comfortable and minimizes energy loss. In fact, by properly sealing and insulating your home, your family can **save up to 10% on your annual energy bill.**



COOL FACT

Many animals have developed their own ways to reduce heat loss by using insulation! The emperor penguin uses its dense, oily feathers and a thick layer of fat beneath its skin to keep warm in Antarctica's subzero temperatures.

EXPERIMENT!

Now that you've learned about home insulation and how it works, try this simple experiment.

MATERIALS

Three identical coffee cans with lids, three identical smaller containers that will fit inside the coffee cans with at least a half inch of space around them, ice cubes, a timer or clock, two materials that you think might work as insulation (e.g., cotton balls, Styrofoam, a cut-up rag, feathers).

TAKE A GUESS

Which material will be the best insulator and keep the ice cube from melting?

PROCEDURE

- ① Place the smaller containers inside the coffee cans.
- ② Surround two of the smaller containers with insulation. Choose one material for each container. Record your materials in the data table below.
- ③ Place a large ice cube in each of the small containers.
- ④ Put the lid on each coffee can and start your timer.
- ⑤ Take a peek at the ice in each container every 5 minutes or so.
- ⑥ In the data table, record how long it took for each ice cube to melt.
- ⑦ If you'd like, repeat the experiment with another type of insulating material.

CONTAINER	INSULATING MATERIAL	TIME IN MINUTES it took for the ice cube to melt
CONTAINER A		
CONTAINER B		
CONTAINER C	NO INSULATION	

FOLLOW-UP QUESTIONS

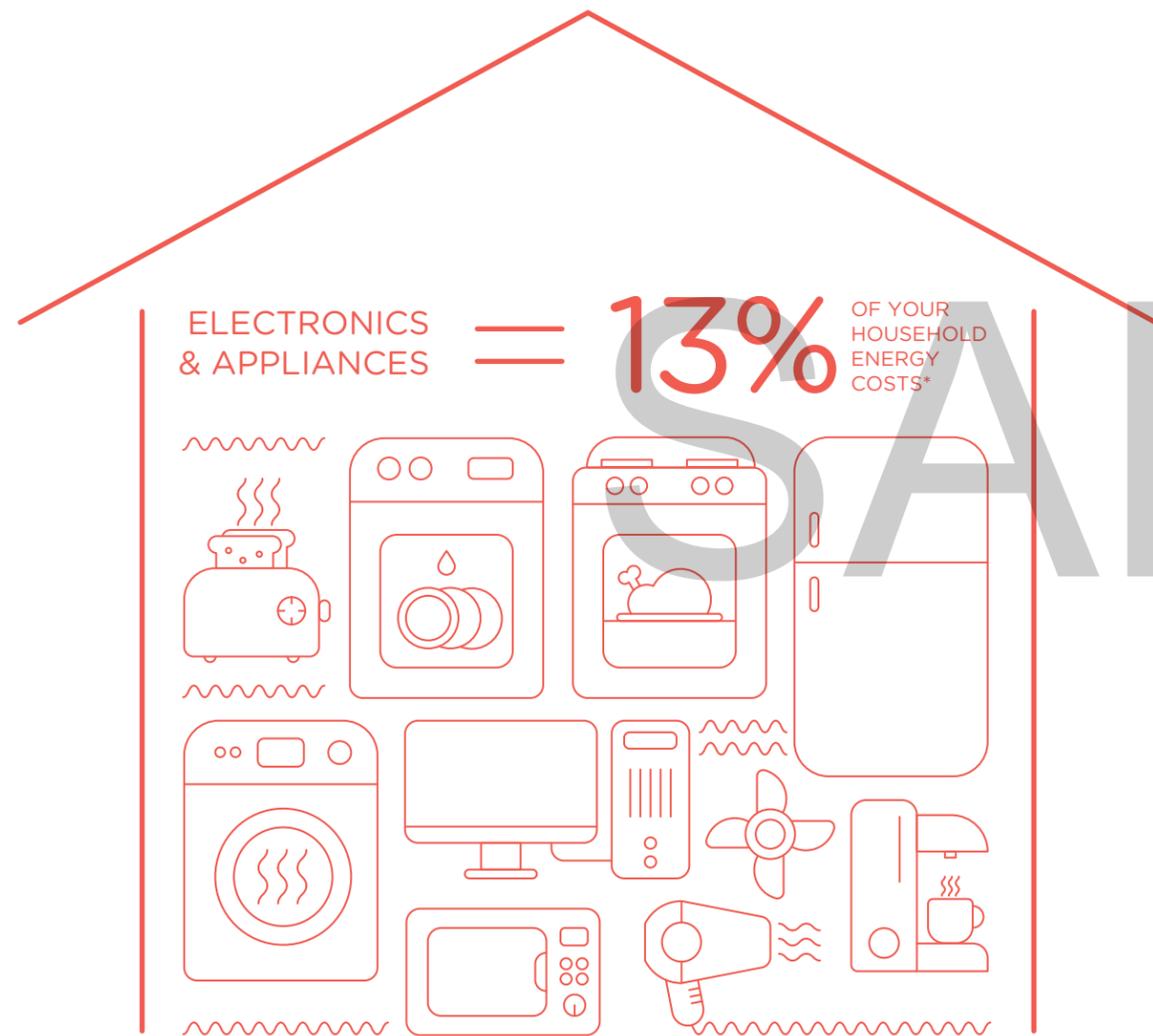
Which container had the slowest melting time? Which insulating material is best? Do you think the results of the experiment would be the same if you put something hot in the inner containers?



IMPORTANT TIP

Keep an eye out for air leaks. Many air leaks and drafts are easy to find because you can feel them. Check vulnerable spots like around windows and doors. If you find a leak, inform an adult—leaks can be sealed with caulk or spray foam.

ELECTRONICS & APPLIANCES IN YOUR HOME



Today, you can find electronics and appliances in almost every room of your home—take a look!

TRY IT!

Appliances and electronics require electricity to work. But how much? Calculate how much energy your electronics and appliance use per month.

NOTE

The wattages provided represent the average. To get a more accurate estimate of your energy use, use the actual wattage listed on your appliance or electronic device instead (usually, the data plate on the back of your appliance will tell you how many watts, amps, and volts are used).

NOTE

Check your utility bill to see how much you pay per kWh!

APPLIANCE OR ELECTRONIC DEVICE	# OF UNITS	(x) WATTAGE	(x) ESTIMATED USE PER MONTH IN HOURS	(=) WATT-HRS PER MONTH (WH/MONTH) TOTAL	(÷1,000 =) KILOWATT-HRS PER MONTH (KWH/MONTH) TOTAL	(x) PRICE PER KWH	(=) TOTAL COST /MONTH
TELEVISION	2	x 150	x 150	= 45,000	÷1,000 = 45	x 0.12	\$5.40
CLOTHES DRYER	#	x 2790	x	=	÷1,000 = ?	x	\$
COFFEE MAKER	#	x 1000	x	=	÷1,000 = ?	x	\$
DESKTOP COMPUTER	#	x 75	x	=	÷1,000 = ?	x	\$
HAIR DRYER	#	x 710	x	=	÷1,000 = ?	x	\$
MICROWAVE	#	x 1500	x	=	÷1,000 = ?	x	\$
REFRIGERATOR	#	x 225	x	=	÷1,000 = ?	x	\$
TOASTER	#	x 1100	x	=	÷1,000 = ?	x	\$

HOW TO USE YOUR APPLIANCES EFFICIENTLY



REFRIGERATOR

- Don't let ice build up in the freezer. Ice buildup causes your fridge to use more energy.
- Don't leave the fridge door open. Try to decide what you want to eat before opening the door.
- Adjust the refrigerator temperature settings. Set the fridge temperature to 36–38 °F and the freezer to 0–5 °F.
- Allow hot foods to cool before putting them in the fridge. Adding heat will force the refrigerator to work harder to keep the air cool inside.
- Keep the fridge full, but not too full. A full fridge will retain the cold better than an empty one. However, keeping the fridge too full can obstruct air circulation.
- Check door seals. A fridge door with a broken seal will let warm air in and cold air out.



DISHWASHER

- Always wash full loads of dishes. It takes the same amount of energy to wash a small load as a full load.
- Use the air-dry option. This will save energy because the machine will not use its heating element to dry your dishes.



OVEN & MICROWAVE

- Instead of the oven or stovetop, use a microwave, Crock-Pot, or toaster oven for small meals. These smaller appliances use less energy than the oven or stove.
- Keep the inside of your microwave clean. This will improve its efficiency.
- Use a lid when heating food in the microwave. Lids help to keep the steam in and help food cook more quickly.



WASHER & DRYER

- When possible, wash in cold water. Most of the energy used for washing clothes comes from heating water.
- Always wash full loads. It takes the same amount of energy to wash a small load as a full load.
- Air-dry your clothes when possible. Air-drying doesn't use any energy!
- Clean the lint filters in the dryer after each use. A clogged filter prevents your dryer from doing its job efficiently.



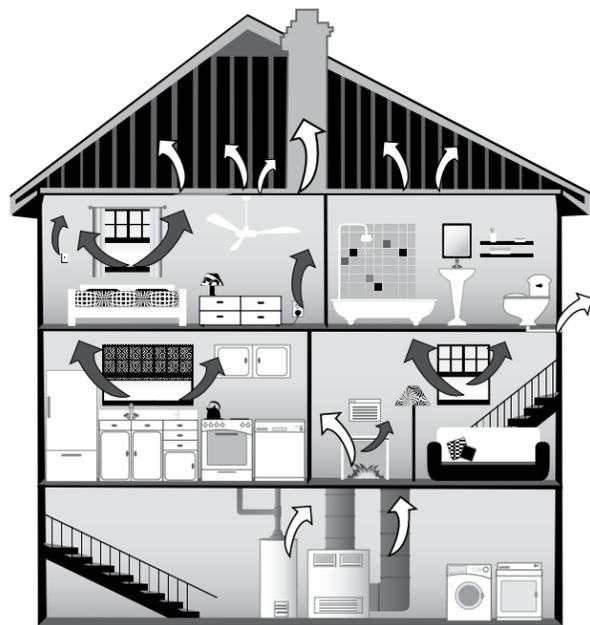
AIR CONDITIONER

- Make sure that you have the right size air conditioner for your home. Buying an air conditioner that is too small or too large will cause the machine to wear down faster and function inefficiently.
- Clean the air filter monthly. Dirty and clogged filters block airflow and will reduce the air conditioner's efficiency.

HOME ENERGY AUDITS

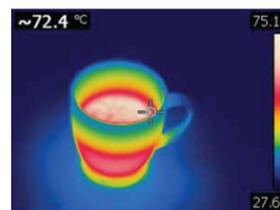
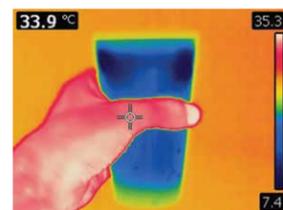
A home energy audit will help you identify ways in which you can make your home more energy-efficient. Energy audits determine where a home is losing energy (which means losing money too!) and pinpoints changes you can make toward an energy-efficient home. You can perform a simple energy audit on your own, but for a thorough look at how your home uses energy, a professional technician called an energy auditor is needed.

Over the next few pages, we will cover what professional auditors look for and the tools they use as well as do-it-yourself audits.



AN AUDIT LOOKS AT THE SYSTEMS OF YOUR HOUSE

- How are the heating and cooling systems working?
- Is air escaping because of leaky windows or a gap in insulation?
- Are appliances working efficiently?



ANALYZE THE IMAGES

Here are two infrared camera images of cups, one containing a hot drink and the other a cold one.

CAN YOU TELL WHICH IS WHICH?

The oranges and reds are warmer and the blues are cooler.

PROFESSIONAL HOME ENERGY AUDIT

For a complete assessment, you'll need to hire a professional home auditor. A professional energy auditor will do a room-by-room assessment of your home that will include checking for leaks, examining insulation, and inspecting the furnace and ductwork.

PREPARATION

Before an energy auditor visits your house, make a list of problems that you have noticed, such as an air leak or drafty room. It is also useful to have copies of your monthly and yearly energy bills handy. Your home energy auditor will use this information during the audit. You can walk through your home with the auditor as they work, and ask questions too!

TOOLS

A professional energy auditor will use a collection of diagnostic equipment and tools to analyze the way your home uses energy. These include common tools you would find at a hardware store, like tape measures, flashlights, and screwdrivers. They will also include specialized equipment like blower doors, infrared cameras, and combustion analyzers.

SAMPLE



1 BLOWER DOOR

Blower door tests locate air leaks by using a special fan to depressurize a house. Usually, a blower door test is done before and after air sealing to check the effectiveness of the work.



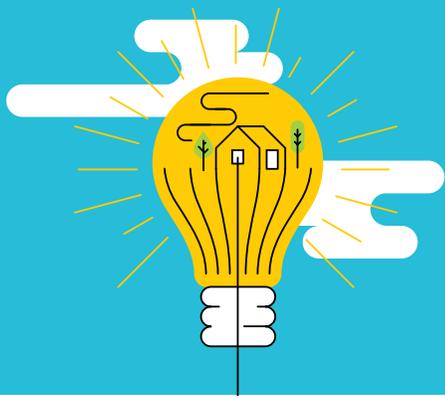
2 INFRARED CAMERA

Thermographic inspections measure the surface temperatures of a home using infrared cameras. Infrared cameras allow auditors to "see" heat. These images help the auditor determine where insulation is needed and where air is escaping through windows and cracks. The infrared images also allow the auditor to check the effectiveness of newly installed insulation.



3 COMBUSTION ANALYZER

Furnaces, water heaters, and other appliances that burn fuel, such as natural gas or oil, are known as combustion appliances. Whenever fuel is burned it produces carbon monoxide (CO), an odorless gas that can be deadly if it escapes into your home. A combustion analyzer will test CO levels around furnaces and other combustion appliances. But you should always have CO alarms in your home to detect any problems.



CONTINUE LEARNING ABOUT ENERGY EFFICIENCY

We hope that reading this booklet is just the start of your interest in home energy efficiency. There are a number of organizations that publish reports and data on energy efficiency. As you continue looking into this topic, they are a great place to start.

Here are some resources to consult:

WWW.EIA.GOV

US Energy Information Agency (EIA): EIA is a government research division that collects and distributes data on energy production, distribution, and usage. You can find reports based on the data and the raw data, as well as the raw data, on EIA's website.

WWW.ACEEE.ORG

American Council for an Energy-Efficient Economy (ACEEE): ACEEE is a Washington, D.C.-based nonprofit that researches all aspects of energy efficiency. Its reports cover a wide range of subjects, from home efficiency to industrial and transportation efficiency programs and even the best ways to talk about energy efficiency.

**ENERGY SAVING TIPS:
THE US GOVERNMENT HAS MULTIPLE WEBSITES
THAT DISCUSS WAYS TO SAVE ENERGY**

WWW.EERE.ENERGY.GOV

Department of Energy Office of Energy Efficiency and Renewable Energy (EERE): EERE's website is full of background information and advice on energy efficiency and renewable energy.

WWW.ENERGYSTAR.GOV

ENERGY STAR®: ENERGY STAR is a program run by the Environmental Protection Agency to evaluate the efficiency of appliances, buildings, and even industrial plants. Earning the ENERGY STAR symbol means that the appliance, building, etc. is more efficient than others that are similar. This website has a wealth of information on choosing energy-efficient options and what needs to be done to achieve efficiency.

**CAREERS:
CONSIDER A CAREER IN ENERGY EFFICIENCY**

WWW.ENERGY.GOV/EERE/EDUCATION/CLEAN-ENERGY-JOBS-AND-CAREER-PLANNING

Clean Energy Jobs and Career Paths: This is a site by the Department of Energy to help you evaluate potential career paths in energy efficiency and renewable energy.

WWW.BPI.ORG/BUILDING-SCIENCE-PRINCIPLES

Building Performance Institute (BPI): BPI is one of the major credentialing organizations in the energy efficiency field. Its website covers what kind of training you'd need, and exams you'd have to take, to become an energy auditor or work on energy-efficiency upgrades.

RESOURCES

U.S. DEPARTMENT OF ENERGY
WWW.ENERGY.GOV

**U.S. ENERGY INFORMATION
ADMINISTRATION**
WWW.EIA.GOV

ENERGY STAR
WWW.ENERGYSTAR.COM