Wood and Pellet Stove Heating

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Before the 20th century, 90% of Americans burned wood to heat their homes. As fossil fuel use rose, the percentage of Americans using wood for fuel dropped, falling as low as one percent by 1970. Then during the energy crises of the 1970s, interest in wood heating resurfaced as a renewable energy alternative. Newer on the scene are pellet fuel appliances, which burn small pellets that look like rabbit feed and measure 3/8 to 1 inch in length. Pellets are made from compacted sawdust, wood chips, bark, agricultural crop waste, waste paper, and other organic materials. Some pellet fuel appliances can burn a wide variety of biomass fuels, including nutshells, corn kernels, small wood chips, barley, beet pulp, sunflowers, dried cherry pits, and soybeans.
Choosing and Installing Wood and Pellet Burning Appliances Today you can choose from a new generation of wood- and pellet-burning appliances that are cleaner burning, more efficient, and powerful enough to heat many average-sized, modern homes. It's also important to use a properly sized appliance for the space to be heated. When an appliance is too big, residents tend to burn fires at a low smolder to avoid overheating, which wastes fuel and is one of the biggest causes of air pollution. A reputable dealer should talk with you about size requirements, but a good rule-of-thumb is that a stove rated at 60,000 British Thermal Units (Btu) can heat a 2,000 square foot home, while a stove rated at 42,000 Btu can heat a 1,300 square foot space. Wood-burning appliances and fireplaces may emit large quantities of air pollutants. Wood smoke contains hundreds of chemical compounds including nitrogen oxides, carbon monoxide, organic gases, and particulate matter, many of which have adverse health effects. In many urban and rural areas, smoke from wood burning is a major contributor to air pollution. Because of this, some municipalities restrict wood heating appliance use when the local air quality reaches unacceptable levels. Others restrict or ban the installation of wood-burning appliances in new construction. Before installing a wood-burning system, you should contact your local building codes department, state energy office, or state environmental agency about wood-burning regulations that may apply in your area. If you have an older wood-burning appliance, consider upgrading to one of the newer appliances certified by the U.S. Environmental Protection Agency (EPA). They include a catalytic combustor that allows combustion gases to burn at lower temperatures, thereby cleaning the exhaust gas while generating more heat. All woodstoves sold today should bear an EPA certification sticker. High-efficiency appliances not only have lower emissions but they are also often safer, since complete combustion helps to prevent a buildup of flammable chimney deposits called creosote. If you want to retrofit an existing non-catalytic wood-burning appliance with a catalytic combustor, you can buy a catalytic damper. These are available as kits and are usually installed in the flue collar. To monitor the stove temperature after adding a catalytic combustor, you should also install at least one heat sensor on the stove body or stove pipe. Several manufacturers sell retrofit kits, and they may be available from wood stove retailers. They are not appropriate for all types of stoves. Again, be sure to follow the manufacturer's installation and operating instructions. The location of the appliance (and chimney) will influence how well heat is distributed and conserved in your home. Most wood- and pellet-burning appliances are essentially space heaters, and should be put in the room where you spend most of your time. Ideally, there should be a way for heat to circulate to the rest of the house. For safety, and to maximize efficiency, you should consider having a professional install your wood- or pellet-burning appliance. A professional will carefully evaluate everything from your chimney to your floor protection. A certified professional can also help you choose the best appliance to heat your home.
Types of Wood- and Pellet-Burning Appliances

The following is a brief overview of the different types of appliances available. High-efficiency fireplaces and fireplace inserts Designed more for show, traditional open masonry fireplaces should not be considered heating devices. Traditional fireplaces draw in as much as 300 cubic feet per minute of heated room air for combustion, then send it straight up the chimney. Fireplaces also produce significant air pollution. Although some fireplace designs seek to address these issues with dedicated air supplies, glass doors, and heat recovery systems, fireplaces are still energy losers. When burning a fire, you should turn your heat down or off and open a window near the fireplace. Only high-efficiency fireplace inserts have proven effective in increasing the heating efficiency of older fireplaces. Essentially, the inserts function like woodstoves, fitting into the masonry fireplace or on its hearth, and use the existing chimney. You must install a flue collar that continues from the insert to the top of the chimney. A well-fitted fireplace insert can function nearly as efficiently as a woodstove. Studies have shown that proper installation of fireplace inserts is very important. Have a professional installer examine the fireplace and chimney to determine if they are suitable for an insert. Inserts should be as airtight as possible. The more airtight it is, the easier it is to control the fire and the heat output. The installer should use only approved fireplace insulating materials to fill any gaps between the fireplace mouth and insert shield. Moving an insert to clean the chimney or liner can be difficult, and is a job best left to a professional chimney sweep. In some situations, a clean-out door can be installed above the insert connection so the insert does not have to be moved as often. Some models have wheels to simplify installation, cleaning, repairs, and other adjustments. Some modern fireplaces heat at efficiencies near those of woodstoves and are certified as low emission appliances. Although designed to include the fire-viewing benefits of a traditional fireplace, this generation of fireplaces can effectively provide heat as well. Through vents under the firebox, room air is drawn in, heated through a heat exchanger, and sent back into the house either through vents at the top of the fireplace or through ducts leading to nearby rooms. Some of these fireplaces are approved to route heated air to a basement auxiliary fan. The air then travels through ducts to other rooms in the house. The fireplace should have a dedicated supply of outside air for combustion. Flues are ideal for leaking heat and warm air out of your home. If you have a fireplace that you don't use, plug and seal the flue. If you use the fireplace, be

sure to close the flue when the fireplace is not in use. You could also use an inflatable stopper, available commercially, to temporarily seal the chimney and avoid air leakage through the flue. Catalytic Wood Stoves, Advanced Combustion Woodstoves, and Centralized Wood-Burning Boilers Wood stoves are the most common appliance for burning wood. New catalytic stoves and inserts have advertised efficiencies of 70%–80%. Advanced combustion woodstoves provide a lot of heat but only work efficiently when the fire burns at full throttle. Also known as secondary burn stoves, they can reach temperatures of 1100°F—hot enough to burn combustible gases. These stoves have several components that help them burn combustible gases, as well as particulates, before they can exit the chimney. Components include a metal channel that heats secondary air and feeds it into the stove above the fire. This heated oxygen helps burn the volatile gases above the flames without slowing down combustion. While many older stoves only have an air source below the wood, the secondary air source in advanced combustion stoves offers oxygen to the volatile gases escaping above the fire. With enough oxygen, the heated gases burn as well. In addition, the firebox is insulated, which reflects heat back to it, ensuring that the turbulent gases stay hot enough to burn. New advanced combustion stoves have advertised efficiencies of 60%–72%. Another benefit is that the secondary channels funnel hot air toward the glass doors, keeping them clean for viewing the fire. They can also be slightly less expensive than conventional woodstoves fitted with catalytic combustors. Like wood stoves, centralized wood-burning boilers have been improved over the last several years. Modern, centralized wood heaters use wood gasification technology that burns both the wood fuel and the associated combustible gases, rendering them efficient up to 80%. In addition, systems are available that can switch to oil or gas if the fire goes out. Masonry heaters Masonry heaters are also known as "Russian," "Siberian," and "Finnish" fireplaces. They produce more heat and less pollution than any other wood- or pellet-burning appliance. Masonry heaters include a firebox, a large masonry mass (such as bricks), and long twisting smoke channels that run through the masonry mass. Their fireboxes are lined with firebrick, refractory concrete, or similar materials that can handle temperatures of over 2,000°F (1,093°C). A small hot fire built once or twice a day releases heated gases into the long masonry heat tunnels. The masonry absorbs the heat and then slowly releases it into the house over a period of 12–20 hours. Masonry heaters commonly reach a combustion efficiency of 90%. Most are intended for burning wood, but they were historically designed to burn almost any type of solid fuel. The relatively small, but intense fire also results in very little air pollution and very little creosote buildup in the chimney. Because most of the heat from the fuel is transferred to the masonry and slowly released into the room over the day, this type of heater does not need to be loaded with fuel as often as other types of wood heating appliances. In addition, if the masonry heater is built where sunlight can directly shine on it in the winter, the heater will absorb the sun's heat and release it slowly into the room. A wide variety of masonry heater designs and styles are available. Larger models resemble conventional fireplaces and may cover an entire wall. Smaller models take up about as much space as a wood or pellet stove. They can be custom-built or purchased as prefabricated units. Some large designs may cost $5,000 or more. Plans and kits are available, but they are not easy do-it-yourself projects and require experience in working with masonry. In addition to their expense, masonry heaters have one significant disadvantage when compared to conventional wood stoves and fireplaces: They cannot provide heat quickly from a cold start. Pellet Fuel Appliances Pellet fuel appliances burn small, 3/8–1 inch (100–254 millimeter [mm])-long pellets that look like rabbit feed. Pellets are made from compacted sawdust, wood chips, bark, agricultural crop waste, waste paper, and other organic materials. Some models can also burn nutshells, corn kernels, and small wood chips. They are more convenient to operate and have much higher combustion and heating efficiencies than ordinary wood stoves or fireplaces. As a consequence of this, they produce very little air pollution. In fact, pellet stoves are the cleanest of solid fuel-burning residential heating appliances. With combustion efficiencies of 78%–85%, they are also exempt from United States Environmental Protection Agency (EPA) smoke-emission testing requirements. Pellet stoves have heating capacities that range between 8,000 and 90,000 Btu per hour. They are suitable for homes as well as apartments or condominiums. Most pellet stoves cost between $1,700 and $3,000. However, a pellet stove is often cheaper to install than a cordwood-burning heater. Many can be direct-vented and do not need an expensive chimney or flue. As a result, the installed cost of the entire system may be less than that of a conventional wood stove. Pellet fuel appliances are available as freestanding stoves or fireplace inserts. Freestanding units resemble conventional cordwood heaters in that they generally heat a single room well, but not adjacent rooms unless you use a fan to force the warm air into those other spaces. There are also fireplace inserts that fit into existing fireplaces. Several companies now make pellet-fired furnaces and boilers for replacement of, or a supplement to, gas or oil fired furnaces and boilers in residential space heating systems. All pellet fuel appliances have a fuel hopper to store the pellets until they are needed for burning. Most hoppers hold 35 and 130 pounds (16 and 60 kilograms [kg]) of fuel, which will last a day or more under normal operating conditions. A feeder device, like a large screw, drops a few pellets at a time into the combustion chamber for burning. How quickly pellets are fed to the burner determines the heat output. The exhaust gases are vented by way of a small flue pipe that can be directed out a side wall or upwards through the roof. More advanced models have a small computer and thermostat to govern the pellet feed rate. Pellet appliances usually require refueling only once a day, and since the fuel is compressed and bagged, the operator does not have to lift heavy, dirty logs. Most pellet appliance exteriors (except glass doors) stay relatively cool while operating, reducing the risk of accidental burns. Since pellet stoves burn fuel so completely, very little creosote builds up in the flue, posing less of a fire hazard. Unfortunately, pellet appliances are also more complex and have expensive components that can break down. They also require electricity to run fans, controls, and pellet feeders. Under normal usage, they consume about 100 kilowatt-hours (kWh) or about $9 worth of electricity per month. Unless the stove has a back-up power supply, the loss of electric power results in no heat and possibly some smoke in the house. Chimney Placement and Sizing Chimneys harness the heat of the fire to create what's called a stack effect. As the warm air from the fire rises, cooler house air rushes into the wood-burning appliance through vents, providing the oxygen the fire needs to burn. Starting a fire with a good hot burn will encourage this healthy draft to flow. Also, between the higher

and lower pressure zones of the home lies a neutral pressure zone. The neutral pressure zone tends to move toward the largest air leak. When the top of the chimney is located above the home ceiling (as it should be), the chimney's neutral pressure zone is above the neutral pressure zone of the house. Such proper chimney placement creates a gentle flow of air into the appliance and out the chimney even when no fire burns. If you are designing or building a new home, consider placing the chimney inside your home. A more traditional chimney, constructed along the outside of a home, will lose valuable heat to the cold, outside air. If the chimney air temperature falls below that of the inside air, the cold, smelly chimney air will be pulled into the house by the low pressure of the stack effect. In such a scenario, the house has become a better chimney than the chimney. So when a fire is lit, smoke fills the room. Chimneys must match the size of the appliance, meaning the flue size should match the stove outlet. If the chimney is bigger than the stove or fireplace outlet, exiting exhaust slows, increasing creosote buildup and decreasing efficiency. High-performance chimneys are also insulated. Older masonry chimneys can be relined to safely and efficiently connect them to newer high-efficiency, wood-burning appliances. Again, the chimney liner should be continuous from the appliance outlet to the chimney top. It is not uncommon to pay as much for the chimney as for your appliance. Free-standing woodstoves exhaust into a connecting pipe, which then connects into the chimney. If the connecting pipe is longer than 8 feet (as in a vaulted ceiling), you should consider investing in double-layer pipe with 1-inch airspace between pipe layers. Efficient modern stoves produce large amounts of heat. Much of this heat can radiate from a longer length of single-layer pipe, slowing down the draft, which can impact the overall efficiency of your wood-burning system. Maintenance To keep your wood- or pellet-burning system operating efficiently and safely, you'll need to maintain it on a regular basis. Every year, preferably before each heating season, have a chimney sweep certified by the Chimney Safety Institute of America inspect your wood-burning system. In addition to cleaning the chimney, a certified chimney sweep should have the knowledge to help make sure your appliance, hearth, connecting pipe, air inlets, chimney, and all other components are functioning efficiently and safely. Catalytic combustors need to be inspected at least three times every heating season and replaced according to the manufacturer's recommendations. Most catalytic stoves or inserts have a view window or thermometer to help you check the combustor. The catalytic cell is removable and replaceable and costs between $75 and $160. Cleaning out the inside of the appliance with a wire brush periodically will also help your wood-burning appliance heat your home efficiently. Even a one-tenth inch of soot can drop the heat transfer efficiency of the metal by 50%. For pellet-fuel appliances, it is very important to follow the manufacturer's instructions for operation and maintenance. Inspect fans and motors regularly, and maintain them properly. Manufacturers advise removing unused pellets from the stove hopper and feed system at the end of the heating season. This reduces the chance of rusting, which can cause expensive damage to the appliance. It also minimizes difficulties in lighting the appliance at the start of the next heating season. Clean the flue vent on a regular basis to prevent soot building up. Wood and Pellet Fuels Selecting and Storing Wood Because a lot of energy can be wasted burning wet wood, you should use wood that has been properly seasoned. Properly seasoned wood is harvested in the spring and allowed to dry throughout the summer. Look for wood that is of even color, without any green. It should have a moisture content of just over 20%–25% by weight. Some well-seasoned wood can in fact be too dry for today's airtight modern stoves. If you place wood that is too dry on a bed of coals, it will instantly give up its gases as smoke, wasting unburned smoke and producing creosote buildup. All species of wood have a similar heat (Btu) content on a per pound basis when completely dry. Therefore, denser woods will generally cost more and burn longer. Woods like oak, hickory, and pine will burn overnight. Aspen builds a hot fire, which helps clean the chimney. When selecting wood, you might also want to find out whether the supplier uses sustainable harvesting practices. Unsustainable practices can negatively impact the environment, causing soil erosion and loss of biodiversity. At least ascertain that the wood was not the result of clear-cutting. Clear-cutting is when all, or nearly all, of the trees are cut down on a piece of land. Store your wood away from the house in case termites discover the woodpile. The top of the pile should be covered, but leave the sides open so air can circulate. If possible, store the wood a foot off the ground (on concrete blocks, for example) to keep it dry. Pellet Fuel Pellet fuel is normally sold in 40 pound (18 kg) bags at about $3–$4 each, or about $120–$200 a ton. You can estimate how much fuel you will need for a heating season by noting that one ton of pellets is equivalent to approximately 1.5 cords of firewood. Most homeowners who use a pellet appliance as a main source of heat use two to three tons of pellet fuel per year. Pellet fuel appliances are often less expensive to operate than electric resistance heating and propane-fueled appliances. Most pellet fuels have a 5%–10% moisture content. Well-seasoned firewood is usually around 20%. Some pellets contain either petroleum or non-petroleum lignin used as a lubricant in the pellet production process, though most contain no additives. Pellets made from agricultural waste contain more ash, but they may produce more heat than pellets made from wood. The Pellet Fuels Institute (PFI) maintains National Residential Pellet Fuel Standards, although fuel quality certification is the responsibility of the pellet manufacturer. Under the standards, there are two pellet fuel grades: premium and standard. The only difference between grades is in the inorganic ash content: premium should be less than 1%, and standard less than 3%. Premium is usually made of core wood (not bark). There are five fuel characteristics prescribed for both grades:

- Bulk density per cubic foot (0.028 cubic meters) shall not be less than 40 pounds (18 kg)
- The diameter shall be 1/4 to 5/16 inch (635-794 mm)
- Maximum length shall be 1 and 1/2 inches (254-127 mm)
- Fines (dust) of not more than 0.5% by weight shall pass through a 1/8 inch (317.5 mm) screen
- Sodium content shall be less than 300 parts per million (ppm). You can check pellet fuel quality by inspecting the bag for excessive dirt and dust. (Dirt can form clinkers in the stove.) There should be less than one half of a cup of dust at the bottom of a 40 pound (18 kg) bag. Pellet stoves designed for low-ash (typically top-fed stoves) tend to operate poorly when used with pellets of a higher ash content. Many pellet appliance manufacturers are redesigning their products to burn pellets with varying ash contents. Although pellet fuel availability is increasing, you should be sure there is a

reliable pellet fuel supplier in your area before purchasing a pellet stove. It is also important to know the type of pellet fuel available before you shop for an appliance. Most pellet fuel appliance dealers either maintain a supply of pellets or recommend a supplier. You may also check the local telephone listings under "Fuel" or "Pellet Fuel," or inquire at a local tree nursery, or at home and garden supply stores.