



HEATING SYSTEMS FOR ENERGY AUDITORS
AND INSPECTORS

Other Heat Sources

Learning Objectives

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OTHER HEAT SOURCES

By attending this session, participants will:

- Be able to identify the less common sources of space heating.
- Know enough about these other sources of heat to be able to help clients make decisions about replacement and installation.
- Understand the DOE requirements for unvented space heaters.
- Know enough about pellet and cord wood to help clients when they are purchasing these fuels.

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- Know enough about these other heat sources to help clients make decisions about replacement and installation.
- Understand the DOE requirements for unvented space heaters.
- Gain a basic understanding of heat pump operation.

Other Heat Sources

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OTHER HEAT SOURCES

- Vented combustion space heaters.
 - Natural gas.
 - Propane.
 - Kerosene.
- Solid fuel space heaters.
 - Pellet stoves.
 - Cord-wood stoves.
- Electric heat.
 - “Central” systems (baseboard units, electric furnace).
 - Space heaters.
- Heat pumps.

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Auditors will find a variety of heat sources in client homes. How do they compare?

- **Vented combustion space heaters** are available in natural gas, propane, and kerosene. Additionally, all are available in direct-vent models that have efficiencies between 80% and 90% and are vented through a wall.
- **Solid fuel space heaters** can be a good choice for clients living in areas where wood is readily available, with a place to store the fuel, and the ability to carry the fuel and clean out the ashes. Pellet stoves are generally slightly more efficient than cord-wood stoves, but have moving parts that may require servicing.
- **Electric heat:**
 - Baseboard electric heat is really an array of space heaters that make up a “central” system that heats the entire dwelling (if the baseboard units are distributed appropriately throughout the dwelling). Electric furnaces have ductwork just as gas- and oil-fired furnaces do, but the heat energy is produced by hot electric coils.
 - Electric space heaters plug into the wall and have a maximum output of 1,500 watts (5,118 *British Thermal Units per Hour (BTUH)*).
- **Heat pumps** both heat and cool. In hot, humid climates, heat pumps are very common, especially in newer homes.

This list is not exhaustive, but it covers the systems you are most likely to find in existing dwellings during your weatherization work.

Visual Assessment – Space Heaters

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WPN 11-6 Space Heater Policy:

“Removal is required, except as secondary heat where the unit conforms to ANSI Z21.11.2. Units that do not meet ANSI Z21.11.2 must be removed prior to weatherization but may remain until a replacement heating system is in place.”




Photo courtesy of New River Center for Energy Research and Training (NRCERT)

No weatherization work is allowed where an unvented gas or liquid fuel space heater is the primary heat source.

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Photo of an *unvented space heater*.

Weatherization Program Notice (WPN) 11-6: Health & Safety Guidance:

- No weatherization work is allowed where an unvented gas- or liquid-fueled space heater is the primary heat source. The policy strongly encourages removal and replacement of such heaters with vented, code-compliant heating systems. The guidance states:
- “Removal is required, except as secondary heat where the unit conforms to ANSI Z21.11.2. Units that do not meet ANSI Z21.11.2 must be removed prior to weatherization but may remain until a replacement heating system is in place.”
- Any unvented gas- or liquid-fueled space heaters used as secondary heat sources that remain in a completed single-family home after weatherization must conform to ANSI Z21.11.2.
- ***Minimum ventilation requirement (MVR)*** guidelines apply.
- WAP funds may only replace a primary heating system. Funds may not be used to replace unvented space heaters left in the home as secondary units.
- The ***Manufactured Home Construction and Safety Standards*** require all fuel-burning, heat-producing appliances in mobile homes, except ranges and ovens, to be vented to the outside. The combustion system must be separate from the interior atmosphere, i.e., draw combustion air from the outside.

Q: Should air sealing be recommended in a home where unvented fossil fuel space heaters are observed?

*A: It depends whether the heating unit is a primary or secondary heat source. DOE will not permit any DOE-funded weatherization work (including air sealing) if the completed dwelling has an unvented gas- or liquid-fueled space heater as the primary heat source. DOE will allow unvented units to remain as secondary heat sources if they comply with ANSI Z21.11.2 and other applicable codes, such as the ***International Residential Code*** and ***International Fuel Gas Code***, and weatherization work can be done.*

Unvented Space Heaters

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Photos courtesy of NRCERT

- Unvented space heaters release all their combustion byproducts into the home.
- Carbon dioxide, water vapor, and compounds of nitrogen and sulfur dioxide will be emitted.

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Photos of two unvented space heaters.

- Unvented space heaters release all their combustion byproducts into the home. In addition to **carbon dioxide (CO_2)** and water vapor, compounds of **nitrogen** and **sulfur dioxide** will be emitted.
- Unvented space heaters are often referred to as “**vent-free**” heaters. There is no difference between unvented and vent-free space heaters.

Q: How much water does the combustion process produce?

*A: About 1 gallon per 100,000 **British thermal units (BTU)**.*

Q: How many gallons of water does a 25,000 BTUH appliance produce per hour?

A: One-quarter gallon (1 quart) per hour.

Q: What do you think happens to all that water vapor on a cold winter day?

A: It condenses on windows and/or it is carried by air currents into the attic or wall cavities, where it may condense on cold surfaces and cause mold.



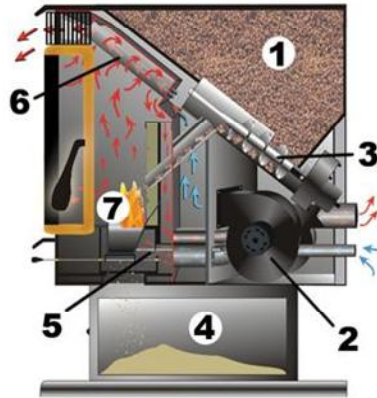
- Wood pellets usually contain between 8,000 and 9,000 BTUs per pound, about the same as dry, high-quality firewood.
- Each pellet is usually about ¼" in diameter by 1" long. They are usually made of wood waste, such as wood chips and sawdust. Wood pellets may be purchased by the bag or in bulk (unbagged and delivered in a truck). Pellets are usually available in various grades.
- Pellet stoves are 75% to 90% efficient, a little better than good cord-wood stoves. Firing rates range from a few thousand BTUH up to 40,000 BTUH, about the same as cord-wood stoves.
- The auger that feeds the pellets to the combustion chamber is electrically driven. Some pellet stoves have a battery backup for the auger in case electricity is interrupted.
- The pellet hopper capacity can vary from 35 to 130 pounds. The larger the hopper capacity, the longer the stove can burn without adding fuel.
- Unlike cord-wood stoves, pellet stoves should be serviced once a year because of the moving parts. The ashes must be removed from the stove regularly, usually about once a week.
- Pellet stoves cost between \$1,700 and \$3,300; installation costs between \$350 and \$550. A pellet furnace can cost \$5,000 to \$7,000; installation costs are much higher. This is significantly more than the cost of a good cord-wood stove.
- Despite the higher costs, some homeowners prefer pellet stoves because they burn more cleanly and have less creosote buildup than cord-wood stoves.
- Direct-vent pellet stoves are available. In these units, the vent goes to the outdoors and combustion supply air is vented to the unit through a dedicated pipe.

Pellet Stove Operation

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How Does a Pelpro Pellet Stove Work?



Graphic courtesy of Pelpro Pellet Stoves

Wood pellet appliances use an automated auger system with a controlled fuel/air mixture to ensure efficient operation.

- Wood pellets are placed in the hopper (1).
- An electric auger (3) feeds the pellets into a burn grate (7) at a rate determined by the temperature control.
- An automated igniter (5) starts the fire (optional on some units).
- Fire heats the air in the heat exchanger tubes (6) and a convection fan blows this heated, uncontaminated air into the room where the stove is situated.
- There is an ash pan (4) below the burn grate into which the residue falls.

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- This illustration from a manufacturer shows how a typical pellet stove works.
- Follow the manufacturer's installation instructions or *National Fire Protection Association (NFPA) 211, Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*.

Bags of Wood Pellets

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Above: Bags filled with pellets for use in pellet stoves.

Right: A handful of fuel.



Photos source: R. Karg

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Pellets can be purchased in bags or in bulk. Prices range from \$200 to \$300 per ton, depending on location. In heavily forested cold climates, the prices tend to be lower than in metropolitan areas.


It is best to purchase pellets in bulk if a client has the space to store them because they are less expensive per ton than when purchased by the bag.

Advise a client who is considering purchasing a pellet stove to make sure wood pellets are locally and consistently available.


Cord-wood Stoves

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A cord-wood stove must be installed on a fire-resistant surface, like the brick shown here.



A face cord is not the same as a full cord.

Photos source: R. Karg

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Photo on the left: This wood stove sits on a brick, nonflammable surface, which is required by code to extend at least 18 inches beyond the stove on all sides.

Photo on the right: Note that the wood in this photo is stored away from the house to avoid leading termites to the structure.

- A cord of firewood is 128 ft³, or a pile 8' long by 4' high by 4' deep.
- Firewood dealers often sell **face cords**. A face cord is 8' long by 4' high, but it might be 1' to 3' deep. A face cord is NOT the same as a full cord. Buyers of firewood must be careful to get what they are paying for.
- A full cord of dry hardwood from deciduous trees contains about 22 million BTUs. It is important to burn firewood when it is dry; most firewood requires 3 to 8 months to dry outdoors.
- Cord-wood stoves usually have a firing rate range of 10,000 to 40,000 BTUH.
- Efficiencies range from 50% (for older, non-airtight models) to nearly 90% (with a catalytic combustor or secondary burn features). The higher the efficiency, the lower the cost of heating and lower the emissions.
 - A clean burn is important, as it leads to a cleaner chimney, which is safer and requires less frequent cleaning.
- Direct-vent cord-wood stoves are available.
- Follow the manufacturer's installation instructions or NFPA 211.

Direct-vent Space Heaters

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Photo courtesy of Rinnai



Direct-vent wall termination



Through-the-wall vent termination of a kerosene model

Vent termination photos courtesy of Monitor

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Photo: A Rinnai direct-vent space heater, 21,500 BTUH, with a programmable thermostat.

- The wall termination for a direct-vent space heater shows the pipe-within-a-pipe configuration of the direct vent assembly. The exhaust gases exit through the inner pipe and the combustion supply air enters through the outer pipe.
- There are many direct-vent gas- and kerosene-fired space heaters. These units are usually safe and efficient.
- See the photo of the “direct-vent wall termination.” These direct-vent units use concentrically arranged exhaust/supply-air pipes; the exhaust pipe is inside the supply-air pipe. Each pipe is sealed from the air inside the dwelling. Because the pipes are concentric, the installer has to drill only one hole in the wall of the dwelling to install the vent system.

Electric Baseboard Heaters

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There are many styles of electric baseboard heaters.

Photos source: R. Karg

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- Electric baseboard heat is almost always 250 watts per running foot, or one **kilowatt hour (kWh)** for each 4 feet (3,412 BTUH).
- In most parts of the country, electric heat is very expensive to operate, but inexpensive to install.



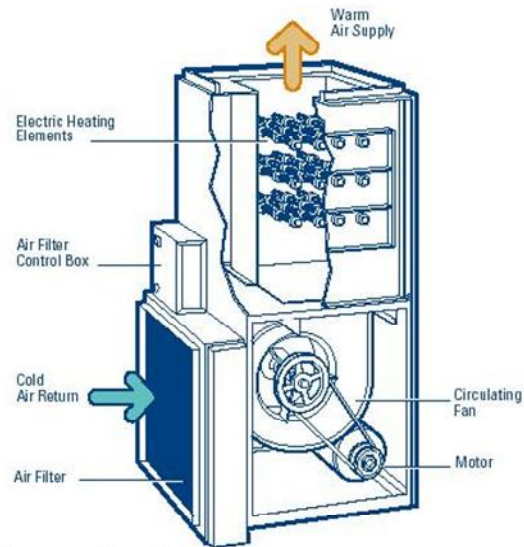
- The maximum output of a portable electric space heater is 1,500 watts; 1 kWh = 3,412 BTUH.
- No combustion occurs in a portable electric space heater. The electric wires heat up from electrical resistance and emit heat.
- For safety, the unit should be approved by a national testing laboratory such as Underwriters Laboratories. A product certified by Underwriters Laboratories will have the UL symbol on it.
- Ensure the unit has a “tip switch” that will shut it off if it is knocked over or falls. All newer models should have this safety feature built in.
- Space heaters are designed to provide small amounts of warm air. They aren't bed warmers, cookers, or clothes dryers, so advise clients never to use them for anything other than helping to warm a room.
- A space heater should always be placed at least 3 feet from curtains, bedding, or furniture.
- Advise clients never to leave a space heater unattended, to turn it off when they leave the room or go to sleep, and to prevent pets and children from getting too close to the unit.
- Ensure there is a grille around the heating element or flame area so little fingers can't get burned.
- The heater should be on a hard, level, nonflammable surface, and never on a carpet or rug that could catch fire.

Electric Furnaces

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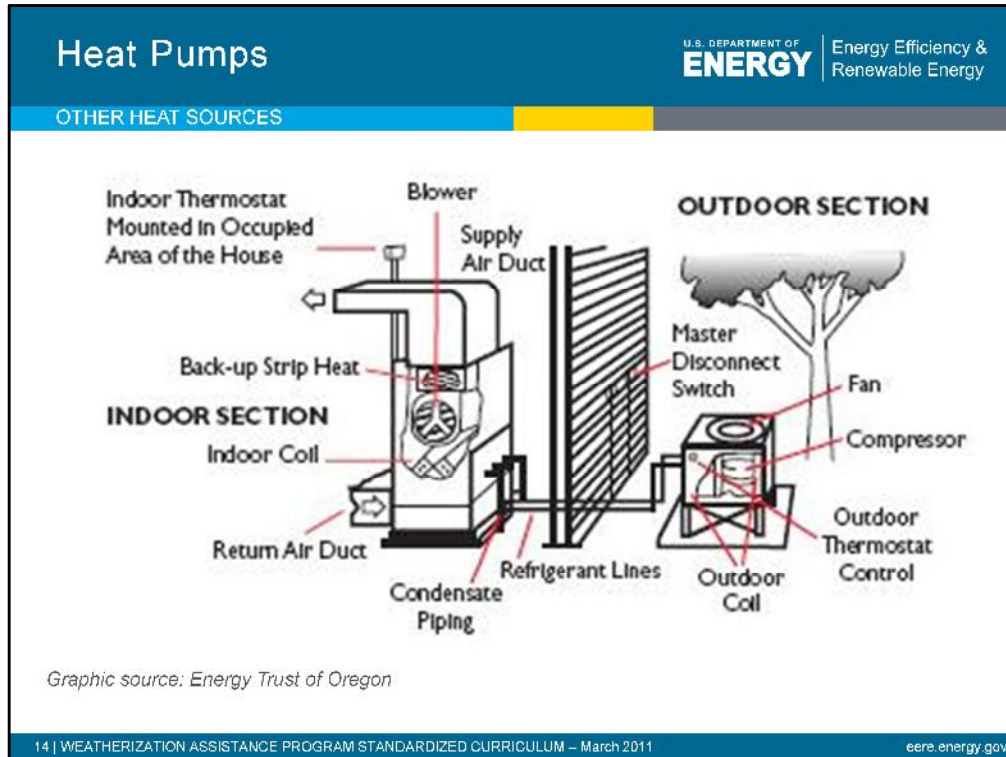


Graphic source: Natural Resources Council Canada, www.nrcan.gc.ca

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- Electric forced-air systems come in a wide range of capacities, generally from 10 kilowatts (34,120 BTUH) to 50 kilowatts (170,600 BTUH). The heating elements, circulation fan, air filter, and control devices are contained in a compact cabinet.
- In many parts of the United States, it is very expensive to operate an electric furnace because of the high cost of electricity.



- Heat pumps are too expensive for many weatherization programs, but energy auditors should have basic knowledge about heat pumps in case their clients have them.
- Heat pumps are very common in hot, humid parts of the United States and seldom found in cold climates or warm, dry climates.
- Heat pumps are unique because they heat and cool, operating much like a refrigerator in the cooling mode. For heating, the circulation of the refrigerant is reversed.
 - In the cooling mode, heat is removed from the indoor air and pumped to the outdoors.
 - In the heating mode, heat is removed from the outdoor air and pumped to the indoors.
- Because it transfers heat rather than burning fuel to create heat, a heat pump uses significantly less energy to supply the same amount of heat as a traditional furnace.
- A heat pump includes an indoor unit and an outdoor unit, which work together to heat or cool air and distribute it through the duct system of the home. Most heat pumps use **electric resistance heaters** (commonly referred to as “**strip heaters**”) to provide supplemental heat when outdoor temperatures are very low.
- Heat pumps are most economical when supplemental heat is not in use. Outdoor thermostats should be installed and configured to prevent strip heat from activating before it is necessary.

Electric air-source heat pumps are a great heating and cooling choice where the winters are mild and the summers are hot.

Summary

OTHER HEAT SOURCES

- Some of the less common heating source types are electric furnaces and baseboards, solid fuel stoves, space heaters, and heat pumps.
- Ensuring client safety requires inspecting heating systems carefully.
- A true cord of wood is different than a face cord. Understanding the ways pellets and cord wood are sold helps the auditor discuss these choices with clients.
- WPN 11-6: Health & Safety Guidance requires removal of unvented space heaters used as primary heat sources, and replacement with vented, code-compliant heating systems.
- Heat pumps heat and cool, acting much like a refrigerator in reverse when in their heating mode.

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- Heat pumps heat and cool, acting much like a refrigerator in reverse when in their heating mode. They are common in hot, humid areas of the country.