#### Selecting a Home Heating System

In most parts of the U.S., space heating is the largest single component of home energy use. The type of heating system can have a significant impact on overall energy costs and on comfort as well. If your existing system is over 20 years old, you may be spending a lot to keep it running - money that might better be spent on a new, more efficient system. If you're buying a new home, choosing one with an efficient and well-designed heating system can pay long-term dividends in terms of both operating costs and comfort.

Selecting an appropriate heating system, either as a replacement or for a new home, requires a basic understanding of the different types of systems, their efficiency ratings and long-term costs (initial cost plus estimated annual operating costs).

**Factors to Consider**

When choosing a new heating system, there are several factors that should be considered:

**Fuel Type or Energy Source**

In most parts of the country, natural gas is the most popular space heating fuel. In areas where natural gas is not available, many homeowners heat with propane or LP gas. Electric heat pumps are also a good option, particularly in less severe climates. Fuel oil is less common, but still used in some parts of the U.S., particularly in the Northeast.

Before deciding on a fuel type, determine which fuels are readily available in your area and their relative cost. A qualified heating contractor should be able to provide some reasonable operating cost estimates for different fuels or energy sources. Your local electric or gas utility may also be able to provide operating cost estimates.

**Distribution System - Forced Air vs. Hot Water**

Most residential heating systems use either forced air or circulating hot water to distribute the heat throughout the home. Forced air heating is the most popular option in most parts of the U.S. The heat is distributed throughout the home via air ducts and registers. Hot water or hydronic systems use a boiler to heat water which is circulated via copper or plastic piping, typically to baseboard radiators. Some hydronic systems circulate the hot water through pipes enclosed in the floor slab, which then radiates the heat evenly throughout the room.

Both types of distribution systems have advantages and disadvantages. The main advantage of forced air systems is that the ducts can also be used for central air conditioning and to filter and humidify the air and to circulate it for ventilation. Forced air systems also have some disadvantages. Because moving air feels cooler, the air coming from the heating registers can sometimes feel cool, even when it is warmer than the room temperature. There can also be short bursts of very hot air, particularly with oversized units, causing uncomfortable temperature swings. Ductwork can transmit furnace noise and can circulate dust and odors throughout the house. Ducts can also leak, losing heated air to attics or basements and raising heating costs by as much as 20-30%. With any forced air system, be sure the ducts have been properly sealed to minimize leakage.

Advantages of hydronic systems include more even temperatures and the ability to use the same boiler to provide domestic hot water. On the other hand, the installed cost of hydronic systems is higher than that of forced-air systems, and they don't allow for central air conditioning, air filtering, or ventilation.

In an existing home, it is usually more economical to stay with the existing distribution system, unless you're undertaking major renovations. If you're purchasing a new home, consider factors like whether you want central air conditioning before deciding on the type of heating system.

**Efficiency**

One of the most important factors to consider is the system's efficiency. The higher the efficiency, the less it will cost to operate. Even a relatively small difference in annual energy costs will add up over the lifetime of the system.

The standard efficiency ratings for residential heating systems are AFUE or Annual Fuel Utilization Efficiency, which is used with natural gas, propane and fuel oil systems, and HSPF or Heating Season Performance Factor, which is used with electric heat pumps.

Both AFUE and HSPF are measures of seasonal efficiency, which takes into account normal operating losses as well as variations in outdoor temperature.

**Overall Cost**

When comparing the costs of different heating systems, be sure to consider not just the initial cost, but also the long-term costs of operating and maintaining the system. The yellow and black EnergyGuide label can help you estimate annual energy costs, and your local utility may also be able to provide some comparative operating costs for different systems. A qualified heating contractor should be able to provide estimates of typical maintenance costs.

**System Types/Options**

The most popular space heating systems are forced air furnaces, hot water boilers and electric heat pumps.

**Furnaces**

New gas, propane or oil furnaces typically have efficiencies between 78% and 96% AFUE, and generally fall into one of three categories.

A "base model" or minimum efficiency new furnace will typically have an AFUE of 78-80% (compared with 60-70% for an older furnace). The increase in efficiency is mainly due to a combination of better heat exchangers, electronic ignition (to replace a standing pilot), and internal vent dampers to reduce off-cycle losses up the exhaust vent or flue. In milder climates, this type may be the most cost-effective option.

Mid-efficiency furnaces have slightly higher efficiencies, up to 83% AFUE for gas or propane, and up to 87% for oil. These systems use even more efficient heat exchangers and have more precise control of combustion air and venting. Mid-efficiency oil furnaces typically incorporate new "high-static" burners that extract more heat from the fuel.

High-efficiency gas or propane condensing furnaces have AFUEs of 90-96%. These furnaces use a second heat exchanger to reclaim some of the heat that is lost in the form of water vapor. The water vapor in the exhaust is condensed, releasing additional useable heat, and lowering the exhaust temperature to the point where it can be vented outdoors via a plastic pipe. Although this type of system is more expensive, it is often the most cost-effective option in cold climates or large homes with high heating requirements.

In addition to the furnace's AFUE, you should also consider the system's electrical efficiency. Furnaces can use a significant amount of electricity, mainly to power the fan motor. Look for a system with a high electrical efficiency. Multi-speed or variable speed fan motors are usually more efficient than single-speed motors.

**Boilers**

Like furnaces, boilers are rated for efficiency with an AFUE. All residential heating boilers manufactured since 1992 must have an AFUE of at least 80%. By comparison, many old boilers have AFUEs of only 55-65%. Features to consider when purchasing a new boiler include efficient controls, low electrical requirements, and the ability to provide indirect water heating.

Efficient controls can reduce losses during off-cycle times and milder weather. Features like modulating aquastats, which adjust boiler water temperature based on outdoor temperatures, can reduce operating costs while also improving comfort.

In addition to their primary fuel, boilers also use electricity, mainly to power the circulating pump(s). Look for a system with high-efficiency pumps and ask your contractor about the system's electrical efficiency.

A new space heating boiler can also provide efficient water heating, because they don't heat and store water at the same time. When installing a new boiler, consider replacing your existing storage water heater with a well insulated indirect tank that connects to a water heating coil in the boiler.

**Electric Heat Pumps**

Heat pumps use the same refrigerant cycle as an air conditioner, but during the heating season they can reverse the cycle to deliver heat to the house. They are much more energy-efficient than other types of electric heat, and in many cases will have operating costs comparable to (or even lower than) gas furnaces. When selecting a new heat pump, look for a high seasonal efficiency or HSPF. The current minimum HSPF for air source heat pumps is 7.6, with high-efficiency models rated at 9 HSPF or higher. The higher the HSPF, the lower your annual heating energy costs.

Ground source or geothermal heat pumps are even more efficient, because they absorb heat from either below the ground or from water pumped from below ground. The efficiency of a geothermal heat pump is expressed as a Coefficient of Performance or COP. New geothermal systems have COP ratings of 2.5 to 4.0, with a COP of 3.0 roughly equivalent to an HSPF of 10. However, they can be much more expensive than air source heat pumps. Some utilities and municipalities provide incentives to help offset the additional cost of geothermal systems.

A new type of heat pump, called a ductless or "mini-split", is an ideal retrofit option for homes with no existing duct system. Multiple wall-mounted indoor units can be installed in individual rooms, all connected to a single outdoor unit. Like any heat pump, this type can provide both heating and air conditioning, but without the expense of installing a duct system.

**System Sizing - Bigger Isn't Always Better**

With any new heating system, proper sizing is important to ensure efficient operation and comfort. Contractors often install larger systems than are really needed, either to avoid callbacks or to compensate for poor distribution systems or inefficient insulation. Most heating systems are most efficient when they run for longer periods of time. An oversized system will meet the demand for heat more quickly, but may never reach its peak operating efficiency.

Before installing a new system, ask your contractor to perform a heating load calculation, which takes into account square footage, insulation levels, air tightness, window orientation and other factors that affect the amount of heat needed

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