your home

VOLUME 20, NUMBER 3

A PUBLICATION OF CRITERIUM ENGINEERS

HOMEOWNER'S TIP

After the mortgage and taxes, energy is the biggest cost of home ownership for most home owners. Managing energy consumption often means compromising comfort. However, even a change of one or two degrees (less heating or cooling) can mean a significant savings in energy. Also, if possible, try to limit heating and/or cooling to the areas of your home you use most frequently. After you see the savings, you may be better able to adjust to the comfort compromises.

IN THIS ISSUE

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Energy? What does it all mean?

Have you ever wondered how you use energy in your home? More basically, have you ever wondered about energy itself? The following is a review of the basics of energy and how we use it to heat and cool our homes. We will also look at some guidelines for saving energy. This is a brief summary of an extensive, complex subject. It is intended to offer a practical perspective, not a detailed analysis.

First, some definitions. These terms are often misused, so it's a good idea to start with the basics.

BTU — BTU is a measure of thermal energy. It stands for British Thermal Unit. One BTU is the amount of heat needed to raise one pound (one pint) of water 1 degree Fahrenheit.

BTUH — BTU per Hour represents the thermal energy requirement per hour to heat or cool a specific volume of air.

Ton — Ton is a measure of cooling; 1 ton is 12,000 BTUH. A ton is the amount of heat removed by an air conditioning system that would melt 1 ton of ice in 24 hours.

KWH — Kilowatt Hour is a measure of electrical energy. One KWH is equivalent to using 1 kilowatt of power for 1 hour or roughly equivalent to keeping your toaster on for 1 hour.

Conditioned space — Conditioned space is typically the living space in a home that is heated and/or cooled (i.e. conditioned). This is usually measured as a volume (cubic feet) rather than an area (square feet). It is about AIR not AREA. A room with a cathedral ceiling has more conditioned space than one with a flat, standard height ceiling.

Building envelope — The building envelope, or shell (walls, roof, floor, windows and doors), separates the conditioned space from the unconditioned space.

(Continued on next page)

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Second, now that we are beginning to understand the vocabulary of energy, let's consider how we use it. To do that, it is useful to distinguish the **source** from the **distribution** system.

The **source** of **heat** is, in most cases, gas, oil, electricity or wood. Heat is produced at the **source** in a furnace (hot air) or a boiler (hot water) by the combustion (burning) of gas, oil or wood. Heat is also produced directly by electricity in various types of electrical devices, including baseboard units and hot air furnaces. This is often referred to as "resistance" heat because the flow of electricity is "resisted" by the device through which it is flowing which causes heat. A heat pump is another way to produce heat with electricity; it will be discussed later.

The heat output of each fuel (energy source) is different. Some average values are shown in Table 1.

Table 1: Average heat output	
Propane	92,500 BTU/gallon
Natural gas*	92,500 BTU/gallon
Natural gas	100,000 BTU/therm
No. 2 heating oil	136,700 BTU/gallon
Hardwood	16,300,000 BTU/cord
Softwood	9,300,000 BTU/cord
Electricity	3,413 BTU/kilowatt hour

* Natural gas in public utility systems is often measured in hundreds of cubic feet (Ccf) or therms. A therm is typically determined by the utility and depends on the quality of the gas.

The source of air conditioning, typically electric, is actually a heat "mover" rather than a heat producer. Essentially, a heat pump or air conditioner (AC) "moves" heat from the conditioned space to the unconditioned space. A compressor is common to both a heat pump and an AC unit. Using a refrigerant and a coil, the compressor "squeezes" heat out of the conditioned air, thus "moving" the heat from where it is not wanted to someplace more acceptable, typically outside. In the heating mode, a heat pump still "moves" heat, but now it is taking it from the unconditioned space (outside) and delivering it to the conditioned space (inside).

There is a limit to how cold the outside temperature can be for a heat pump to function. This is why heat pumps need backup (electrical resistance heat or natural gas) in cold temperatures, typically below 30° F.

Now that we have examined the source, how we use energy to create heating or cooling, let's consider the distribution (how we get energy from the source to the conditioned space).

Heat is distributed by water (steam or liquid) or air. Cooling is typically distributed by air. Water distribution uses a system of pipes to move heat energy around the house. Air distribution uses a system of ductwork to move conditioned air around the house. Air distribution for heat is typical in areas that are heavily dependent on cooling because that allows dual-purpose ductwork. Water distribution for heat requires a separate air system for air conditioning.

We use energy to produce heat or cooling, and then we distribute energy via water or air. How can we minimize our use of energy? In other words, how can we maximize energy efficiency?

The first stage of efficiency is combustion efficiency (burning gas or oil to produce heat). Combustion efficiency does not apply to electric because there is no combustion. How efficiently does your heating equipment convert energy to flame (flame energy is the heat source)? The combustion efficiency of oil-fired equipment ranges from 70% to 85%, with most new equipment running close to 85%. The combustion efficiency of gas-fired equipment ranges from 75% to 90%, depending on the age and type of equipment.

The second stage of efficiency is thermal conversion efficiency. How well does your heating equipment convert the energy from the flame to heat ready to be distributed throughout your house? In other words, how well does your furnace use the flame energy to produce warm air? Or, how well does your boiler use the flame energy to produce hot water?

Older cast-iron, steam and hot water units score low on thermal conversion efficiency, often as low as 50%. Most modern boilers (water) will reach about 80%. Some multi-pass boilers will reach 90%. Most hot air furnaces operate at about 80% thermal conversion efficiency. Electricity is the most thermally efficient, at about 95%, and there is no combustion efficiency to consider. However, electricity is among the most expensive energy sources available.

So, to calculate efficiency, first convert the fuel to flame energy then convert that to heat. In the worst case (70% combustion, 50% thermal conversion), only 35% of the energy from fuel consumed will reach the conditioned space to heat your home.

For comparison, electrical devices such as heat pumps and AC units have a similar measure of efficiency, the coefficient of performance (COP), which is essentially the ratio of electricity used to heat moved. An efficient device will typically have a COP in the range of 5 to 6. Higher is more efficient. Also, you may encounter a seasonal energy efficiency rating (SEER) on heat pumps and AC units. A low-end SEER, typical for window air conditioners, is 10, but new, larger central air systems can go up to 17 or 18. Higher is better. A unit with a SEER of 18 costs half as much to run as one with a SEER of 9. Typically, for new equipment, you should expect a SEER of at least 12.

Now we have discussed the first step in an energy-efficient home, optimizing the efficiency with which you are using your energy to produce heating or cooling. By the way, all of the ratings noted above will deteriorate with time. As equipment gets older, it becomes less efficient. Good annual maintenance will help slow the deterioration.

The second step in achieving an energy-efficient home is the building envelope. How well does the building envelope separate the conditioned air from the unconditioned air?

Fundamentally, there are three criteria: conduction, infiltration and radiation. Conduction is the direct loss of energy through the components of the building envelope. Infiltration is the loss of energy by air leaks (around doors and windows, in ductwork, etc.). Radiation is the flow of heat into or out of the building based on exposure to the sun. The use of radiant energy shields and low-e windows reflect heat either into or out of the house, depending on the orientation, and reduces energy use.

At this point, balance must also be considered. The most efficient home will be the tightest home. However, that home will also be the most uncomfortable because very little fresh air reaches the inside. Indoor air quality (IAQ) must be considered when optimizing efficiency. The ideal condition is a completely sealed house with an independent fresh air source on the HVAC system.

Table 2: Heating	
Northeast (average)	40 BTU/hr/SF
Northeast (efficient)	30 BTU/hr/SF
Southeast (average)	25 BTU/hr/SF
Southeast (efficient)	20 BTU/hr/SF
Northwest (average)	40 BTU/hr/SF
Northwest (efficient)	30 BTU/hr/SF
Southwest (average)	30 BTU/hr/SF
Southwest (efficient)	20 BTU/hr/SF

Table 3: Cooling	
Northeast (average)	1 Ton/400 SF
Northeast (efficient)	1 Ton/500 SF
Southeast (average)	1 Ton/300 SF
Southeast (efficient)	1 Ton/400 SF
Northwest (average)	1 Ton/400 SF
Northwest (efficient)	1 Ton/500 SF
Southwest (average)	1 Ton/400 SF
Southwest (efficient)	1 Ton/500 SF

The amount of insulation needed to minimize conduction losses varies by region. Most states have established standards for energy-efficient construction. Also, the federal Department of Energy has many good guidelines. Visit www.eren.doe.gov/consumerinfo. Also, the EPA has quite a bit of information in their "Energy Star" program at http://www.energystar.gov/default.shtml.

Evaluating the energy efficiency of an existing home is often done by "rules of thumb." A few, for different parts of the country, are shown in Tables 2 and 3.

These are rules of thumb: Every house is different. Local conditions vary. Altitude makes a difference. By converting the actual energy used with the information provided here, however, at least you will have a sense of the efficiency of the home you are considering. For example, you know a 2000 square foot house in the Northeast uses 1500 gallons of oil each year to heat it: 1500 gallons times 136,700 BTU/gallon divided by 2000 SF, equals 102,525 BTU/SF per heating season. If a heating season runs for 210 days (5040 hours), then dividing 102,525 by 5040, we get an average BTU/hr/SF of just over 20.

Energy costs will continue to rise. Having a good understanding of how your home uses energy will help you minimize those costs.

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