



Everyday Environmental Stewardship

Boilers and Furnaces

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Key issue:

Inefficient heat generation

Stewardship Opportunity

High-efficiency equipment

Timely maintenance and, when needed, replacement of heat generating equipment is important to achieving best-possible efficiency and preventing sudden breakdowns. A standard 15 year-old boiler or furnace can have an efficiency rating well below 70%.¹ New equipment can reach an efficiency of well over 90%. High efficiency boilers and furnaces are available for both oil and natural gas. Replacing old equipment can increase heating efficiency by 20% or more. This means 20% less green house gases emitted into the atmosphere and 20% savings on heating fuel costs, which climb every year.

Heating systems can last 25 years, or more. Many houses-of-worship and homes have heating 30+ year-old heating systems. Though these systems still work, they have passed their useful life. In other words, there is more reliable, more efficient equipment on the market. Since the heating system is a very large energy consumer, it also provides the great opportunity for stewardship.

When replacing a boiler or furnace, use the most efficient equipment on the market. Most new boilers and furnaces have AFUE² ratings in the mid 80% range, though they can reach up to 97%. Look for *condensing-mode equipment* which reaches over 90% efficiency.

Today's equipment also has features not included on older equipment. These features include electric ignition eliminating the need for a pilot light (and consequently standby cost), new combustion technologies increasing efficiency, and sealed combustion using outside air, reducing draft and improving safety.

Hot-Air

Furnaces generate warmth by heating air and blowing it through air ducts. Furnaces have a central fan blowing the hot air through all of the air ducts. This fan can consume much electricity. A hot-air systems make zoning extremely difficult. Consider replacing the fan with one that runs efficiently at low or variable speeds to significantly cut down on electricity consumption.

¹ **Boilers** heat water, for hot water ("hydronic") or steam systems. **Furnaces** heat air.

² AFUE is Annual Fuel Utilization Efficiency

Steam

Since steam systems boil water, they always run at 212° or higher. This may actually be too hot for much of the heating season, when the differential between inside and outside temperature is 35°± or less (68° inside vs. 38° outside, for example.) Steam boilers run at a much higher temperature than hydronic boilers, so they are by definition less efficient. Why heat water to 212° degrees when 160° or less works? So when building new and especially when undergoing major renovations, consider switching to a more efficient hydronic heating system. And remember, steam pipes don't last forever. Steam condenses in the system and over time causes rust throughout the pipes. (The photo above of a pipe almost entirely filled with rust is from *Christ Church United*, Lowell, which has learned the hard way!) If the steam system is 75+ years old, it's getting near time to change pipes and radiation also.



Hydronic

Hydronic boilers heat water to a desired temperature. Assuming the boiler has an *outdoor reset control*, this enables higher efficiency.³ Compared to hot air and steam systems, hydronic systems run at much lower temperatures. Because these systems use heated water run through small pipes, it is easy to add zones by installing a valve in the boiler room which controls flow to the hydronic supply pipes for the zone. **Zones** are identified based on timing and frequency of use. The biggest “zone” in a house-of-worship (the sanctuary) often has over 50% of space needed heat, but is used typically about 3 hours/week, for Sabbath services. By comparison the smallest but most frequently used zone is the office. Zoning with *smart* programmable thermostats is an easy way to lower heating fuel consumption. Ask for heat only when a space is used! All Saints Parish, Brookline went from 3 to 14 zones after its environmental assessment, and, in combination with highest efficiency hydronic boilers, reduced its fuel consumption by 40%!

Condensing Equipment for Highest Efficiency

One new technology which helps boilers and furnaces reach their highest efficiency is condensing. Condensing is when the steam in the boiler or furnace exhaust condenses back into water thus releasing heat. Condensing boilers and furnaces heat up quickly, use 30 - 70% less fuel and have the highest AFUE ratings, generally over 90%.

³ *Outdoor reset controls* matches heat generated to need based on the differential between outside and inside temperature. An outside temperature of 40° might need the boiler to heat to 130°, while an outside temperature of 20° might need the boiler to heat to 160°.

Oil vs. Natural Gas

New high efficiency natural gas boilers and furnaces can reach higher efficiency than oil-fired equipment. See the *EnergyStar* product information. (Link below.) Old or new oil-fired equipment can use bio-heat fuel as a way to further reduce environmental impact.

Calculation Model

Though these products can be more expensive to purchase up front, the cost difference will be paid back over time through lower energy bills. Here is a sample, showing the calculation of benefits of various approaches. This uses a typical household-scale effort.

New boiler

Replace the 17± year-old gas-fired boiler or furnace (80% efficient) with high-efficiency equipment rated at 135,000 btu. New 92% efficient condensing-mode equipment will result in a 15% improvement in efficiency as compared to the efficiency. The old boiler or furnace used 1,500 therms, costing \$2,460 at \$1.64/therm. The new equipment reduces use to 1,275 therms, costing \$2,091, saving \$369. To buy and install the new efficient equipment would cost approximately \$7,450. Regaining this money entirely through savings on gas bills would take about 20 years at this year's price (\$7,450/\$369 saved at 15% efficiency improvement). Since fuel prices are virtually guaranteed to rise and there will be some gas company financial incentive, the actual payoff time will be considerably shorter.

$$\begin{aligned} &(\text{New Efficiency} - \text{Old Efficiency})/\text{Old Efficiency} = \text{Savings} \\ &(92\% - 80\%)/80\% = 15\% \text{ savings!} \end{aligned}$$

$$\begin{aligned} &\text{Savings \%} \times \text{Annual Therms} = \text{Therms Saved} \\ &\text{Savings \%} \times \text{Annual \$s} = \text{\$s Saved} \end{aligned}$$

Remember to use *Heating* Therms and \$s only. Net-out the cost of generating domestic hot water (DHW). (See the MIP&L *EES* on DHW.) Using a boiler with an “on-demand” DHW generation capacity is a double-benefit, reducing the cost of both heating and DHW equipment!

Of course, sooner or later the heat generation equipment must be replaced anyhow. **So**, a better way to understand the benefit is to figure the cost of a “typical” installation vs. “high-efficiency” equipment installation. For the example above, the typical equipment will cost about \$5,850 to install. It will have an efficiency about what the current equipment has: 80±%. The *Net* cost for the “high-efficiency” equipment is \$1,600 (the cost of the high efficiency – the cost of the conventional equipment). Saving the same money means the “net” cost is paid-back a bit more than 4 years. If the installed equipment is gas and the utility company provides an \$800 rebate, the *Net* cost is only \$800, which means the pay-back happens in just over 2 years. With that kind of return replacing the heat generation equipment before the end of its “useful life” will make sense financially and in terms of good environment stewardship.

Before Buying New Equipment...



Find and pluck the low-hanging fruit! Improve the efficiency and insulation of the building before buying and installing a new heating system. A few simple actions will save on use and cost immediately. Two examples of *low-hanging fruit* are “smart” programmable thermostats, and interior “storm” windows. After improving the building’s heating efficiency as much as possible, you may actually need a smaller boiler or furnace, costing less to install and using even less fuel!

Boiler efficiency rating does not include the heat lost in the piping system which can account for as much as 35% loss. Insulating heating pipes and ducts will raise efficiency.

Make sure to check out the Thermostat, Utility Cost and Use, Domestic Hot Water, Interior “Storm” Windows, Home Energy Audit, Maintenance, BioHeat, Zoning and other *EES* files before buying and installing a new heating system. All of these have important information on how to lower heating fuel use and being more environmentally friendly.

www.MIPandL.org

Links

A good resource is EPA’s *Guide to Energy-Efficient Heating and Cooling*
http://www.energystar.gov/ia/products/heat_cool/GUIDE_2COLOR.pdf

Go to the *EnergyStar* web sites or more information on product lists of all energy star boilers, furnaces, and their efficiency ratings, savings calculators, manufacturer lists and more.

http://www.energystar.gov/index.cfm?c=boilers.pr_boilers

http://www.energystar.gov/index.cfm?c=furnaces.pr_furnaces