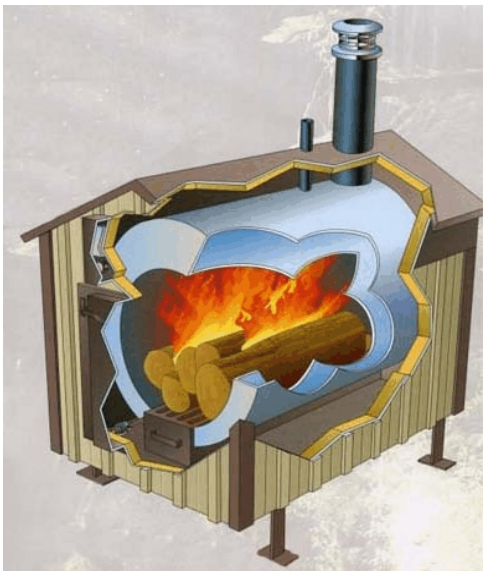
Using Wood as a Residential Heating Fuel
Issues and Options

August 2005

An increase in the use of outdoor wood fired boilers in Wisconsin is raising concerns about the effect of wood smoke on air quality. This fact sheet discusses some of the issues raised by residential wood heating.

Outdoor Wood-Fired Boilers

An outdoor wood-fired boiler is an natural or forced draft wood stove, surrounded with a water jacket. Typically mounted some distance from the building, it is connected to a home heating or hot water system through underground piping.



Outdoor wood fired-boilers are typically hand-loaded with cordwood or split firewood, and allowed to burn around-the-clock. Heat output can be regulated by remote controlled dampers, and the heated water stored in tanks for circulation on-demand.

The economic benefits of outdoor wood-fired boilers for residential heating must be carefully considered. While the operating costs of these appliances can be lower than furnaces using higher priced fuels (e.g. liquid propane), the high initial purchase price and installation costs can lead to long pay-back periods. Furthermore, the cost of wood as fuel can vary greatly depending on whether it is purchased from a vendor, or cut and dried by the homeowner.

How much wood will you burn?

If 100 million BTUs is the amount of energy needed to heat a moderately sized insulated house in southern Wisconsin with a modern, efficient wood-heating appliance during a typical winter, 4 full cords of oak firewood (at 20% moisture) will be needed as fuel.

Outdoor wood-fired boiler performance is also variable. Combustion efficiency claims by manufacturers may not be realized by the owner. Boiler design, operating procedures, and fuel moisture and BTU content, all play an important part in extracting the most useable heat from the fuel. These factors are also important for the amount of smoke and other air pollutants that are created when wood is used as a heating fuel.

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Wood Burning and Air Quality

In 2002, the Wisconsin Department of Natural Resources began to monitor levels of very fine particulates (PM2.5) in the air. Fine particles are produced any time fuels such as coal, oil, diesel or wood are burned. Fine particles come from fuels used for everything from power plants to wood stoves and motor vehicles.

Burn Barrels

Open burning of woody material (both burn barrels and brush piles) is another source of fine particle air pollution.

When plastics and other non-wood materials are also burned (illegally), the amounts of hazardous air pollutants can rise dramatically.

Fine and coarse particles can cause a variety of serious health problems. When exposed to these particles, people with heart or lung diseases and older adults are more at risk of hospital and emergency room visits. These effects have been associated with short-term exposures lasting 24 hours or less.

Particles can aggravate heart diseases such as congestive heart failure and coronary artery disease. If a person has heart disease, particles may cause them to experience chest pain, palpitations, shortness of breath and fatigue. Particles have also been associated with cardiac arrhythmia and heart attacks.

Particles can aggravate lung diseases such as asthma, emphysema and bronchitis, causing increased medication use and doctor visits. If a person has lung disease, and is exposed to particles, they may not be able to breathe as deeply or vigorously as normal. Such a person may have respiratory symptoms including coughing, phlegm, chest discomfort, wheezing and shortness of breath. Particles can also increase a person's susceptibility to respiratory infections.

Over the last several years, the DNR has regularly issued air quality advisories due to high levels of airborne fine particles in Wisconsin. These advisories have been issued in both winter and summer, and alert us to a deterioration in our air quality.

Wood Heating and Air Pollution

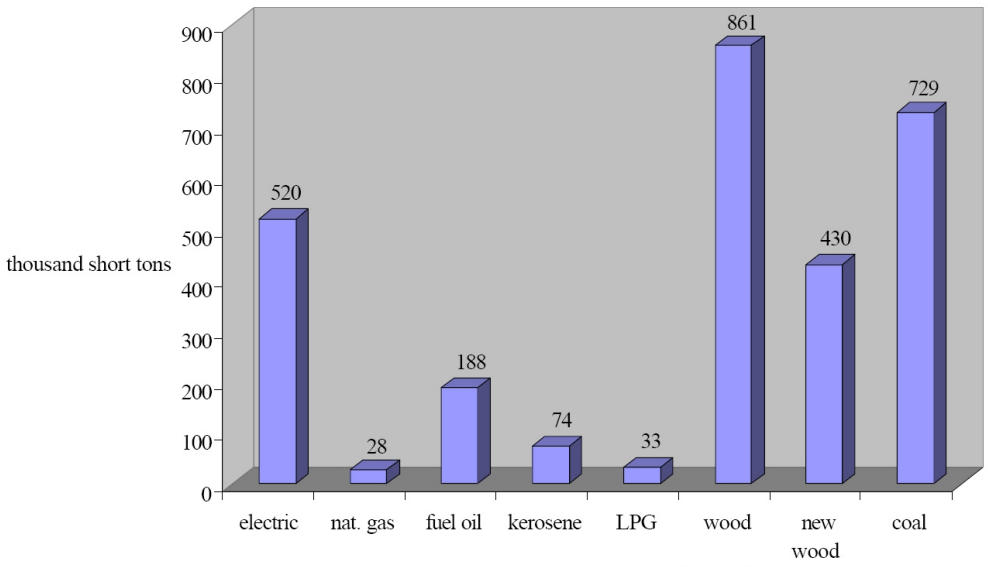
A study of ambient air quality in residential neighborhoods around Montreal, Canada found "....wood combustion contributes to the deterioration of ambient air quality. Concentrations of certain pollutants can be five times higher in winter than in summer".

In addition to fine particles, residential wood burning emits polycyclic aromatic hydro-carbons (PAHs), dioxins and furans, carbon monoxide, volatile organic compounds and metals into the air we breathe.

In 1988, USEPA introduced wood heater regulations that require indoor wood stove manufacturers to undergo emissions testing at an EPA-accredited laboratory to certify that each wood stove model complies with the particulate emission limit of 7.5 g/hr for non-catalytic wood stoves and 4.1 g/hr for catalytic wood stoves. Currently, outdoor wood fired boilers are not required to meet these emission standards.

While there are many sources of PM2.5, using wood as a residential heating fuel contributes more to fine particle pollution than any other type of heating fuel. The chart below (1998 EPA study) shows that both older and new EPA approved wood heaters are major sources of fine particles.

Effective fine particulate emissions per quad of heat delivered



Source: Houck, James E. et al, Proceedngs - Emission Inventory: Living in a Global Environment, v.1, pp 373-384, USEPA 1998

Source: www.qc.ec.gc.ca/dpe/publication/air_qualit_rdp_en.pdf

Controlling Air Pollution From Wood Heating

Controlling air emissions from outdoor wood fired boilers in order to maintain good air quality is problematic. Each owner-operator will have their own source of fuel, operating procedures, and without industry or federal standards for emissions, each manufacturer's boiler will create different amounts of air pollution. While fine particle air pollution only occurs during special weather conditions, banning the use of these boilers during a winter air quality alert would leave homeowners without a heat source.

The Wisconsin Department of Natural Resources does regulate air emissions from business and industry, but has limited jurisdiction over residential wood burning. Presently, there are prohibitions against burning recyclable materials (such as plastics and paper), and a permit requirements for open burning. However, Wisconsin communities (towns, villages, cities and counties) are able to enact ordinances that control outdoor burning and outdoor wood fired boilers.

Local ordinances have been enacted around Wisconsin to prevent the spread of fires, control nuisance smoke and prevent air pollution. Some of their provisions include:

- General prohibitions on open burning;
- Restrictions on the conditions when burning can take place (e.g. only in winter);
- Prohibitions against outdoor wood fired furnaces and boilers within municipal boundaries;
- Specified setbacks, minimum lot sizes and stack heights for outdoor wood fired boilers.

While these regulations help meet safety concerns, and serve to prevent neighbor conflict over the effects of smoke, they do not address the problem of poor air quality caused by many small sources of wood smoke over a wide geographic area. If the use of wood as a home heating fuel increases without controls on the air pollution it causes, Wisconsin communities will increasingly see a deterioration of their air quality, more frequent air pollution health advisories, and an increase in adverse health effects caused by fine particle air pollution.

Additional Information and Resources

USEPA -

www.epa.gov/airnow/aqguidepart.html
www.epa.gov/Compliance/monitoring/programs/caa/whlganda.html

US Forest Products Laboratory -

www.fpl.fs.fed.us/tmu/wood_for_energy/wood_for_energy.html

Great Lakes Trash and Open Burning Website -

www.c2p2online.com/

WI-DNR -

www.dnr.state.wi.us/org/aw/air/health/ppFAQ.htm
www.dnr.state.wi.us/org/caer/ce/ob/

UW-Extension -

www.uwex.edu/shwec/Pubs/pdf/woodfiredboilers.pdf
www.uwex.edu/shwec/Pubs/pdf/burnbarrel.pdf