PO Box 1611, Montpelier, Vermont 05601 • ph 802-223-7770 • Fax 802-223-7772 • www.biomasscenter.org

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Biomass Energy Resource Center

AIR EMISSIONS

From Modern Wood Energy Systems

Anyone interested in wood heating systems wants to know the answer, at some level, to the question:

"What comes out the chimney?"

The answer is not simple.

All combustion processes—whether the fuel is oil, gas, wood, or coal—emit dozens of exhaust components, all having different characteristics.

The question of stack (chimney) emissions is further complicated by the incorrect assumption that what we know about residential wood stoves holds true for modern wood systems currently used in institutional, commercial, and utility settings. These wood systems are significantly cleaner than wood stoves for the following reasons:

- The mess associated with cordwood storage and use in a home's living space and with ash removal from a stove, is absent. Woodchips are confined to a storage bin and boiler room, with no dirt or dust entering the rest of the building.
- Unlike home woodstoves, there are virtually no visible emissions and odors associated with modern woodchip and pellet systems.
- Modern woodchip systems emit far less particulate matter (PM10), an exhaust product of wood combustion known for its adverse effects on human respiratory health compared to wood stoves.
- These systems should also not be compared with outdoor wood boilers, which, as a class, burn very inefficiently with high particulate emissions, even compared to modern residential wood stoves.
- Pollution-control technologies are available to reduce emissions for applications where warranted.

Particulates

In terms of health impacts from wood combustion, particulate matter (PM) is the air pollutant of greatest concern. Particulates are pieces of solid matter or very fine droplets, ranging in size from visible to invisible. Relatively small PM, 10 micrometers or less in diameter, is called PM10. Small PM is of greater concern for human health than larger PM, since small particles remain air-born for longer distances and can be inhaled deep within the lungs.

Increasingly, concern about very fine particulates (2.5 microns and smaller) is receiving more attention by health and environmental officials for the same reasons. Work investigating wood and pellet boiler emissions of very fine particulates is ongoing. BERC will actively engage in this discussion and recommend changes in combustion techniques and pollution-control options as appropriate based on the state of the scientific information.

All but the very best wood burning systems, whether in buildings or power plants, have significantly higher PM emissions than do corresponding gas and oil systems. For this reason, it is necessary to use a stack with a height that will effectively disperse emissions into the air and reduce ground-level concentrations of PM (and other pollutants) to acceptable levels.

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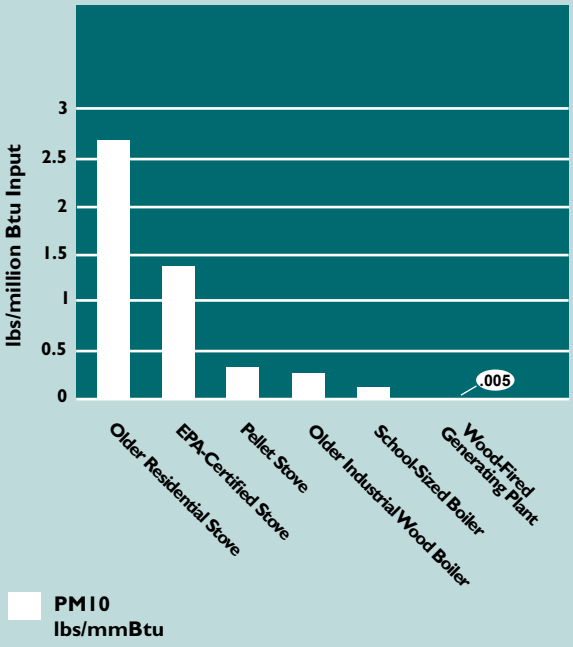
It should be noted that a conventional wood stove has PM emissions 500 times greater than a wood-fired power plant with sophisticated emissions control equipment, for the same amount of wood fuel input. School wood-system chimneys emit virtually no visible smoke (the white plume of vapor on cold days is condensed water).

Stack height is determined based on worst-case weather conditions and what is necessary to ensure air quality at the ground meets health-based standards. Currently, there is much greater risk from PM in the exhaust of idling school buses than from wood-heating plant emissions.

Particulate Matter (PM10) from Various Wood Combustion Systems



This chart shows the PM10 emission rates for the same energy input comparing a number of wood-energy technologies, ranging from common wood stoves to a clean-burning wood-fired power plant. In general, a school wood-energy system emits only 1/15 (7%) the PM10 of the average wood stove in use today for the same level of fuel energy input. Over the course of a year, a large, wood-heated high school (150-200,000 square feet) may have the same particulate emissions as four or five houses heated with wood stoves.

Other Emissions

Other air pollutants of concern include:

Sulfur Oxides (SO_x) cause acid rain. Modern wood systems have 1/6 the SO_2 emissions of fuel oil.

Nitrogen Oxides (NO_x) cause ozone, smog, and respiratory problems. Wood and fuel oil combustion have similar levels of NO_x emissions.

Carbon Monoxide (CO) is produced by all fuel combustion processes. The level produced by wood combustion depends very much on how well the system is tuned, but is significantly higher than with oil. CO emissions from wood burning are of relatively minor concern to air quality regulators, however, except in areas like cities that have high levels of CO in the air from traffic exhaust.

Volatile Organic Compounds (VOCs) are a large family of air pollutants, some of which are produced by fuel combustion. Some are toxic, others are carcinogenic. VOCs elevate ozone and smog levels in the lower atmosphere, causing respiratory problems. Both wood and oil combustion produce VOCs—wood is higher in some compounds and oil is higher in others. VOC emissions can be minimized with good combustion practices.

Natural gas is the cleanest burning of all fuels, having significantly lower SO_x and NO_x emissions than wood or oil. The molecular structure of natural gas is very simple, compared to the complex chemical composition of wood and oil molecules, resulting in predictable, clean combustion for gas.

Climate Change

Global climate change is the most pressing environmental challenge of our time and the major cause of climate change is emissions of carbon dioxide (CO_2) from burning fossil fuels such as oil, gas, coal, and gasoline.

One of the most important environmental benefits of using sustainably produced wood for energy in place of fossil fuels is its positive impact in moderating long-term global climate change.

Fossil fuel combustion takes carbon that was locked away underground (as crude oil, gas, or coal) and transfers that carbon to the atmosphere as *new* CO_2. When wood is burned, on the other hand, it recycles carbon that was already in the natural carbon cycle, which is recaptured through sustainable forest growth. Consequently, the net long-term effect of burning wood fuel is that no new CO_2 is added to the atmosphere—as long as the forests from which the wood came are sustainably managed.

Since wood burning is carbon neutral and burning fossil fuels causes climate change, when wood replaces fossil fuel the net impact is that, over the long term, CO_2 levels in the atmosphere are reduced. If a gas or oil heating system is converted to wood, net CO_2 emissions for heating are reduced by 75-90 percent depending upon how much of the fossil fuel use is replaced. For this reason, heating with wood is a powerful tool for an institution or community interested in meaningfully addressing climate change and renewable energy through its energy use.

Printed March 2008