

## AIR QUALITY ISSUES ASSOCIATED WITH WOOD BOILERS

- Like other combustion sources, wood boilers emit a variety of pollutants, including particulate matter (PM), nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO), volatile organic compounds (VOC), sulfur dioxide (SO<sub>2</sub>), carbon dioxide (CO<sub>2</sub>), hazardous air pollutants, and trace elements.
- Wood boilers emit PM, NO<sub>x</sub>, and CO in much greater quantities than the other pollutants. For this reason, we carefully track these three pollutants. (*Note: Wood boilers also emit greater quantities of CO<sub>2</sub>; however, unlike fossil fuels, woody biomass is “carbon neutral” – see discussion below on greenhouse gases*).

### WOOD BOILERS REDUCE POLLUTION FROM FIRE ACTIVITIES

- Burning forest slash in open piles contributes significantly to regional haze. Air quality is substantially improved if slash, small trees, and brush are burned in a highly efficient wood boiler (typically as wood chips) instead of in an open pile in the forest.



These three photos show the amount of smoke emitted from typical slash pile burning activities.

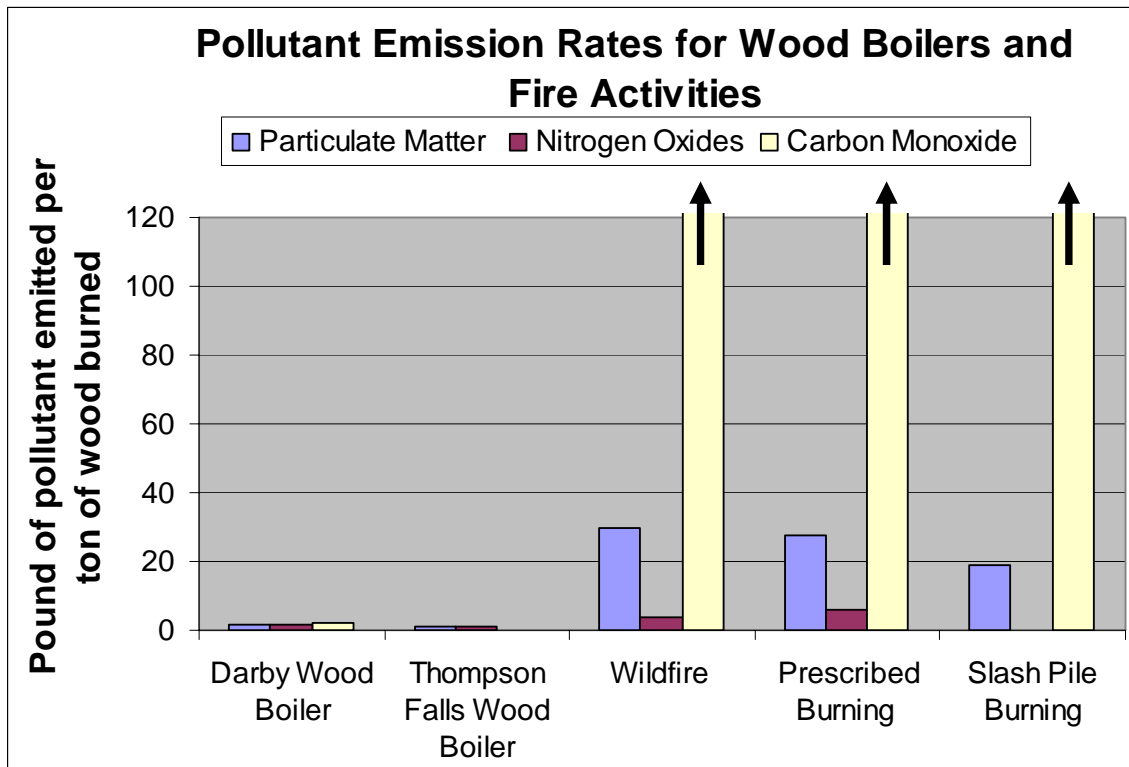


Phillipsburg, Montana wood boiler facility with exhaust stack.



In contrast to the massive smoke emitted from burning slash piles, normally you cannot see the exhaust gas emitted from a wood boiler stack or you might see a moist steamy gas with no visible smoke as shown in the above photo of the wood boiler stack in Darby, Montana.

# CHART 1



Emission Rates (lbs/ton of wood)	Darby Wood Boiler	Thompson Falls Wood Boiler	Wildfire <sup>a</sup>	Prescribed Burning <sup>b</sup>	Slash Pile Burning <sup>c</sup>
<b>Particulate Matter (PM) <sup>d</sup></b>	1.9	0.9	30	27.4	19
<b>Nitrogen Oxides (NOx)</b>	1.5	1.2	4	6.2	Not available
<b>Carbon Monoxide (CO)</b>	2.0	0.2	140	167	170

<sup>a</sup> Source for PM wildfire estimate: EPA Report: Development of Emissions Inventory Methods for Wildland Fire, Contract 68-D-98-046, Table 38, page 61 (February 2002). Source for NOx and CO wildfire estimates: AP-42, Chapter 13.1 - Wildfires and Prescribed Burning, page 13.1-3 (October 1996).

<sup>b</sup> PM and CO prescribed burning estimates are specific to the Rocky Mountain Region. Source: AP-42, Chapter 13.1 - Wildfires and Prescribed Burning, Table 13.1-4, page 13.1-11 (October 1996); NOx prescribed burning estimate is not specific to the Rocky Mountain Region. Source: EPA Report: Development of Emissions Inventory Methods for Wildland Fire, Contract 68-D-98-046, Table 39, page 62 (February 2002).

<sup>c</sup> Slash pile burning estimates based on emission factors for "average piles" under the "Pile-and-burn slash" category. Source: EPA Report: Development of Emissions Inventory Methods for Wildland Fire, Contract 68-D-98-046, Table 38, page 61 (February 2002).

<sup>d</sup> Represents total particulate matter, except the following: Darby's emission rates exclude condensibles, which are negligible; Wildfire and Slash Pile Burning emission rates represent PM-10 (particulate matter of less than 10 microns in size).

Chart 1 and the accompanying table compare the air emission rates of wood boilers to wildfires, prescribed burning, and slash pile burning. These rates are shown as pounds of pollutant emitted per ton of wood burned. This chart illustrates that the emissions from wood boilers are negligible compared to emissions from wildfire, prescribed burning, and slash pile burning activities. Therefore, reducing wildfire risks and burning slash and other woody biomass in a wood boiler substantially improves overall air quality.

*Note: The emission rates for Darby and Thompson Falls are based on actual stack tests performed in 2004 and 2006, respectively.*

**\*\*\*\*\* Detailed calculations are on file with the Forest Service \*\*\*\*\***

<b>Air Emission Reductions Achieved by a Fuels for Schools Wood Boiler</b>			
	<b>Wildfire</b>	<b>Prescribed Burning</b>	<b>Slash Pile Burning</b>
<b>Particulate Matter</b>	<b>94%</b>	<b>93%</b>	<b>90%</b>
<b>Nitrogen Oxides</b>	<b>64%</b>	<b>77%</b>	<b>Not available</b>
<b>Carbon Monoxide</b>	<b>99%</b>	<b>99%</b>	<b>99%</b>

This table illustrates the percent of air pollution that can be reduced if a given amount of wood is burned in the Darby, Montana wood boiler instead of in a wildfire, prescribed burn, or slash pile. The wood boiler in Darby, Montana, which was the first wood boiler installed under the Fuels for Schools initiative, has no air pollution controls.

## **WOOD BOILERS ARE CLEANER THAN SOME FOSSIL FUEL BOILERS**

- Wood boilers emit
  - Less PM, NO<sub>x</sub>, and CO than coal boilers.
  - More PM and CO than fuel oil, natural gas, and propane boilers.
  - Less NO<sub>x</sub> than No. 6 fuel oil boilers.
  - Roughly the same amount of NO<sub>x</sub> as distillate oil and propane boilers.
  
- Air pollution control devices, such as fabric filters or cyclones, can reduce PM emissions by 70 to 99.9%.
  
- Administrators and facility managers of wood boilers work closely with state air quality personnel and engineering & design consultants to address air quality issues early in the project planning and development.
  
- In geographic areas that have particulate matter concerns, winter inversions, or any other air quality issues, it is especially important to work closely with local and state air quality personnel to determine the most appropriate stack height for the wood boiler and whether an air pollution control device is necessary.

## CHART 2

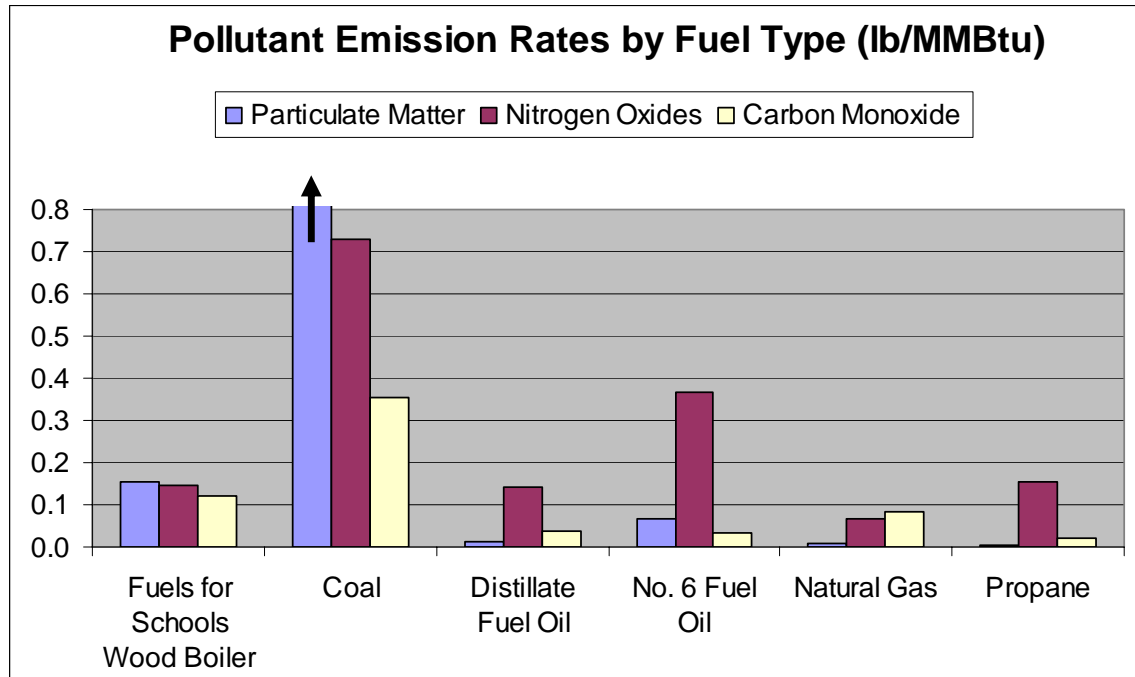


Chart 2 shows typical air emission rates for boilers burning various fuels. These rates are shown as pounds of pollutant emitted per MMBtu (million British thermal units) of fuel burned by the boiler. 1 MMBtu is a basic measure of heat energy, which is equivalent to roughly 8 gallons of gasoline.

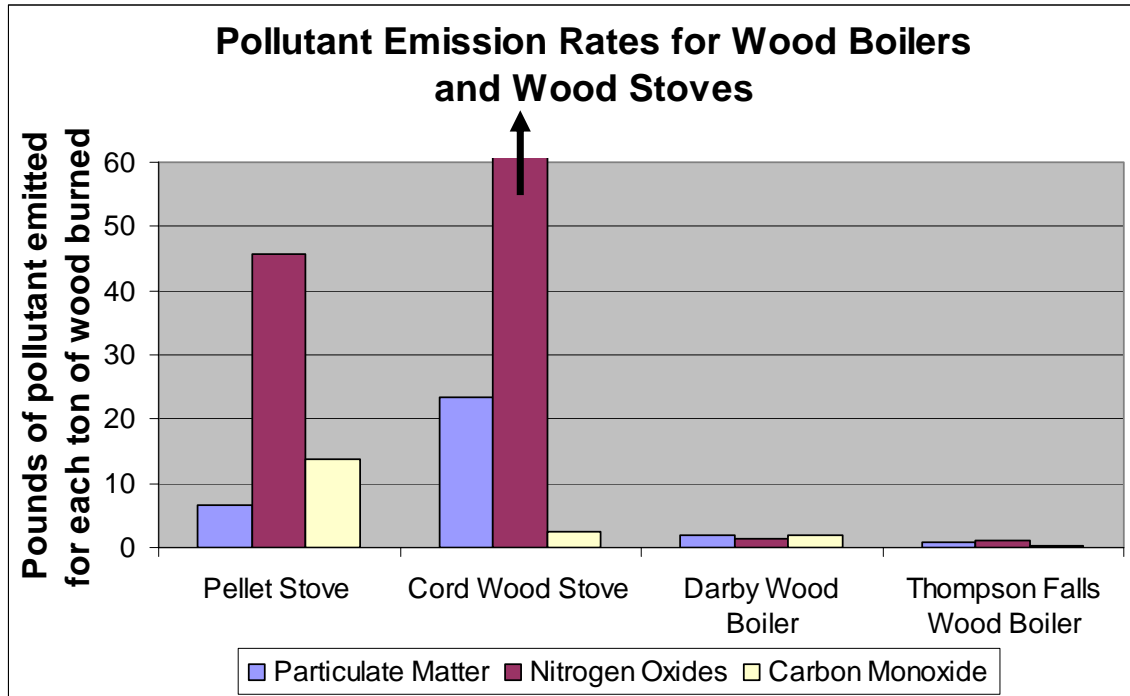
The emission rates for coal and natural gas boilers represent the average of controlled and uncontrolled emission rates (with and without air pollution control equipment). The emission rates for the “Fuels for Schools wood boiler” represent the average actual emission rates measured during stack tests for the wood boilers at the Darby, Montana and Thompson Falls, Montana schools. Darby has no air emissions controls whereas Thompson Falls reduces particulate emissions via a cyclone.

*Note: The emission rates for the fossil fuel boilers (coal, fuel oil, natural gas, and propane) are based on AP-42 emission factors published by the Environmental Protection Agency as of June 2006.*

**\*\*\*\*\* Detailed calculations are on file with the Forest Service \*\*\*\*\***

## WOOD BOILERS USE EXTREMELY EFFICIENT CLEAN TECHNOLOGY

**CHART 3**



Emission Rates (lbs/ton of wood)	Pellet Stove	Cord Wood Stove	Darby Wood Boiler	Thompson Falls Wood Boiler
<b>Particulate Matter</b>	<b>6.5</b>	<b>23.5</b>	<b>1.9</b>	<b>0.9</b>
<b>Nitrogen Oxides</b>	<b>45.8</b>	<b>158.7</b>	<b>1.5</b>	<b>1.2</b>
<b>Carbon Monoxide</b>	<b>13.8</b>	<b>2.4</b>	<b>2.0</b>	<b>0.2</b>

Chart 3 and the accompanying table compare the air emission rates for wood stoves and wood boilers. These rates are shown as pounds of pollutant emitted per ton of wood burned. The wood stoves do not have any emissions controls. In addition, the Darby wood boiler has no air emissions controls; however, a cyclone reduces the particulate matter emissions from the Thompson Falls wood boiler. As illustrated, commercial wood boilers emit substantially fewer pollutants than wood stoves because they use advanced technology that combusts the wood more efficiently.

*Note: The emission rates for wood stoves are based on AP-42 emission factors published by the Environmental Protection Agency as of June 2006. The emission rates for Darby and Thompson Falls are based on actual stack tests performed in 2004 and 2006, respectively.*

\*\*\*\*\* Detailed calculations are on file with the Forest Service \*\*\*\*\*

## WOOD BOILERS REDUCE GREENHOUSE GAS EMISSIONS

- Greenhouse gas emissions (global warming):
  - Unlike the traditional fuels, such as coal, oil, natural gas, or propane, wood has **net neutral carbon dioxide emissions** because wood is a part of the natural carbon cycle. Living trees continually uptake carbon dioxide throughout their lifespan. Therefore, as long as trees are grown to replace wood that is burned in a boiler, wood combustion does not increase total atmospheric carbon dioxide.
  - Unlike fossil fuels, wood combustion can help prevent global warming by reducing global greenhouse emissions.
  - As illustrated below, wood combustion accompanied by continued forest growth is part of the closed carbon cycle whereas fossil fuel combustion is part of the open carbon flux cycle.

