



An organization to promote Green Development Standards

Wood Stoves, Fireplaces and Outdoor Wood Furnaces

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CAUTION:

Please verify any information you copy from this document before using it. If you have any questions, please email admin@greenWR.

Note: The information about wood stoves on the web is often unreliable and often lacks supporting data. When data is provided, many studies are undated or out of date and do not include the 2020 EPA certification standards.

Introduction

NOMENCLATURE

There is some confusion over the nomenclature used to describe wood stoves and fireplaces. To avoid confusion, this article uses the generic term “heaters”. This includes:

- “wood burning room heaters” which is used by the EPA
- “solid fuel-burning appliance” which is used by the National Code of Canada and by the Ontario Building Code.
- Examples of “solid fuel” are
 - Wood (firewood or pellets)
 - Coal
 - Biomass (Corn, Peat, etc.)
- “heater” includes:
 - indoor stoves
 - indoor fireplaces
 - indoor furnaces
 - outdoor furnaces or boilers

Heaters do not include:

- propane or gas stoves and fireplaces
- outdoor wood fireplaces
- BBQs
- Traditional open wood fireplaces as they are not very efficient (<10%)¹.
- Wood fired maple syrup evaporators

Heaters emit fine particles as smoke. These particles vary in size but the ones that are 2.5 microns or less are the ones that are a health hazard and are regulated. Particulate Matter is abbreviated as PM_{2.5}. The rate at which particle matter is emitted is measured in grams per hours (g/h).

REGULATIONS

In the US prior to the 1988, particle emissions from heaters was as high as 15 g/h². In 1988, the Environmental Protection Agency (EPA) introduced regulations to limit emissions to 7.5 g/h for non-catalytic heaters and 4.5 g/h for catalytic heaters. In 2015, the limit for all heaters was set to 4.5 g/h³.

In 2020, the EPA regulation (2020) set the limit for fine particle emissions to 2.5 grams per hour⁴ for “wood burning room heaters” except pellet stoves which must limit emissions to 2.0 g/h. It is illegal to manufacture, import or install wood heaters that do not meet the EPA regulations.

In Canada, the Canadian Standards Association (CSA) regulates heaters and CSA B415 sets the emissions from solid fuel-burning appliance to 4.5 grams per hour. There are no restrictions on the manufacture of stoves or fireplaces that do not meet the regulation.

The Ontario Building Code [Section 9.33.1.2](#) requires all solid fuel-burning appliance to conform to CSA B415.1-10.

Note: the regulations only limit the amount of Particulate Matter (PM_{2.5}) emitted. They do not regulate the amount of greenhouse gases or other pollutants produced by the heaters

Most municipalities require a building permit be issued for the installation of any heater or chimney.

Many municipalities also require that a heater be inspected by a WETT (Wood Energy Technology Transfer) certified installer. However, this only applies to installations where a building permit has been issued ⁵.

Many, if not all, insurance companies require that all heater installations be inspected by a WETT certified installer whether a building permit has been issued or not.

Note: WETT only certifies that the heaters have been installed to code and it is safe to operate. WETT do not certify stoves.

Emissions from Heaters

Fires and smoke damage is the main concern with heaters and this has been the focus of building codes and insurance companies.

However, wood smoke consists of over 100 different chemicals including ⁶:

- Arsenic
- Black carbon (soot)
- Cadmium
- Carbon dioxide
- Carbon monoxide
- Dioxin
- Lead
- Methane
- Nitrogen oxides
- Sulfur oxides
- Volatile organic compounds

These emissions are not regulated by the EPA or CSA.

HEALTH

Environment Canada and Health Canada have identified many hazardous chemical substances in wood smoke, including:

- *PM2.5 (inhalable particulate matter less than 2.5 microns in diameter) - PM2.5, which consists of a mixture of microscopic particles of varied size and composition, has been declared a toxic substance under the Environmental Protection Act. These particles can be inhaled deep into the lungs, leading to serious respiratory problems, including excess mortality, especially among those with pre-existing cardiopulmonary illness.*
- *Carbon Monoxide (CO) - can reduce the blood's ability to supply necessary oxygen to the body's tissues, which can cause stress to the heart. When inhaled at higher levels, CO may cause fatigue, headaches, dizziness, nausea, confusion and disorientation and, at very high levels, lead to unconsciousness and death. Fire Prevention Canada advises that CO detectors be installed in every home that has a combustion appliance or an attached garage.*
- *Oxides of Nitrogen (NOx) - can lower the resistance to lung infections. In particular, nitrogen dioxide can cause shortness of breath and irritate the upper airways, especially in people with lung diseases such as emphysema and asthma.*
- *Hydrocarbons (HC) - can damage the lungs.*
- *Volatile organic compounds (VOCs) - can cause respiratory irritation and illness. Some VOCs emitted by wood-burning appliances, such as benzene, are known to be carcinogenic.*
- *Formaldehyde - can cause coughing, headaches and eye irritation and act as a trigger for people with asthma.*
- *Polycyclic aromatic hydrocarbons (PAHs) - Prolonged exposure to PAH's is believed to pose a cancer risk.*
- *Dioxins and furans- Some dioxins and furans are carcinogenic.*
- *Acrolein - can cause eye and respiratory tract irritation.*

Canadian Lung Association ⁷

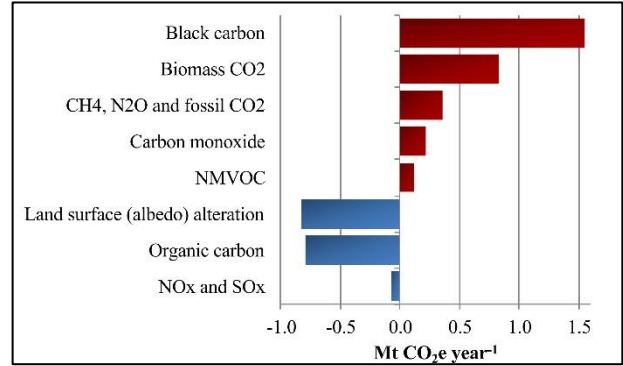
CLIMATE CHANGE

PM_{2.5} is essentially black carbon (soot) which contributes to global warming. Trees are a carbon sink and sequester carbon until they are burned at which point the carbon, in the form of CO², is released back into the atmosphere. In addition, the soot absorbs heat and it also causes snow to be less reflective, allowing more heat to reach the ground.

The impact of heaters on global warming is complicated and for a discussion on this, see [this article](#) ⁸

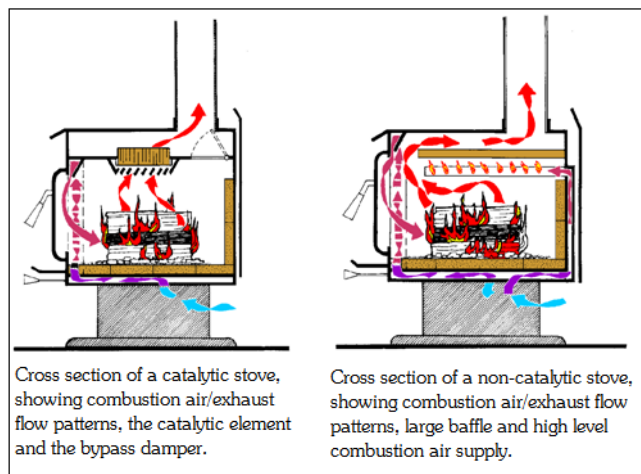
There is both a warming and cooling effect and the article says that wood smoke contributes 3% to Norway's total GHG CO₂e.

However, this article was published in 2018 and does not reflect the 2020 EPA standard of 2.5 g/h. If all heaters are converted to EPA certified appliances, then net impact would be closer to zero.



Types of certified wood heaters

There are 2 types of certified heaters⁹



<https://calorimetri.com/review/catalytic-vs-non-catalytic-woodstoves/>

Catalytic: Catalytic heaters re-burn the smoke to raise the temperature of the smoke so there is complete combustion. These heaters are at least 80% efficient and usually do not produce much smoke. However, some of these heaters emit a small amount of smoke when refueling as the bypass damper must be engaged to prevent damage to the catalyst which allows for incomplete combustion.

Catalytic heaters provide a long even burn but are a bit harder to light and re-fuel. The catalyst needs some regular maintenance and will eventually need replacing. These heaters emit less particles than non-catalytic heaters, typically about 1.5 g/h but some are as low as 0.4 g/h¹⁰.

Catalytic heaters can burn for up to 40 hours on a single load of firewood.

Non-catalytic: These heaters raise the smoke temperature by injecting fresh air into the smoke for a secondary burn. These heaters are also at least 80% efficient and meet the EPA requirement of 2.5 g/h.

Non-catalytic heaters are easier to operate, require less maintenance and are less expensive to purchase.

Non-catalytic heaters can burn for about 12 hours on a single load of firewood.

In practice, there is little difference in the PM_{2.5} emissions or the efficiency between catalytic and non-catalytic heaters ¹¹.

Outdoor furnace or boiler

An outdoor furnace is designed to burn large pieces of wood (up to 4 foot long) to reduce the time spent splitting firewood. These furnaces, also called boilers, heat water/antifreeze that is



then piped to the house to provide heat (either to radiators or a heat exchanger). The problem is that when the thermostat in the house has reached its set point, the furnace reduces the air intake to slow the fire down. This causes the fire to smoulder and produce excessive quantities of smoke. In addition, the water jacket around the firebox prevents the fire from reaching temperatures needed for complete combustion.

There are a few EPA certified outdoor wood furnaces but the majority of installed outdoor wood furnaces are not certified and can emit about 30 g/h of PM_{2.5}.

Types of wood

Wood heaters must burn dry seasoned firewood in order to be efficient. Wet wood wastes heat energy to boil off the water. For a discussion on wood types and heat values, see this article ¹²

Dry wood will have a moisture content of less than 20%. See this article on wood moisture content ¹³.

“The best way we have to compare relative heat values of various fuels is to break them down into heat units or BTU’s. A standard cord of well-seasoned hardwood (stack of wood 4’X 4’X 8’ or 128 cubic feet) contains the heat equivalent of about 20 million BTU’s. By way of comparison this is more or less equivalent to the heat value in 145 gallons of #2 fuel oil or 215 gallons of LP gas.”

Michigan State University ¹⁴

215 gallons is about 1.0 cubic metres of natural gas ¹⁵.

WOOD AS AN ENERGY SOURCE

No matter what type of heater or the type of wood burned, CO₂ is released in the air ¹⁶. Wood produces more soot than natural gas but the amount of CO₂ produced relative to natural gas is unclear. Wood essentially recycles existing carbon that was already captured from the atmosphere while burning fossil fuels adds new carbon to the air. Furthermore, the impact of methane (natural gas) on global warming is 80 times that of the same quantity of CO₂ over the first 20 years ¹⁷. The environmental costs of producing and transporting natural gas is much greater than the costs of using a local wood supply.

Chimneys

No matter what type of heater is used, or what type of firewood is burnt, the insurance industry recommends cleaning the chimneys annually.

Model by-law for Municipalities

The Federal Government has developed a “Model Municipal By-Law for Regulating Woodburning Appliances” ¹⁸ which would prohibit installation of heaters that are not certified by the CSA or EPA.

Example of local municipalities:

- North Dundas – outdoor wood furnace. (45km south of Ottawa) ¹⁹
- Strathroy – outdoor wood furnace (30 km west of London) ²⁰

The Canadian Council of Ministers of the Environment Code of Practice for Residential Wood Burning Appliances (2012), although out of date, is a good reference for the impacts on health, standards and smoke management ²¹.

Grants and Loans

There does not appear to be any Federal or Provincial grants or loans available to upgrade a non-certified heater to a certified unit.

Recommendations

At this point we do not know how many heaters are being used and the amount of emissions being released. We do know that certified heaters release about half the GHG and other pollutants than old non-certified heaters but only because they burn 50% less wood for the same heat output.

An inventory of heaters used in the Region should be created to determine the number and type of units, the amount of wood consumed, and the efficiency of the heaters.

Until we know the extent of the problem, the only recommendations we can make are:

- All new or replacement heaters must be CSA or EPA certified whether a building permit is issued or not.
- Non-certified should be banned where air pollution (smog) is a problem or where smoke is likely to cause allergies and other medical problems in the neighbourhood. (In Canada, non-certified heaters are banned in Montreal ²² and Vancouver ²³)
- Traditional open wood fireplaces should be banned as there is no control over their particle emissions.
- The burning of artificial fireplace logs should be banned as they produce no heat but, according to an EPA study, have similar emissions to fire wood ²⁴

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