



Wood Heaters and Air Pollution: Reducing Smoke Emissions

Why does the government regulate wood heater emissions?

*Wood smoke is associated with health problems such as asthma, chronic lung disease, heart problems and premature births and deaths.*¹

Recent studies indicate that "air pollution from wood heaters and open fireplaces (in Perth) accounts for:

- *16 premature deaths each year;*
- *four extra cases of lung cancer;*
- *905 extra hospital admissions; and*
- *73,000 extra reduced activity days."*²

*By 1992 in Australia, 25.4% of Australian houses and 40% of Western Australian homes had wood heaters installed in their homes to burn firewood... this number has been slowly reducing.*³

*"...from May to August 2004, the use of wood heaters and open fireplaces contributed 1375 tonnes of respirable particles, and 34,000 tonnes of carbon monoxide into the (Perth) airshed."*²

Purpose

Air pollution produced from wood heaters during the cold winter months in the city of Perth and regional Western Australia (WA) has negative environmental and health impacts on the community.

Wood heaters (including fireplaces and wood stoves) are a key air pollution source leading to the formation of the brown "winter haze" that typically occurs in the atmosphere during cold, still nights. Other air pollution sources contributing to the occurrence of haze include wildfires and controlled burns, mainly in spring months.

Wood smoke consists of particulate matter (PM) and other air pollutants, which when inhaled into our lungs have negative health impacts. These impacts are generally most severe in children, the elderly and people suffering from respiratory or breathing problems.

The Department of Environment and Conservation (DEC) is responsible for managing and protecting the State's air quality, with assistance and co-operation from other levels of government, industry and the public. Air Quality Information Sheets (AQIS) offer the Department's current view on key air pollution issues and guidance on acceptable practices used to protect WA's air quality.

This AQIS has been developed by DEC to provide information:

- To the Western Australian community on wood heater emissions and associated impacts;
- On how the community can assist in improving local and regional air quality by reducing smoke emissions from their wood heater.



Scope

The information in this AQIS will be of particular use to wood heater owners in WA, who wish to seek advice on how to operate their wood heaters to minimise smoke emissions. The information will also be of interest to people seeking general information on key sources and potential impacts of air pollution in WA. A glossary is included at the back of the document to define key air pollution terms used in this AQIS.

“Particles cause many of the environmental and health problems associated with wood smoke...they are a major source of air pollution in winter time.”¹

“Particulate matter is composed of solid particles, and liquid droplets... including elemental carbon, adsorbed organic compounds, sulphates, nitrates, ammonia, metals and other trace elements.”⁴

The fine particulate matter of PM_{2.5} penetrates deeper into the lungs than coarser particulate matter (PM₁₀), which can increase its impacts on human health.⁶

“PM increases the risk of respiratory death in infants under one year, affects the rate of lung function development (and) aggravates asthma...in children.”⁶

Air toxics are a component of wood smoke with potentially severe health impacts as they can be carcinogenic in humans.⁴

“United States Environmental Protection Agency researchers suggest that the lifetime exposure risk from domestic wood heater emissions is 12 times more than the lifetime cancer risk from exposure to an equal amount of cigarette smoke.”¹⁰

What air pollution is produced by wood heaters?

Within wood heaters, the incomplete combustion of the wood leads to the production of air pollution in the form of smoke. This wood smoke can contain the following air pollutants:

- Particulate Matter (PM₁₀ and PM_{2.5} - particulate matter with an equivalent aerodynamic diameter of 10 micrometres (microns) or 2.5 microns respectively);
- Volatile Organic Compounds (VOCs);
- Carbon monoxide (CO);
- Nitrogen oxides (NO_x); and
- Other air toxics (e.g. acetaldehyde, acetone, benzene, formaldehyde, polycyclic aromatic hydrocarbons).

What are the impacts of air pollution from wood heaters?

Health: Wood smoke air pollution can cause numerous health problems (e.g. asthma, lung disease, cancer) and can aggravate chronic conditions in people with respiratory and cardiovascular difficulties. For example, PM_{2.5} may be inhaled deep into the lungs which can have health impacts including respiratory or heart disease.

Carbon monoxide emissions can cause dizziness, confusion, headaches and in high concentrations lead to death. NO_x can restrict the respiratory system in humans, and can contribute to the formation of acid rain when combined with water vapour in the air. Air toxics from wood heaters include substances that can potentially cause cancer in humans.⁵

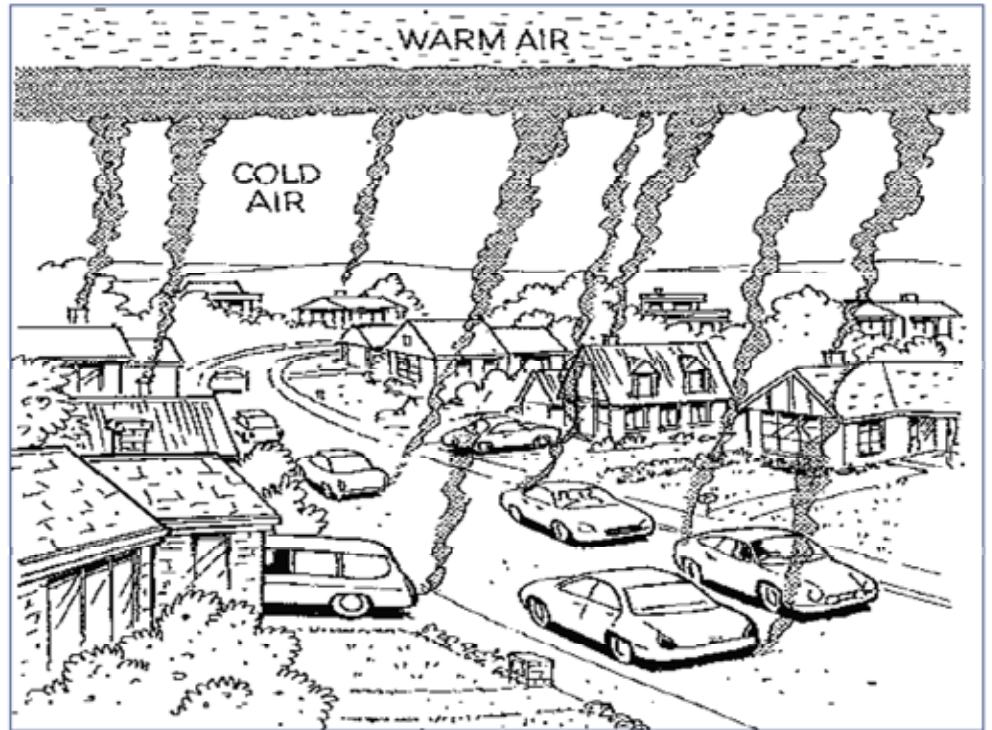
Vegetation and Crops: Air pollution can restrict processes enabling vegetation and crops to grow (e.g. photosynthesis) and contribute to the premature death of vegetation. Wood heater emissions are not currently managed by the state government for vegetation impacts.⁷

Visibility: Particles in wood smoke can impact on the aesthetics of the surrounding environment, by limiting visibility. For example, the appearance of the brown “winter haze” in Perth.

Odour: If you can smell wood smoke, then you are inhaling air pollution emissions from solid waste burning either from wood heaters or other sources e.g. backyard burning, wild fires or controlled burns. Although these smells may conjure images of “bush” life, the wood smoke can cause you adverse health impacts.

Impacts of wood smoke air pollution are increased when **temperature inversions** develop during cooler nights with a clear sky. Temperature inversions occur on cold, windless nights when ground surface air cools and becomes denser. This cold air then stops mixing with the warmer, lighter air above it. The cold air becomes trapped at the surface, and creates a layer of concentrated air pollution including wood smoke emissions. The temperature inversion prevents the dispersion of the air pollution near the ground surface, increasing its impact on the environment.⁸

Temperature inversions tend to trap air pollution at the earth's surface from any air pollution source close to the surface, including smoke emissions from chimneys and vehicle emissions (see below)



How is the Government managing wood heater emissions?

Current laws in WA related to wood heater emissions include the *Environmental Protection (Domestic Solid Fuel Burning Appliances and Firewood Supply) Regulations 1998*. This law regulates the moisture content of wood sold by firewood suppliers and also outlines emission standards for wood heaters by referencing the appropriate Australian and New Zealand Standard (AS/NZS4013:1999).

Local governments in WA act on community complaints including air pollution related nuisance within their jurisdictions under the Health Act 1911 (WA). This Act allows local governments to formulate local laws regarding smoke from wood heaters.

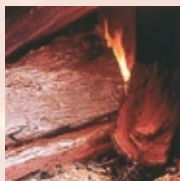
The Perth Air Quality Management Plan was released in 2000, and outlines 12 initiatives to protect air quality in the Perth region. Initiative 9 is Haze Reduction, which includes several programs for the urban area to decrease haze occurrence. Programs include education campaigns of wood heater impacts, haze alerts, smoke patrols, rebate programs and wood heater workshops to assist local government managing smoke emissions⁸.

National ambient air quality standards for criteria pollutants including particulate matter (PM_{10} and $PM_{2.5}$) specify concentrations of pollution allowed in the atmosphere through National Environment Protection Measures (NEPMs). Excessive wood smoke emissions can lead to exceedances of these national ambient air quality standards.





Dull Fire



Moderate Fire



Bright Fire



Recommendations: How can you reduce air pollution from your wood heater?

You can reduce smoke pollution from your chimney by following these simple steps ^{5,9} :

1. Keeping woodpiles under cover.

- Keep your firewood dry and in a well-ventilated area.

2. Never burn green, wet or treated wood:

- Green or wet wood generates 50 per cent less heat than dry wood, and produces more smoke emissions.
- Burn seasoned firewood, which has been drying for approximately 6-12 months and has less than 20 per cent moisture content.

3. Have your flue checked and cleaned by a professional before winter begins.

4. Never burn old household rubbish, rubber, coal, charcoal, plastics, solvents, paints, driftwood and treated wood, as they can produce toxic and corrosive emissions.

5. Start your fire with lots of paper and dry kindling with the wood heater air control fully open:

- This approach will assist in developing a bright, hot fire quickly.

6. Keeping the fire burning brightly.

- A clean and efficient fire will have bright swirling flames and red hot embers, which will reduce smoke emissions from your chimney.

7. Do not overfill your wood heater with large logs.

- Large logs can smother the fire, leading to increased smoke production. Smaller logs will help a fire to burn more brightly and efficiently.

8. Do not leave your wood heater smouldering overnight:

- This limits the oxygen available to the fire, which leads to increased air pollution
- Open fireplaces should not burn overnight unattended as this can create a potential fire hazard.

9. Minimise your wood heater use during still nights (which will improve local air quality) or when a haze alert has been issued by the Bureau of Meteorology.

10. Check your chimney for smoke.

- If your wood heater is working properly, your chimney should be almost clear of smoke. Significant amounts of smoke indicate your chimney is working inefficiently and wasting fuel.

11. If you have an old wood heater that won't stop smoking then consider:

- adding flue sections or increase the height of the chimney to increase the draw of air from the wood heater, improving combustion;
- purchasing a new wood heater compliant with AS/NZS 4013:1999;
- switching to a flued gas or electric heater, which will reduce particle emissions.

More Information?

For more information related to this topic please read the following publications, which are available on the DEC website at <http://www.dec.wa.gov.au>:

- Wood Heater Policy Options Paper
- Brochure on Wood Smoke – Halt the Haze
- Perth Home Heating Survey 2004 Technical Report.

With the further development of Air Quality Information Sheets, additional information on air pollution issues affecting Perth and WA will be published on the DEC website.

To comment on this AQIS or for more information, please contact DEC's Air Quality Management Branch at our Perth offices on (08) 9333 7436 or email airquality@dec.wa.gov.au citing the AQIS topic and version.

The AQIS recommendations do not override any statutory obligation or Government policy statement on air pollution control. Alternative practical environmental solutions to suit local conditions may be considered. Also this AQIS shall not be used as the Department's policy position on a specific matter, unless confirmed in writing. This AQIS is provided as general information only.

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GLOSSARY

Acetaldehyde

A clear, strong smelling organic liquid or vapour, that can cause numerous health impacts with exposure including irritation of the skin, eyes and respiratory system, headaches and dizziness. In severe cases exposure can lead to liver or kidney damage and death. Common sources of acetaldehyde include manufacturing of industry organic chemicals, rubber, plastics, fuels, chemicals and pesticides. Motor vehicle emissions and petrol stations are additional sources of this air pollutant.¹¹

Acetone

Acetone is a colourless strong smelling liquid or gas that is highly flammable. Health impacts associated with high level acetone exposure include irritation of the eyes, respiratory system, headaches, nausea and vomiting. Severe health impacts of acetone exposure include kidney, liver or nerve damage. Sources of acetone include paints, varnishes, manufacturing of chemicals, plastics, lime, paper and motor vehicles. Motor vehicles and aeroplanes are also a source of acetone.¹¹

Air Pollution

Degradation of the air quality by the presence of natural and foreign substances present in the atmosphere, which can have adverse impacts on human health, vegetation, livestock, agriculture, materials and aesthetics (e.g. visibility).

Air toxics

Air toxics represent a large number of air pollutants that are present in the ambient air and have characteristics that are hazardous to human health and the environment. Air toxics include benzene, 1,3 butadiene, polycyclic aromatic hydrocarbons, heavy metals, volatile and semi-volatile organic compounds and persistent organic pollutants. Air toxics are produced by motor vehicles, industry emissions, paints and adhesives, cigarette smoke and burning of fuel including the incomplete combustion of wood. Exposure to air toxics can produce increased eye, nose and throat irritation. Air toxic exposure is also linked to increased occurrences of cancer, and respiratory and nervous system damage.

Benzene

Benzene is a clear to light yellow coloured liquid, with an aromatic odour. It evaporates in the air easily, and is a hazardous air pollutant. Benzene can be produced during industry manufacture (e.g. plastics, pesticides) and is also used as a solvent. Benzene is also found in motor vehicle fuels. Health impacts associated with benzene exposure include skin and eye irritations, headaches and vomiting. Benzene is also carcinogenic and long term exposure can lead to the development of cancers such as leukemia.¹¹

Carbon dioxide (CO₂)

A colourless, odourless gas that occurs naturally in the atmosphere, and primarily produced by fuel combustion. Carbon dioxide is the most important principal greenhouse gas, with emissions a factor contributing to climate change.

Carbon monoxide (CO)

Carbon monoxide is a colourless, odourless, highly toxic gas, which is readily taken up by the blood and interferes with oxygen absorption. It is one of the most common and widely distributed air pollutants. It is commonly produced by motor vehicles, industrial emissions, houses, cigarettes and area sources (gardens, office blocks and service stations). Relatively small quantities of carbon monoxide can impair bodily functions with prolonged and acute exposure being fatal.

Formaldehyde

Formaldehyde in its pure form is a gas with a pungent odour. Exposure to formaldehyde can lead to allergic conditions impacting on the skin and lungs, and other health impacts including shortened life expectancy and reproductive problems. Within indoor environments, sources of formaldehyde include building materials, fabrics, cigarettes and gas combustion.¹¹



Haze

The term used to describe the presence of very small airborne particles in concentrations large enough to affect visibility. Sources of haze include smoke, vehicle emissions, secondary production, dust, sea-salt particles and organic acids. Smoke can originate from domestic sources including wood heaters, fireplaces and backyard burning. Health studies have shown that increased levels of particles and smoke in the air are associated with increased reports of illness, hospitalisation and death.

National Environment Protection Measures (NEPM)

National Environment Protection Measures are statutory instruments defined in the National Environment Protection Council (NEPC) legislation. They outline agreed national objectives for protecting or managing aspects of the environment. The NEPMs in place that are relevant to air quality are:

- Ambient Air Quality
- Diesel Vehicle Emissions
- National Pollutant Inventory
- Air Toxics

Implementation reports and more information on the NEPMs are available at the Environment Protection and Heritage Council website at www.ephc.gov.au.

Nitrogen oxides (NO_x)

Oxides of nitrogen are gases that can undergo chemical reactions to produce photochemical smog. Most common are nitric oxide (colourless, odourless gas) and nitrogen dioxide (orange-brown gas with a stinging smell). They are produced by the combustion of fossil fuels, motor vehicles, gas appliances and industry. Low levels of NO_x can irritate and damage the eyes, nose, throat and lungs.

Ozone

A reactive toxic chemical gas that is produced by a photochemical process between the sun and ozone precursors (e.g. hydrocarbons and oxides of nitrogen). Ozone exists in the upper atmosphere ozone layer (stratospheric ozone) as well as at the Earth's surface in the troposphere (ozone). Ozone in the troposphere causes negative health and environmental impacts, and is a cause of photochemical smog.

Particulate matter (PM)

Particulate matter is a mix of solid and liquid particles suspended in the air. Particles are produced by wood heaters, fires and diesel vehicles. Particles less than 10 microns (one seventh the width of a human hair) can lodge in respiratory tracts and lungs and have been linked to asthma, respiratory disease, cardiovascular disease and premature death. Particles with a diameter of 2.5 microns or less are small enough to penetrate deep into our lungs, causing irritation and structural damage.

Polycyclic aromatic hydrocarbons (PAHs)

PAHs are a group of more than 100 organic compounds. They are colourless, whitish to greenish solids that often attach to particulate matter. They are usually produced by combustion processes including motor vehicles, wood heaters, industrial emissions, agricultural burning and also natural sources (volcanoes and fire). They can cause health effects ranging from eye, nose and throat irritation to organ damage and may even cause death.

Volatile organic compounds (VOCs)

VOCs cover a wide range of gaseous organic compounds and include hydrocarbons, oxygenates and halocarbons. Carbonyls are a reactive subset of VOCs. They include the aldehydes such as formaldehyde and acetaldehyde and the ketones such as acetone and methylethylketone. VOCs are found in carpets, particle-board, cigarette smoke, wood smoke, paper products, pesticides, cleaning agents, glues, paints, solvents and some industry emissions. Their main environmental significance is their role in photochemical smog formation. They can also cause health effects ranging from eye, nose and throat irritation to liver and kidney damage.