



WM-AIR

IMPACT OF WOODBURNING ON AIR QUALITY



Wood burning stoves and open fires are an increasingly popular form of heating in the UK. In a small proportion of homes they are the main source of heat, but in many households they are a supplementary heat source valued for aesthetic appeal. They are also considered by some to be a greener way of heating the home than the use of fossil fuels (e.g. gas or coal) as wood, when sustainably sourced, can be considered a renewable fuel from a carbon perspective.

A DEFRA domestic wood use survey¹ found that 7.5% of UK population use wood fuel but only 2.3% solely use wood fuel. Of the domestic wood fuel users, 40% used open fires and 52% used closed stoves, with the woodburning heating season generally running from October to March.

Health impacts

Exposure to poor air quality results in short- and long-term health impacts and is estimated to be responsible for up to 36,000 premature deaths each year across the UK². The health effects of short- and long-term exposure to fine particles (PM_{2.5}) are well documented, including respiratory and cardiovascular diseases, and lung cancer. There is emerging evidence of impacts on cognitive function.

Emissions from wood burning

Wood burning emits nitrogen oxides (NO_x), carbon monoxide, volatile organic compounds (VOCs) and high

levels of particles. Many VOCs emitted in wood smoke are known to be carcinogenic, including benzene, polycyclic aromatic hydrocarbons (PAHs) and formaldehyde.

Particulate matter (PM) is classified by particle diameter, with PM₁₀ representing particles with a diameter of 10 µm or below and PM_{2.5} representing particles with a diameter of 2.5 µm or below. Air quality controls focus on these smaller particles as they can penetrate more deeply into the lungs and therefore have a greater impact on health.

PM has both direct (primary) and indirect (secondary) sources. While primary particulates are emitted directly into the atmosphere (e.g. soot), secondary particulates are formed in the atmosphere from the processing of reactive gases such as NO₂ and VOCs.

The UK government's Clean Air Strategy has identified emissions from solid fuel combustion as the single largest primary source of particles in the UK making up 38% of total direct emissions³. Research by Kings College London⁴ estimated that primary emissions of PM_{2.5} from wood burning ranged from 6 – 9% of annual emissions in urban areas. Particulates formed from wood burning emissions made up between 23 and 31% of total (primary and secondary) urban derived PM_{2.5} in Birmingham and London (2009-2015). Controlling particulate emissions from wood burning is therefore an essential component of reducing urban PM_{2.5} concentrations.

The scale of emissions from wood burning are dependent on the fuel type and the appliance used. Emissions are higher

¹ DEFRA: Summary results of the domestic wood use survey. DEFRA, London UK, 2016. Available at <https://www.gov.uk/government/publications/summary-results-of-the-domestic-wood-use-survey> Last accessed 16/06/22

² Royal College of Physicians (RCP). Every breath we take: the lifelong impact of air pollution. Report of a working party. London: RCP, 2016

³ DEFRA: Clean Air Strategy, DEFRA, London, 2019.

⁴ Font A. and Fuller G.: Airborne particles from wood-burning in UK cities, King's College London, London, 2017.

from open fires than from closed stoves. Emissions from dry, seasoned wood are significantly lower than those from wet wood. As emissions are linked to ambient temperature and heating need, they are highly seasonally dependent with higher levels of pollutant emissions in the winter months. In summer months garden bonfires may be a source of PM_{2.5} emissions. Wildfires (e.g. Saddleworth Moor fires) have also been shown to cause large emissions of PM_{2.5}⁵ and hotter, dryer weather caused by climate change is likely to increase the frequency of these events.

source of particulates into indoor air. The use of wood burning stoves has been shown to increase indoor PM_{2.5} concentrations by 196% compared to a non-use control group⁶. Wood burning can influence PM_{2.5} exposure in nearby dwellings well beyond visible smoke plumes.

Wood burning and cost of living

Increased domestic gas, electricity and heating oil prices are likely to cause some individuals to consider alternative heating sources, including solid fuel combustion.

Less affluent communities often have greater exposure to poor air quality. A 2019 analysis of air pollution and inequalities in London⁷ found that Londoners living in more deprived areas were likely to experience annual average NO_x and PM_{2.5} concentrations 13 and 6% higher than the least deprived areas respectively. Increased solid fuel combustion, and hence PM emissions, in these communities could exacerbate this difference increasing environmental health inequalities.

Legislation

Domestic wood burning in England is currently permitted only if the wood has a moisture content of less than 20%. DEFRA guidance for use of open fires and wood burning stoves⁸ advises users to: consider burning less fuel, buy “burn ready fuel”, season wood, use approved solid fuels instead of house coal and not to burn treated waste wood.

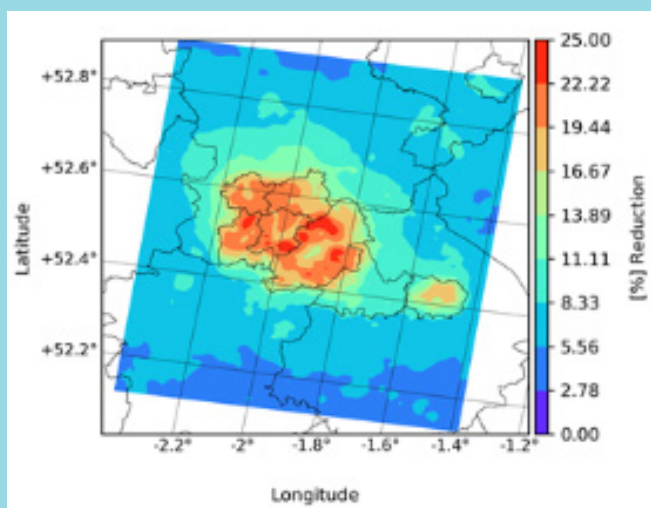
Many parts of the UK sit within smoke control areas. These areas are designated by local authorities with the aim of reducing air pollution. In these areas you can only burn “authorised fuels” (e.g. approved types of briquettes)⁹ in most fires. However, unauthorised fuels may still be used with an “exempt appliance”¹⁰. Outdoor fires such as bonfires and barbecues are not impacted by smoke control areas. The Environment Act, 2021 amended the Clean Air Act, 1993 to enable faster and simpler enforcement.

Wood burning in the news

The impact of increased fuel costs on the use solid fuels for heating has been widely reported in the media with headlines such as “Gas price hike sparks rush to buy logs and stoves as people turn to wood burners for winter heating” (inews 12/10/21) and “Why now is the time to install a wood-burning stove and beat the energy crisis” (Telegraph 9/5/22)

Case study

The impact of a hypothetical reduction of 85% of wood burning-related emissions within the West Midlands region (only) has been modelled by WM-Air, focussing upon the month of January. The simulations show that the reduction in wood burning leads to a 17 – 25% reduction in total PM_{2.5} concentrations across much of the region. This air quality gain is achieved from changes within the west Midlands region only: further improvements would result from coordinated regional or national action.



Effect of reduction in wood-burning emissions within the West Midlands region only, on PM_{2.5} levels across the region. Within-region-only changes have a significant impact for this emission source.

Impact of wood burning on indoor air quality

Most people typically spend most of their time indoors, at home, at places of work or study, or commuting. Solid fuel combustion such as wood burning can act as a large

⁵ Graham, A.M., Pope, R.J., Pringle, K.P., Arnold, S., Chipperfeld, M.P., Conibear A., Butt E.W., Kiely L., Knotte C. and McQuaid J.B.: Impact on air quality and health due to the Saddleworth Moor fire in northern England. Environmental Research Letters, 15, 074018, 2020

⁶ Chakraborty R., Heydon, J, Mayfield M. and Mihaylova L.: Indoor Air Pollution from Residential Stoves: Examining the Flooding of Particulate Matter into Homes during Real-World Use. Atmosphere, 11, 1326, 2020

⁷ Logika Noise Air Quality Consultants: Air pollution and inequalities in London: 2019 Update. Logika Noise Air Quality Consultants, London, 2021

⁸ DEFRA: Open fires and wood-burning stoves: A practical guide. DEFRA, London, UK. 2022

⁹ DEFRA: Authorised/Certified Fuels. <https://smokecontrol.defra.gov.uk/fuels.php>

¹⁰ DEFRA: Exempt Appliances. <https://smokecontrol.defra.gov.uk/appliances.php>