

A summary of “A review of the Impact of
Domestic Combustion on Air Quality”

Stove Industry Alliance, October 2019

Executive Summary

Air quality is fundamental to public health and wellbeing and it is a global issue. Members of the Stove Industry Alliance (SIA) are committed to advancing the wood burning stove industry and to play their part in not just meeting but exceeding legislative requirements for the efficiency and emissions of wood burning stoves.

In January 2019 the UK Clean Air Strategy¹ suggested that the “increase in burning solid fuels (wood and coal) in our homes (domestic burning) is having an impact on our air quality and now makes up the single largest contributor to our national PM emissions at 38%”.

However, the true contribution of domestic burning to air pollution remains poorly constrained and model uncertainty remains high, particularly in comparison to other emission sources.

Emissions from domestic burning have significantly decreased since the 1950s when smoke control legislation was first introduced and we also now have a better understanding regarding the impact of stove and open fire use in homes, how pollution from domestic burning can travel through the atmosphere, and the resulting health impacts on the local and wider population.

In order for the stove industry to best address the issue of particulate matter emissions and their impact on air quality, HETAS, with support from the SIA, has sought to commission a review of existing scientific research, literature and methodologies that focus on the contribution of domestic burning to UK air pollution.

This review has been co-authored by Edward J. S. Mitchell PhD, Joshua Cottom PhD, Douglas Phillips PhD and Ben Dooley PhD, and has been subsequently peer reviewed by Professor Alan Williams CBE, FEng University of Leeds and Professor Jenny Jones FRSC, MEI University of Leeds.

This document offers a summary of the findings of this review and sets out to provide clarification on some of the uncertainties surrounding particulate matter emissions from burning wood and other solid fuels in and around the home, and to put in context some of the reporting that has misrepresented domestic wood burning’s contribution to PM emissions.

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https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf

Background & Introduction

The 38% figure quoted in the Clean Air Strategy is based on the assumption that 6m tonnes of wood fuel are burnt each year in the UK. This figure was stated by AQEG, Defra's Air Quality Expert Group based on findings in the BEIS Domestic Wood UK Survey² carried out in 2015 and published in 2016.

To arrive at this figure BEIS conducted a user survey of 1,206 members of the public using wood fuel to heat their homes. In early 2019 the SIA conducted its own user survey to 10,620 members of the public using wood stoves at home and using the same questions and methodology as applied to the BEIS survey.

Based on the results of this survey, which have been independently reviewed and verified by Kiwa UK, the volume of wood burnt each year in the UK is closer to 1.85m tonnes. Applying this more up to date and accurate figure to the calculation used within the Clean Air Strategy the percentage of PM2.5 attributable to domestic wood burning would fall to 14.9%.

The SIA estimates that
**1.85m tonnes of wood is
burnt in the UK each year.**

The SIA survey showed that 96.5% of users were using their appliances for heating and not purely for aesthetic purposes. This is a vital consideration and a valid endorsement of wood fuel as part of an affordable low carbon heating strategy for the UK.

The SIA user survey also found that more than 27% of appliances are open fires or stoves that are over 10 years old. As a result of significantly reduced efficiency when compared to modern wood burning stoves, open fires and older stoves account for over 51% of the UK's annual wood fuel consumption³.

Replacing these models with new Ecodesign ready stoves would reduce emissions by nearly 45%, and with this reduction applied, wood burning would account for around 8% of PM2.5 emissions in the UK.

Analysing the assumptions made to date on the UK's wood fuel consumption reveals large uncertainty in the BEIS 2016 Domestic Wood Use Survey's figures and indicates that the contribution to air pollution from wood burning has been significantly overstated.

The above estimates of domestic wood burning's contribution to national PM emissions is based on the current emission factors with the NAEI (National Atmospheric Emissions Inventory). The Review of the Impact of Domestic Combustion on Air Quality also highlights

² <https://www.gov.uk/government/publications/summary-results-of-the-domestic-wood-use-survey>

³ The BEIS report in 2016 estimated that open fires were responsible for more than half of the wood burnt annually in domestic combustion in the UK.

that these emission factors are three times the level of emissions permitted under the new Ecodesign legislation, which is now implemented in modern Ecodesign Ready stoves. As these become more prevalent and a higher proportion of the volume of stoves and fireplaces in people's homes, the report points out that these emissions factors need to be reviewed and updated. This will further reduce the estimated proportion of particulate matter coming from domestic combustion.

A Review of the Impact of Domestic Combustion on UK Air Quality further seeks to analyse both the top down and bottom up⁴ emissions calculation methods used by government, and its findings confirm considerable uncertainty and poorly constrained results when employing either method.

The *Review* clearly indicates therefore that the volume of emissions being attributed to domestic combustion is almost certainly significantly overstated and needs further review.

The *Review* also concludes that modern Ecodesign Ready wood stoves and fireplaces can be integral part of the solution. The *Review* recommends a strategy of replacing older stoves and open fires with Ecodesign Ready appliances and educating consumers on using dry fuel in the correct manner on these appliances; and highlights the material impact this could have in improving air quality.

Key Findings

The following is a summary of the key findings of *A Review of the Impact of Domestic Combustion on UK Air Quality*.

- **The bottom up approach has been overestimating wood burning by up to 3 times.** Further analysis shows that estimated wood consumption in the UK in comparison with other countries is substantially over estimated. If the recent lower estimate from the SIA User Survey findings is applied, the total contribution of stoves to PM drops to 9.6% for PM10 and 14.9% for PM2.5.
- **The PM2.5 emissions factor as reported by the NAEI is 3 times higher than the limit given under new Ecodesign regulations.** Existing evidence demonstrates that appliances are capable of meeting the Ecodesign emissions limits meaning that it is possible that the NAEI's emissions factors are currently overstating the impacts of domestic burning.

⁴ Top down and bottom up calculation methods for emissions comprise a number of different tests and calculation methods. Bottom up methods are those that derive calculations from consumption of wood fuel, usually from sales figures and user surveys and the like. Top down are measurements of PM using instrumentation and equipment to identify and measure particles in the air.

- **The top down approach is open to huge errors due to old equipment.** An aethalometer is the common instrument used for measuring air particles. The majority of aethalometers⁵ used for quantitative monitoring within the UK carry high levels of uncertainty due to large amounts of variation within the instruments default values. The aethalometers used in the King’s College research are only 2 wavelength and cannot distinguish domestic wood burning on its own from other biomass combustion sources. The accuracy may be improved by upgrading the network of aethalometers from 2 wavelengths to 7 wavelengths, in conjunction with other source apportionment methods (other than levoglucosan).
- **Measuring levoglucosan cannot distinguish definitively between different sources of biomass combustion.** In order to assess particulate matter from wood smoke, the King’s College report uses levoglucosan as a measurement to support the aethalometer results. However, this cannot distinguish definitively between different sources of biomass combustion as levoglucosan is also produced by other processes such as cooking and cigarette smoke.
- **In respect of secondary particulate matter**, the release of precursor gases (e.g. VOCs and NOx) can significantly increase the mass of PM emitted from stoves, and this is an issue with open fires and older stoves. However, the Review concludes that efficient modern appliances can see these reduced to near zero during stable combustion conditions. The Review shows improving the stoves reduces primary PM, secondary PM precursors and toxicity.
- **Open burning of garden waste⁶ has very high concentrations of PM and is not being distinguished from stoves.** Further research needs to be undertaken using multiple chemical tracers to see if they can reliably identify specific source of biomass combustion.
- **Emissions from unregulated domestic sources such as barbeques, chimineas, firepits, pizza ovens, smokers and bonfires make a significant contribution to air pollution.** Government and legislators must look to facilitate some control, just as they have done with the stove industry, on these unregulated areas.

80-90 thousand tonnes of charcoal are imported and burned on UK barbecues each year.

⁵ According to Harrison et al. (2012), there are “many facets to [UK air quality] data which cast doubt on whether the instrument [2 wavelength aethalometer] is reliably reflecting concentrations of woodsmoke”.

⁶ Open waste burning is a significant contributor to man-made pollution at 4.7%.

- **Biomass burning in agriculture and land management (prescribed burning) makes a large contribution to air pollution.** This must be further researched, identified and quantified so as not to skew unwarranted assumptions and actions towards domestic burning for heat⁷.
- **Wildfires in Europe are estimated to be 600,000 hectares of forest.** 50% of PMs are transboundary⁸ so this needs to be further researched and understood.

The Role of the Wood Stove Industry

In addition to the key findings identified above, *A Review of the Impact of Domestic Combustion on UK Air Quality* also highlights the following areas in which the wood stove industry can help improve air quality:

- **Modern wood burners with improved combustion release a high proportion of harmless inorganic salts as a proportion of the total PM2.5 emissions.** Switching to modern appliances has health benefits not only in the reduced mass emissions of gas and particulate pollutants, but also in the relative toxicity of those particles.
- **Moving to the sale of only Ecodesign compliant appliances will provide air quality benefits,** as will reducing the numbers of open fires and older, inefficient stoves in use.
- **Burning wood on a modern appliance can be a key part of a sustainable economy where it forms an integral part of woodland strategy.** Local wood production, management and the local economy all combine with wood burning in a sustainable integrated support structure. Wood burning uses normal woodland management waste.
- **Support customers through incentives to choose the lowest emission appliances to replace open fires and old stoves.** This will significantly reduce emissions from wood burning in homes by targeting the 27.4% of appliances which are open fires or stoves older than 10 years.
- **Encourage users to burn only high-quality sustainable and renewable fuel.** 52% of users burn wood only, transitioning the remaining users away from coal

⁷ Note that the report does not refer to the impact of biomass boilers on emissions, which has also increased significantly in recent years.

⁸ Transboundary is where emissions have the potential to travel great distances and results in activity outside the UK such as Europe having an impact on air quality in the UK. 50% of PMs are transboundary.

to smokeless fuels and towards wood and biomass will improve air quality and reduce greenhouse gas emissions. Users need to be encouraged to use dry wood such as wood fuel certified under the Woodsure “Ready to Burn” scheme, which is confirmed as having less than 20% moisture levels.

Further Research & Recommendations

A number of areas for further research have been suggested as well as future recommendations by the authors of *A Review of the Impact of Domestic Combustion on UK Air Quality*. In summary these are:

- **Numerical calculation factors used for estimating the sources of wood burning emissions needs research.** Government support is required to review and update these to produce accurate estimates of the contribution to PM_{2.5} from domestic burning, including a review of the existing inventory datasets.
- **Research support into other emission sources.** It is vital that research is conducted into the use of other sources, such as barbecues, fire pits, commercial cooking, wildfires, prescribed fires and other biomass used to generate heat and electricity.
- **Apply regulation to the most polluting sources.** Appliances used for outdoor heating and cooking such as barbecues, chimeneas, pizza ovens, firepits and garden incinerators pose a health hazard if they continue to be unregulated. They are also an extremely inefficient use of fuel in comparison to modern Ecodesign compliant stoves and boilers.
- **Monitoring equipment must be reviewed and updated.** This must be done alongside a review of fixed ratio methods for attributing levoglucosan concentrations.
- **A domestic burning emissions expert panel should be created.** This panel would help guide and formulate appropriate actions to help reduce solid fuel emissions from homes.
- **Increase local funding sources.** Improve the availability of funding to local authorities so that they may properly investigate and monitor local air quality conditions.
- **Improve public awareness and education.** The public are currently largely uninformed on the impact of domestic burning. Ensuring that accurate evidence-based information is disseminated and made openly available to the public should take precedence.

- **Outreach programmes.** The effective promotion of best practices for stove use and other domestic burning appliances, and wood fuel quality is vital to ensure modern wood burning stoves are operating at minimum emissions levels and maximum efficiency.
- **Further explore heat pumps and wood stove hybrid heating systems for domestic heating.** Heat pumps are a steady state heat source that can be supported by fast response cleaner wood burning stoves for rapid top-up heating in a very low carbon society.

Conclusion

Mitchell et al. make clear in *A Review of the Impact of Domestic Combustion on UK Air Quality* that historic techniques and assumptions need updating to reflect modern wood burning appliances and the current state-of-the-art techniques in measurement methods and calculations.

Daily, monthly and annual variations in man-made PM emissions need to be better researched, analysed and understood to ensure that proper fact-based conclusions are drawn. The *Review* concludes that current assumptions are very uncertain and likely to be significantly overstating the apportionment of PMs attributable to domestic combustion.

Wood burning has an important role in the future of domestic heating when considering the challenges of climate changes, fuel poverty and fuel security. There is strong evidence demonstrated in this report that modern wood burning appliances can play a key role in helping to reduce emissions and improve air quality.

As the *Review* points out, wood stove upgrade programmes across the world have had significant positive benefits in air quality during peak heating time and unfavourable weather events, demonstrating that cleaner burning appliances make a real difference.

Wood stove upgrade programmes have had significant positive benefits on air quality.

The stove industry is committed to continuing to work with government and key stakeholders to incorporate the results of this research and develop more meaningful estimate and outputs to guide action to reduce overall pollution from domestic activities.

To this end SIA members have already demonstrated their commitment to developing Ecodesign compliant appliances well ahead of the 2022 deadline and the recently launched SIA Retail Group is a significant step to further raise public awareness of the benefits of modern wood burning appliances.

The SIA strongly believes that modern wood burning stoves are high efficiency, low emission, renewable and sustainable biomass heating solutions that their owners can be proud of; and is committed to an on-going programme of continuous improvement in firebox technology to reduce emissions even further.