

**Imperial College
London**

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@drgaryFuller

Keep the home fires burning? Wood burning and air pollution

**Hammersmith & Fulham Council
Climate Change and Ecology Policy and Accountability Committee
28th March 2023**



KEEP THE HOME FIRES BURNING

COMMEMORATING, IN MUSIC AND SONG, THE CENTENARY OF

THE GREAT WAR



Health impacts of air pollution in the UK (annual)

Estimates of annual deaths attributable to air pollution in the UK

- 40,000 (RcP 2016) (PM2.5 and NO2)
- 55,000 (EEA, 2017) (PM2.5, NO2 and O3)
- **29,000 -43,000 [Mitsakou et al 2022 – UKHASA] [PM2.5 and NO2]**
- 64,000 – Lelieveld et al 2019 using new global air pollution impact analysis
- 99,000 from global estimates Vohri et al 2021

3,600 to 4,100 deaths
— estimated to be
attributable to human-
made PM_{2.5} & NO₂ in
London, annually

Ella Kissi-Debrah — 1st
person in UK to have
air pollution listed as a
cause of death.

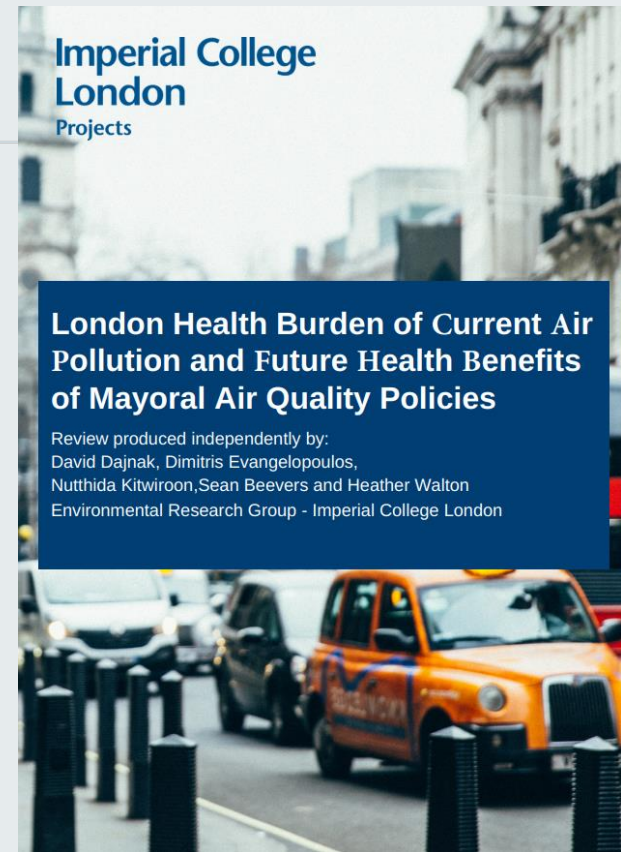
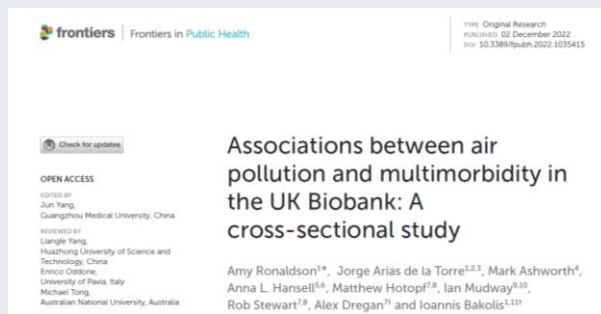
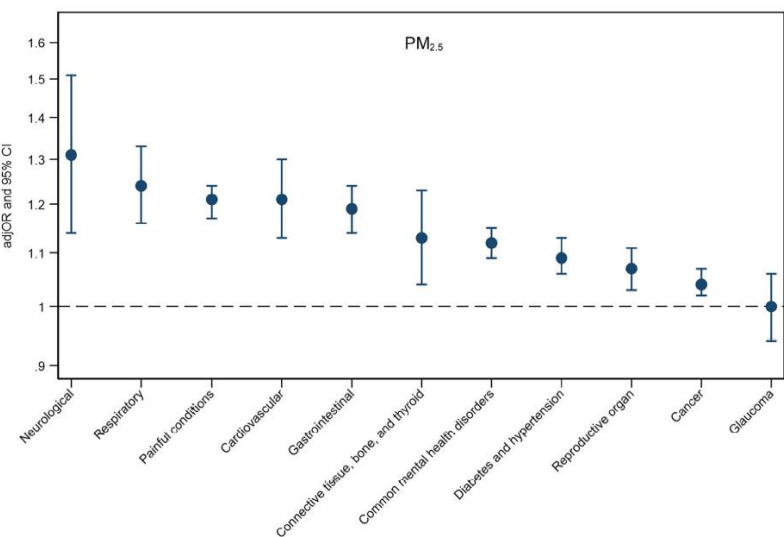
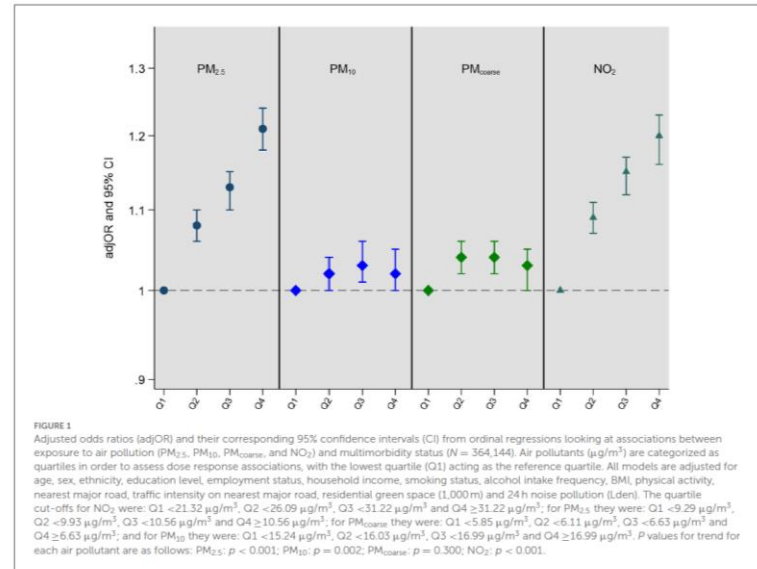


Photo Ella Roberta Family Foundation

Are the impacts of air pollution hiding in plain sight in the everyday ailments that affect the lives of so many?



An extra 20% chance of multiple long-term illnesses for those living with particle pollution that is worse than the 2040 England target.



Impact of London's low emission zone on air quality and children's respiratory health: a sequential annual cross-sectional study

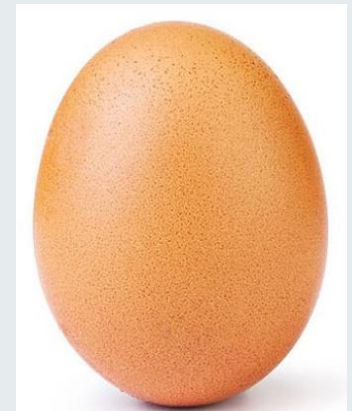
Ian S Mudway, Isobel Dundas, Helen E Wood, Nadine Marlin, Jeenath B Jamaludin, Stephen A Bremner, Louise Cross, Andrew Grieve, Alex Nanzer, Ben M Barratt, Sean Beevers, David Dajnak, Gary W Fuller, Anna Font, Grainne Colligan, Aziz Sheikh, Robert Walton, Jonathan Grigg, Frank J Kelly, Tak H Lee, Chris J Griffiths

Summary

Background Low emission zones (LEZ) are an increasingly common, but unevaluated, intervention aimed at improving urban air quality and public health. We investigated the impact of London's LEZ on air quality and children's respiratory health.



Lancet Public Health 2018
Published Online
November 14, 2018



“Within London's LEZ, a smaller lung volume in children was associated with higher annual air pollutant exposures”
But better air – bigger children's lungs.

(With all credit to Jim Gauderman et al for pioneering this type of study)

We are now learning that air pollution can have life-long impacts

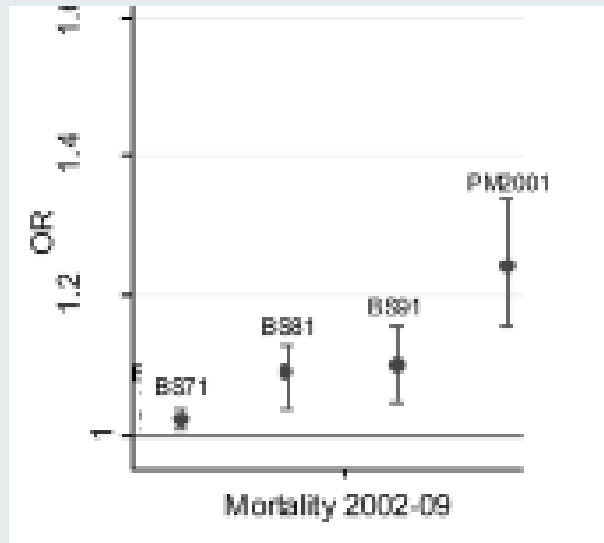
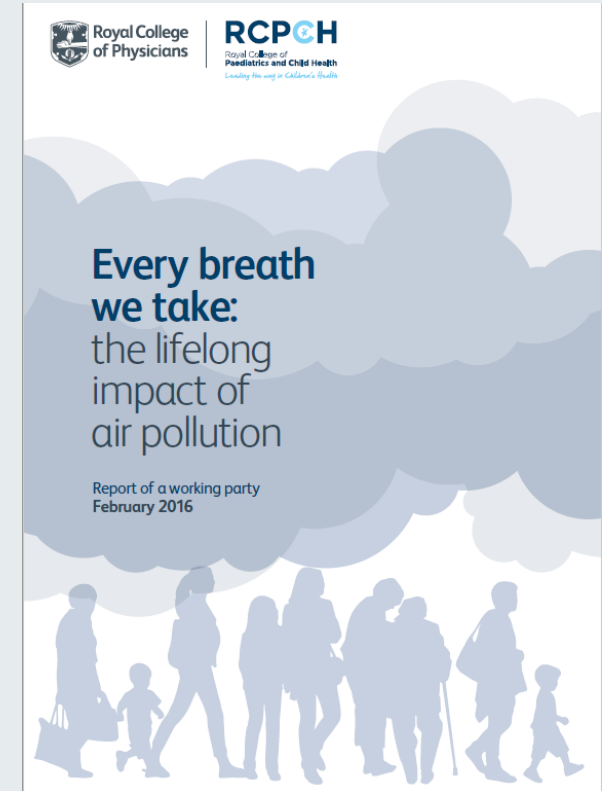


Figure 3 ORs (95% CI) per 10 $\mu\text{g}/\text{m}^3$ for BS exposure in 1971, 1981 and 1991 and PM_{10} in 2001 and mortality in each subsequent decades. Adjusted for age and sex, social class of individual and area, population density and geographical region. Source: ONS Longitudinal Study (authors' own work). CV, BS, black smoke; cardiovascular disease; ONS, Office for National Statistics.



Downloaded from <http://thorax.bmj.com/> on February 9, 2016 - Published by group.bmj.com
Thorax Online First, published on February 8, 2016 as 10.1136/thoraxjnl-2015-207111
Environmental exposure

ORIGINAL ARTICLE

Historic air pollution exposure and long-term mortality risks in England and Wales: prospective longitudinal cohort study

Anna Hansell,^{1,2} Rebecca E Ghosh,¹ Marta Blangiardo,¹ Chloe Perkins,⁵ Danielle Vienneau,^{1,3,4} Kayoung Goffe,¹ David Briggs,⁵ John Gulliver¹

OPEN ACCESS

ORIGINAL ARTICLE

Early-Life Exposure to the Great Smog of 1952 and the Development of Asthma

Prashant Bharadwaj¹, Joshua Graff Zivin¹, Jamie T. Mullins², and Matthew Neidell³

¹Department of Economics, University of California San Diego, La Jolla, California; ²Department of Resource Economics, University of Massachusetts Amherst, Amherst, Massachusetts; and ³Mailman School of Public Health, Columbia University, New York, New York

ORCID ID: 0000-0002-6827-760X (J.T.M.).

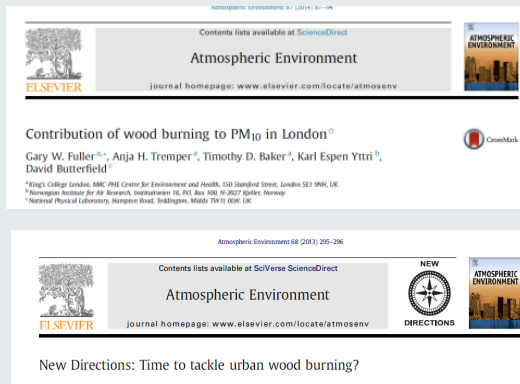
This winter marks the 70th anniversary of London's Great Smog



Keep the home fires burning?

In 1950s 18 percent of UK coal was used to heat homes. This created 60 percent of winter time particle pollution

Today the 8 percent of homes that used solid fuel emit more particle pollution than the exhausts from all the vehicles on our roads.



Solid fuels on open fires are the most polluting way to heat your home.

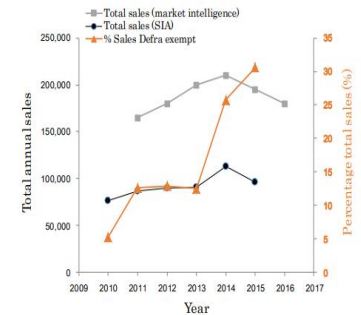


Figure 21. Total estimated wood stove sales, sales by the Stove Industry Alliance (SIA) and percentage of Defra Smoke Exempt Appliance in the United Kingdom. Conclusions



Kantar (2020) survey in 2018/2019 (~50 k homes)

27% of UK primary PM_{2.5} from solid fuel (3/4 is wood) nearly 2x that from transport exhausts (NAEI)

In London 17% primary PM_{2.5} from domestic wood burning (LAEI, 2019)

Just 8% of UK homes burn wood indoors (3% in London, 27% in NI, 38% in rural homes*)

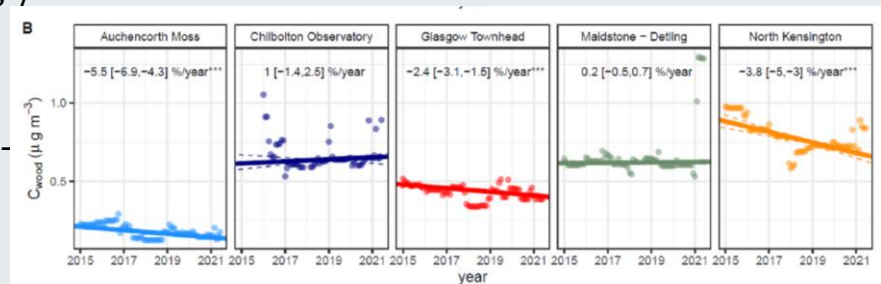
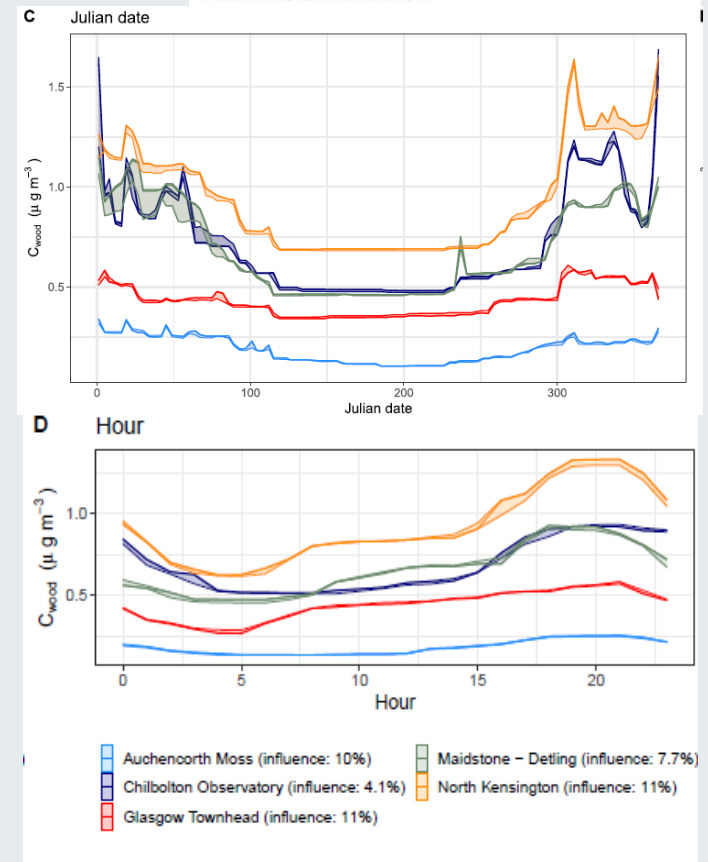
Only 4% wood burning homes rely on solid fuel for heating. Only 8% burnt wood for “necessity” 46% burnt for “tradition” or “aesthetics”

46% wood burners were in social grades AB

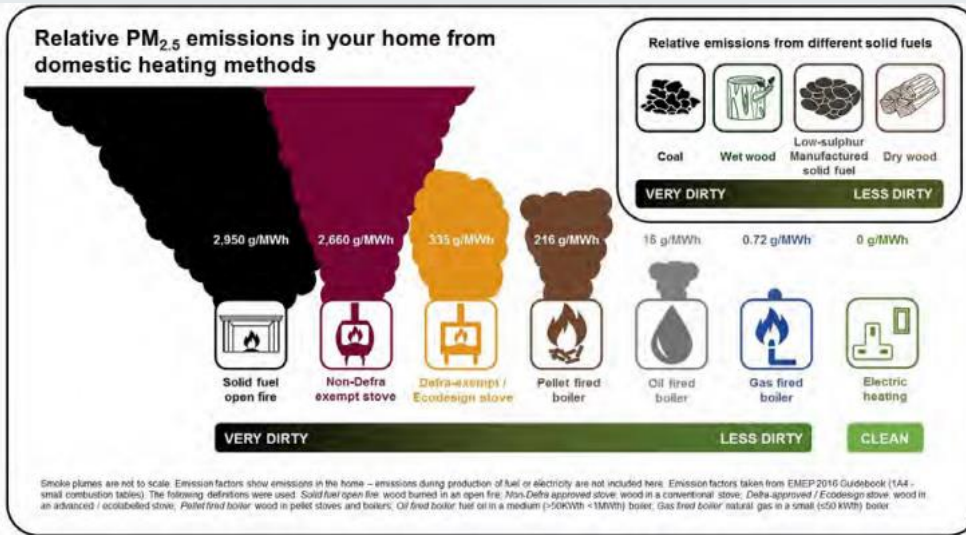
14% of homes burnt outdoors (mostly cooking)

Wood burning is not climate neutral over decades / ~ century

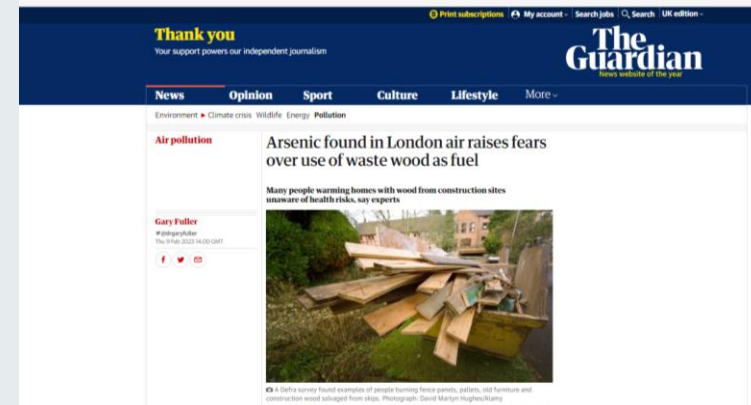
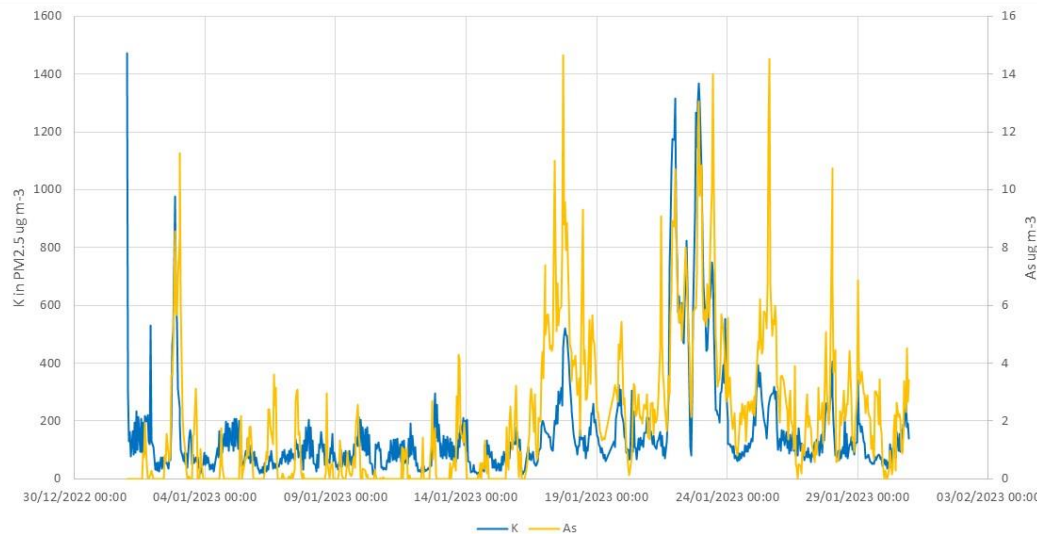
* What will be the impacts of rising energy prices - gas, heating oil etc.?



What you burn and how you burn it matters



But stove owners burn nearly twice as long as those with open fires – Kantar, 2020.



Impacts on indoor air pollution?



Article

Indoor Air Pollution from Residential Stoves: Examining the Flooding of Particulate Matter into Homes during Real-World Use

Rohit Chakraborty ^{1,*}, James Heydon ², Martin Mayfield ¹ and Lyudmila Mihaylova ³

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New Directions: Time to tackle urban wood burning?

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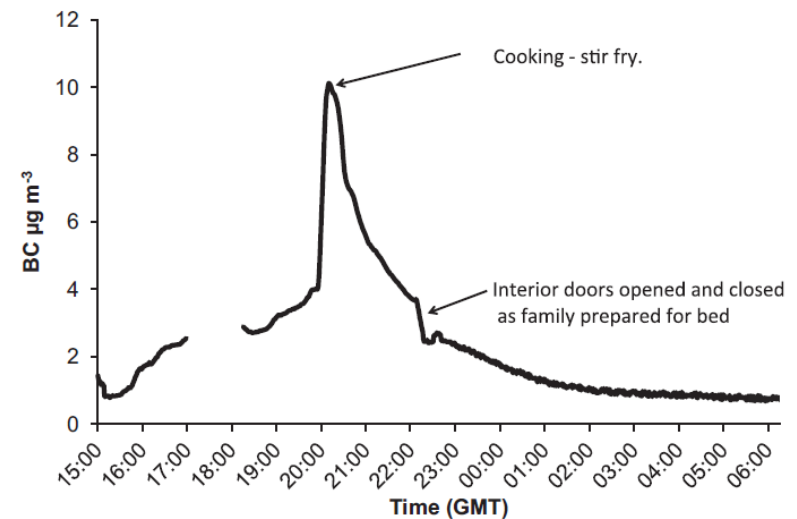
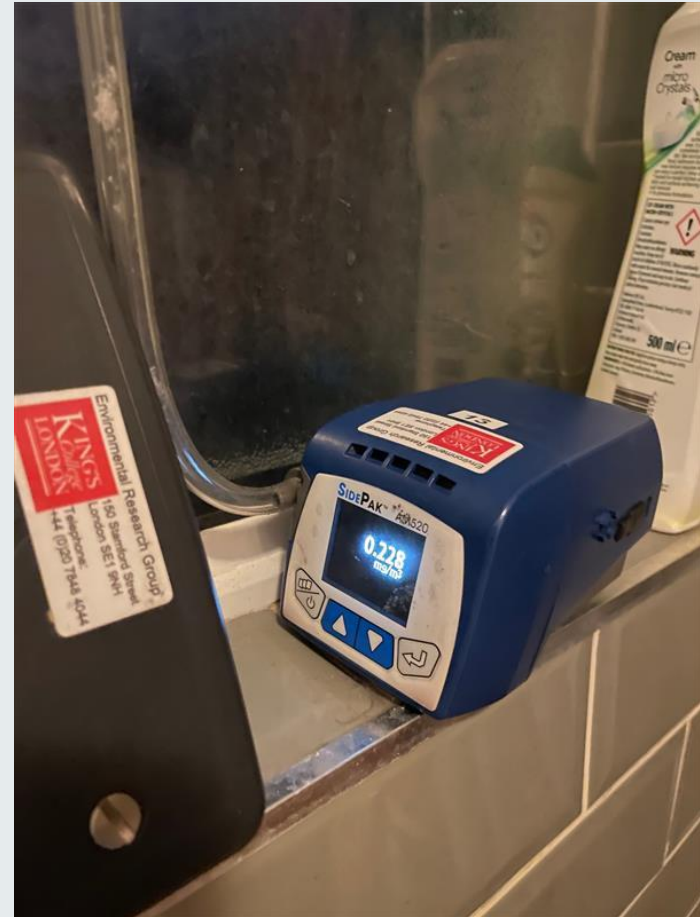


Fig. 2. Indoor black carbon concentrations (10 min mean), Sunday 14th February 2010.

Mapping new types of air pollution hotspots



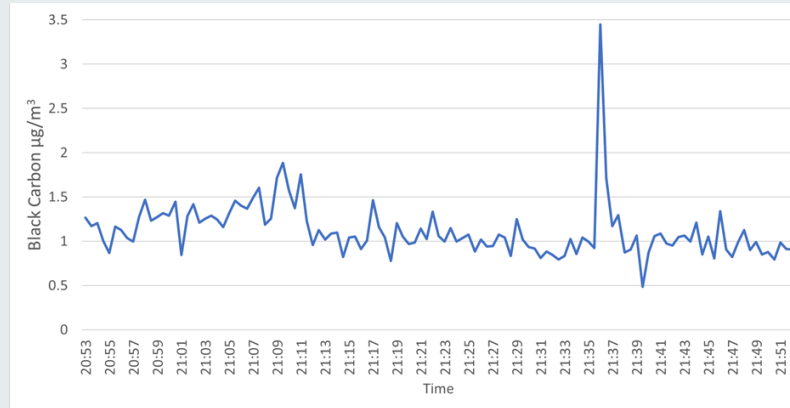
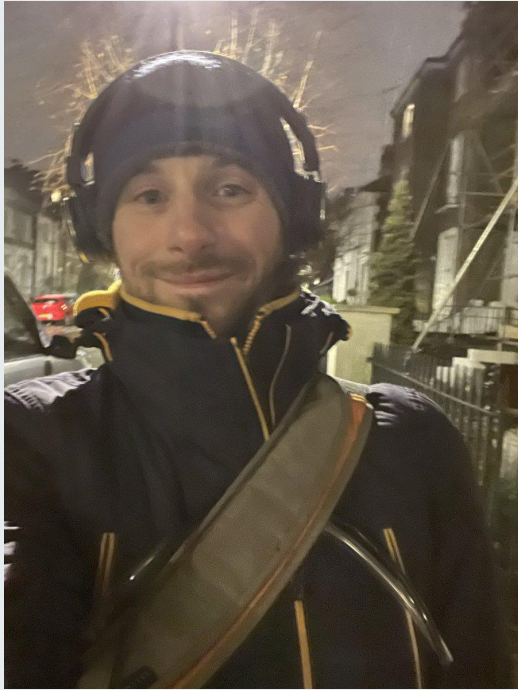
Anecdotal evidence from social media, complaints and our own measurements suggest that wood burning hotspots might exist

Mapping new types of air pollution hotspots

– pilot portable measurement studies for the London boroughs



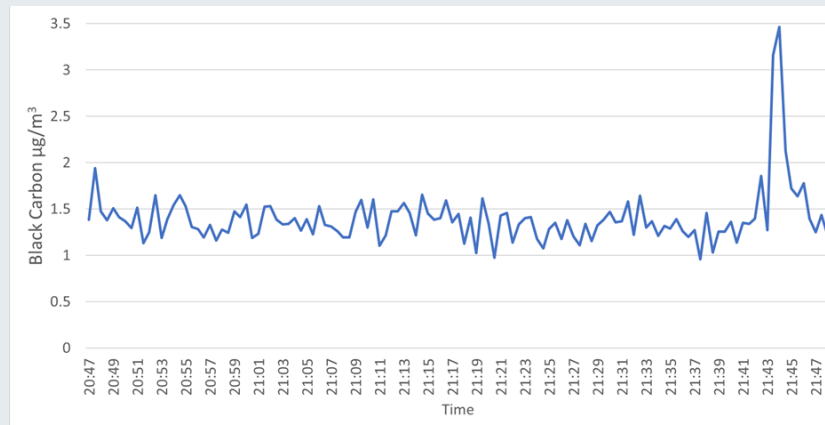
Islington



Rule of thumb: (Fuller et al 2014)

Black carbon is about 10% of total ambient PM from wood burning.

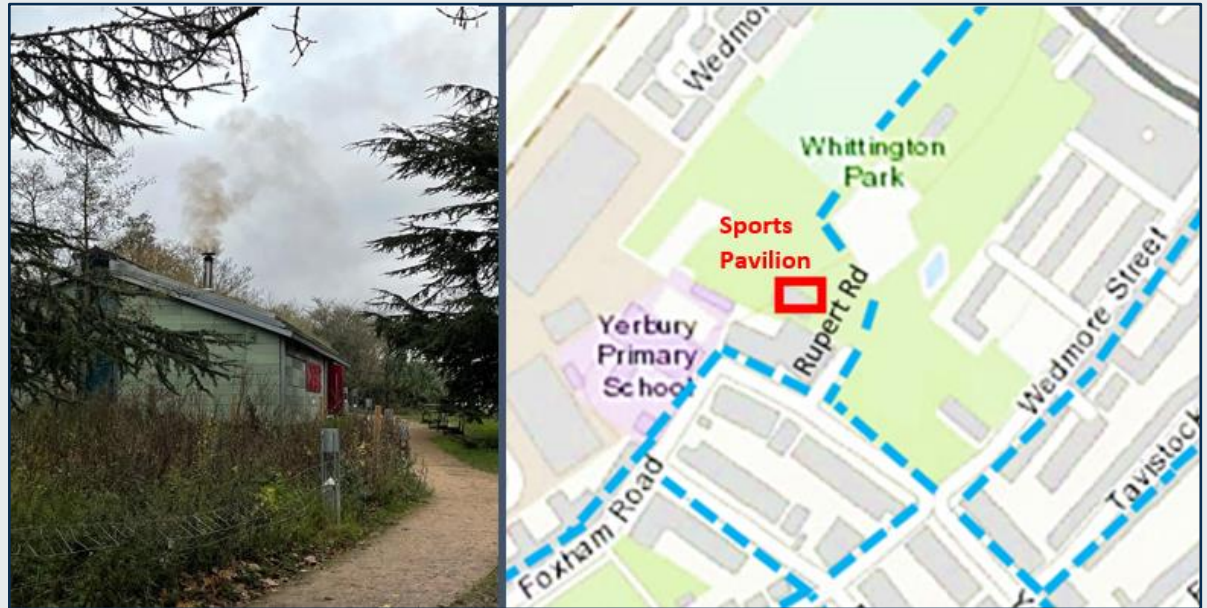
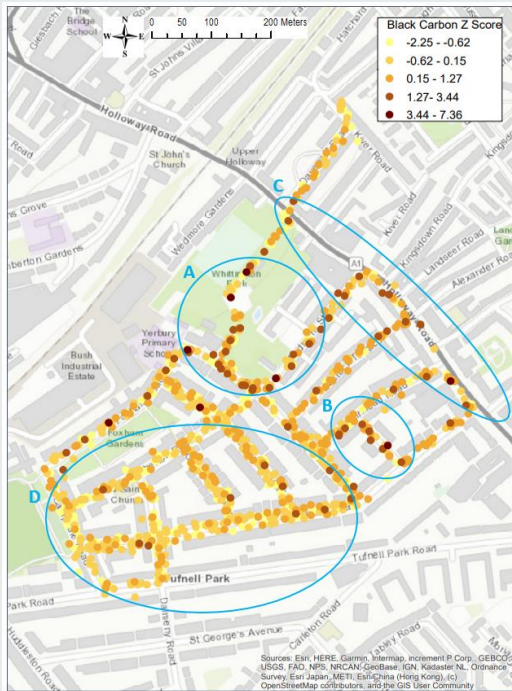
⇒ Max PM_{2,5} ~ 30 – 40 $\mu\text{g m}^{-3}$



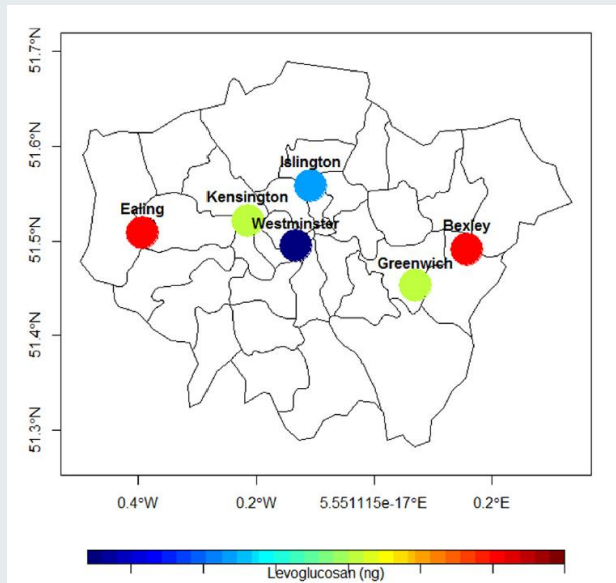
Islington - winter 2020

Incredibly challenging experiment given the difficulties of operating in “deep” lockdown.

Measurements of black carbon only.



Hotspots – are spikes transient and concentrations diffuse?



Atmospheric Environment 87 (2014) 87–94

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

ELSEVIER

ATMOSPHERIC ENVIRONMENT

Contribution of wood burning to PM₁₀ in London[☆]

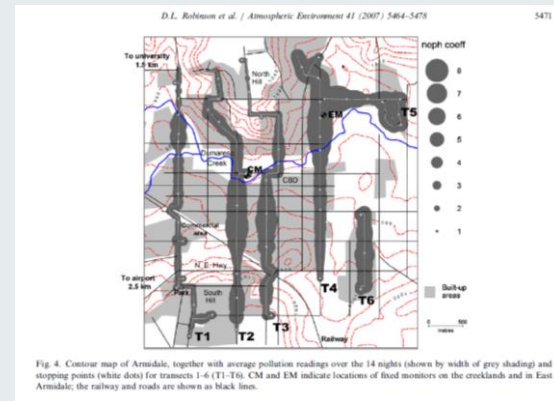
Gary W. Fuller^{a,*}, Anja H. Tremper^a, Timothy D. Baker^a, Karl Espen Yttri^b, David Butterfield^c

^a King's College London, MRC-PHE Centre for Environment and Health, 150 Stamford Street, London SE1 8NL, UK

^b Norwegian Institute for Air Research, Instituttveien 18, P.O. Box 100, N-2007 Kjeller, Norway

^c National Physical Laboratory, Hampton Road, Teddington, Middlesex TW20 0NW, UK

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Available online at www.sciencedirect.com

ScienceDirect

Atmospheric Environment 41 (2007) 5464–5478

ATMOSPHERIC ENVIRONMENT

www.elsevier.com/locate/atmosenv

Spatial variability and population exposure to PM_{2.5} pollution from woodsmoke in a New South Wales country town

D.L. Robinson^a, J.M. Monro, E.A. Campbell

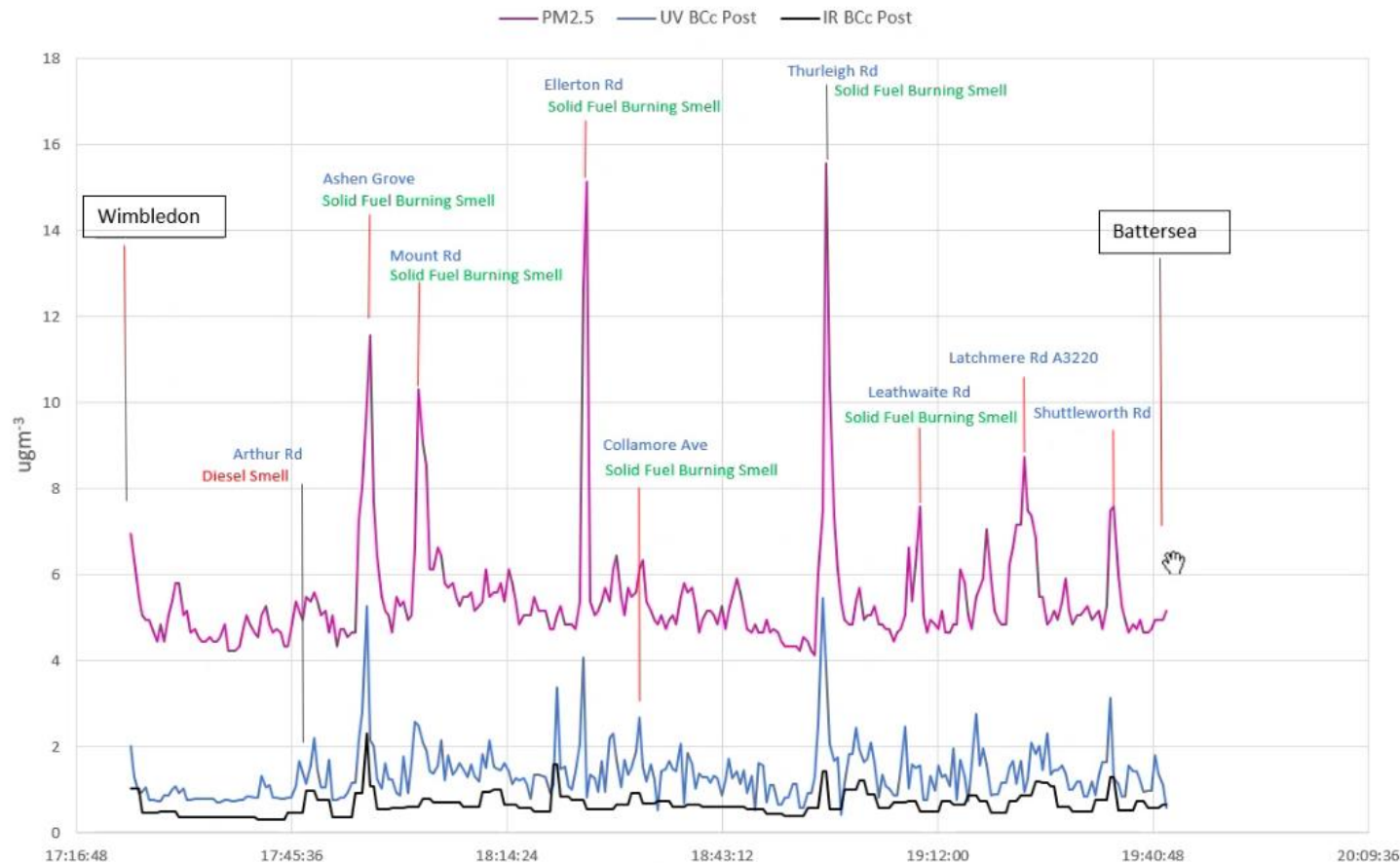
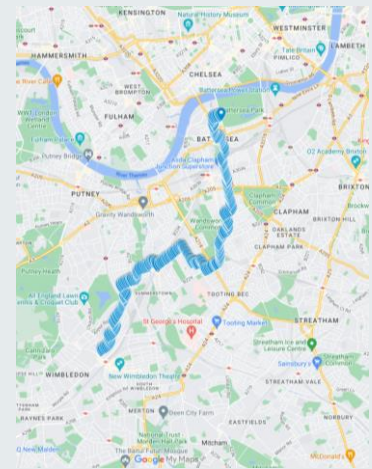
^a UNE Air Quality Research Group, Armidale, NSW 2351, Australia

Received 16 June 2006; received in revised form 15 January 2007; accepted 18 January 2007

Need to investigate via multiple fixed measurement sites in an urban area or walking routes along straight line transect?

Transect walking winter 2022/23

This winter's experiments for a group of 19 London Boroughs – work in progress by John Casey et al.



Despite smoke control, Londoners use open fires more than any other region except NI (2 x the GB mean)

Table 3.9: Appliance type and age by region (% of indoor burners) (CAS)

	Country				Region of England								
	England	Scotland	Wales	Northern Ireland	North East	North West	Yorks & Humber	East Midlands	West Midlands	East of England	London	South East	South West
Unwtd base	848	103	130	137	49*	134	105	104	75*	90*	34*	156	101
An open fire	27%	28%	21%	73%	24%	28%	32%	19%	14%	28%	56%	28%	28%
Stove installed before 2000	6%	3%	7%	1%	5%	9%	6%	4%	10%	8%	7%	5%	3%
Stove installed between 2000 and 2009	11%	13%	8%	1%	6%	9%	9%	11%	9%	13%	4%	13%	17%
Stove installed after 2009	39%	47%	38%	19%	47%	37%	38%	58%	49%	38%	10%	32%	39%
Stove unsure of installation date	5%	4%	8%	2%	7%	5%	5%	5%	12%	4%	2%	5%	4%
A biomass boiler	0%	0%	1%	1%	1%	0%	2%	0%	0%	0%	0%	0%	2%
Other (for example, range cooker, pellet stove)	7%	4%	12%	3%	6%	6%	4%	3%	3%	6%	10%	14%	5%
Don't know	4%	1%	6%	1%	3%	6%	6%	0%	3%	3%	12%	4%	3%

* Treat findings for these subgroups with caution due to the low base sizes.

Walters (2015 - DECC) survey found 68% solid fuel burners in London used an open fire vs England average of 40% in 2014

Solutions - what's been tried and what works...

Scheme	Success?
Clean Air Act – smoke control areas	75% ↓ PM due to smokeless coal in 1950s London Relied on simple supply chain Widely ignored today – 27% open fires in SCAs, 56% in London.
Smokey coal bans	75% ↓ PM London 1950s 70% ↓ PM Dublin 1990 Not widely used fuel Now in England
Wet wood standard	Not tired before Sold wet wood is only 20% of total wood burned
Stove standards – Defra approved, Ecodesign, Clearskies, Nordic Swan	More emissions in real-world vs test – can be 3-16x greater! Turnover is slow ~60% > 10 years old England, 90% in London. Having invested, stove users use their appliance 1.9 x more than those with open fires.

Solutions - what's been tried and what works...

Scheme	Success?
Subsidies for new stoves	Eg Libby Montana almost all stoves upgraded ↓ winter PM by 27%. <u>Less wheeze in children.</u> Similar results from Rhone Valley.
Subsidies to replace stoves and fireplaces with other heating	Eg Launceston, Aus – wood burning homes dropped from 66% to 30%, PM ↓ 40%, <u>death rates ↓ by 11% vs places with no scheme</u>
Burn bans – banning wood burning on polluted days.	Eg across the US, esp western states. Requires publicity and enforcement PM ↓ 20-30% raises public awareness of wood burning harm too. <u>Reductions in hosp admissions in CA</u>
Behavioural change campaigns (not just telling people the law!)	Several councils requested no bonfires or no burning in lockdown. Best campaign is / was run by Environment Canterbury (South Island. NZ)

Solutions - what's been tried and what works...



Warmer Cheaper



Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha




Smoke-free burning means a cosy nest...

Low pollution days and nights require everyone with fires to burn smoke-free. You'll get a warmer home, use less firewood AND help improve Canterbury's air quality.



Kindling Cracker







If you can't wait to get your hands on this great NZ invention, then click here to buy your very own one right now. kindlingcracker.com




Warmer Cheaper

Good Burning Technique

Checklist:

-  **Newspaper**
some knotted sheets help
-  **Lots of kindling**
might be more than you use now
-  **Small logs**
actually small, about triple the size of kindling
-  **Big logs**
with a good fire base you will use less of these to keep cosy for the night
-  **Coat**
to keep warm when popping outside to check your chimney for soot
-  **Step 1**
Setting the fire






Let us squark you through it.




Dave's Firewood Tips on the Best Firewood

Smoke-free fire master, Dave Pullen from the New Zealand Home Heating Association shares his top picks for the best firewood to burn a warmer, cheaper, smoke-free fire.

Plantation Pine, Douglas Fir and Blue Gum are widely available from Canterbury's Good Wood merchants and are the best woods to use and mix to get your fire just right.

Firewood name and description	Description when split	Recommended
1. Plantation Pine  <p>Best for cooking One of the most common firewoods, used throughout New Zealand as it comes from pine plantations and burns very cleanly. Thin compact bark.</p>	Smooth grained wood, mostly free of knots, light coloured. Drying time (ready to burn) 1 to 2 years. Moisture content - 15 - 20%.	✓
2. Douglas Fir/Oregon  <p>Best for kindling Normally taken from plantations when 20-30 years old. Light smooth bark.</p>	Has distinctive orange centre with white ring towards the bark. Ideal for splitting to make kindling. Very few knots & light in weight. Drying time (ready to burn) 1 to 2 years. Moisture content 15 - 20%.	✓
3. Blue Gum  <p>Best for Long Burn In the hardwood category, light coloured smooth bark. When split shows radial cracking, which indicates low moisture. Heavier than pine.</p>	Light to dark in colour. Normally smooth grained wood with no knots. Drying time (ready to burn) 5 to 6 years. Moisture content 15 - 20%.	✓
4. Old Man Pine  <p>Normally cut from fern shelter belts - 40 to 50 years old, very thick heavy bark. Tends to smoke a lot when lighting & re-lighting.</p>	Medium colour, lots of knots and gum. Drying time (ready to burn) 2 to 3 years. Moisture content 15 - 20%.	✗ If you have any Old Man Pine, we recommend you burn this to kindling to limit the amount of smoke.
5. Macrocarpa  <p>Usually cut from fern shelter belts. Similar to old man pine but with thin bark.</p>	Brownish dark colour with knots showing and little gum. Heavier than pine. Drying time (ready to burn) 3 to 5 years. Moisture content 15 - 20%.	✓



Warmer Cheaper

Smoke-Free Fire Demonstrations

Videos

Wood burning is not carbon neutral

Compare

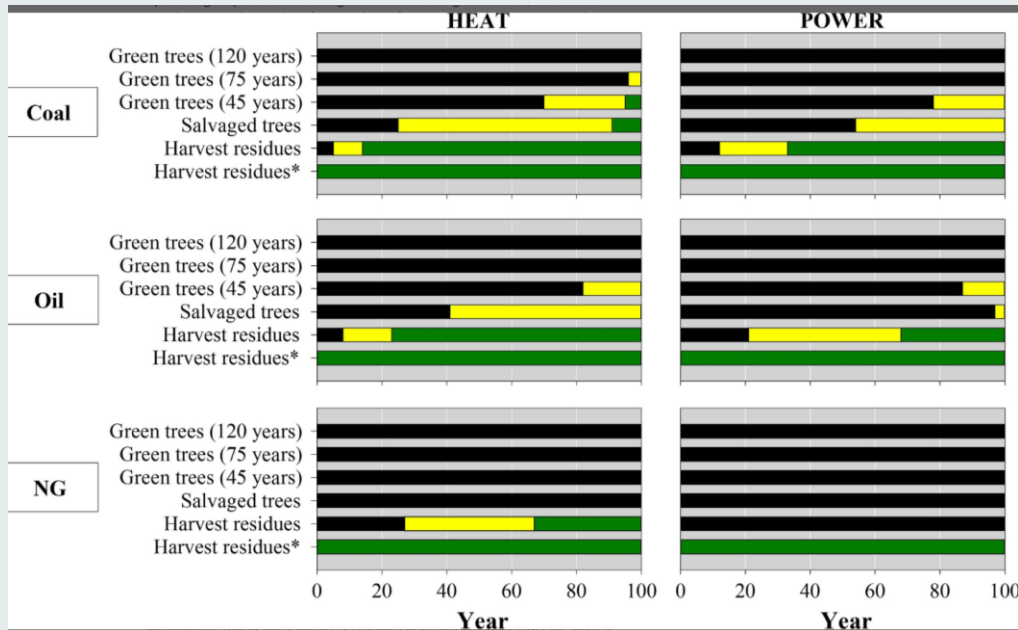
- 1) Chopping down a tree and burning it instead of using a fossil fuel
- 2) Leaving the tree in the forest and burning a fossil fuel instead

For the same unit of heat, burning wood emits more CO₂ than fossil gas, oil or coal.

So, more CO₂ in the air after an evening in front of the wood fire than fossil fuel

Carbon neutrality relies on forest regrowth to reabsorb the carbon – how long?

Impacts on biodiversity?

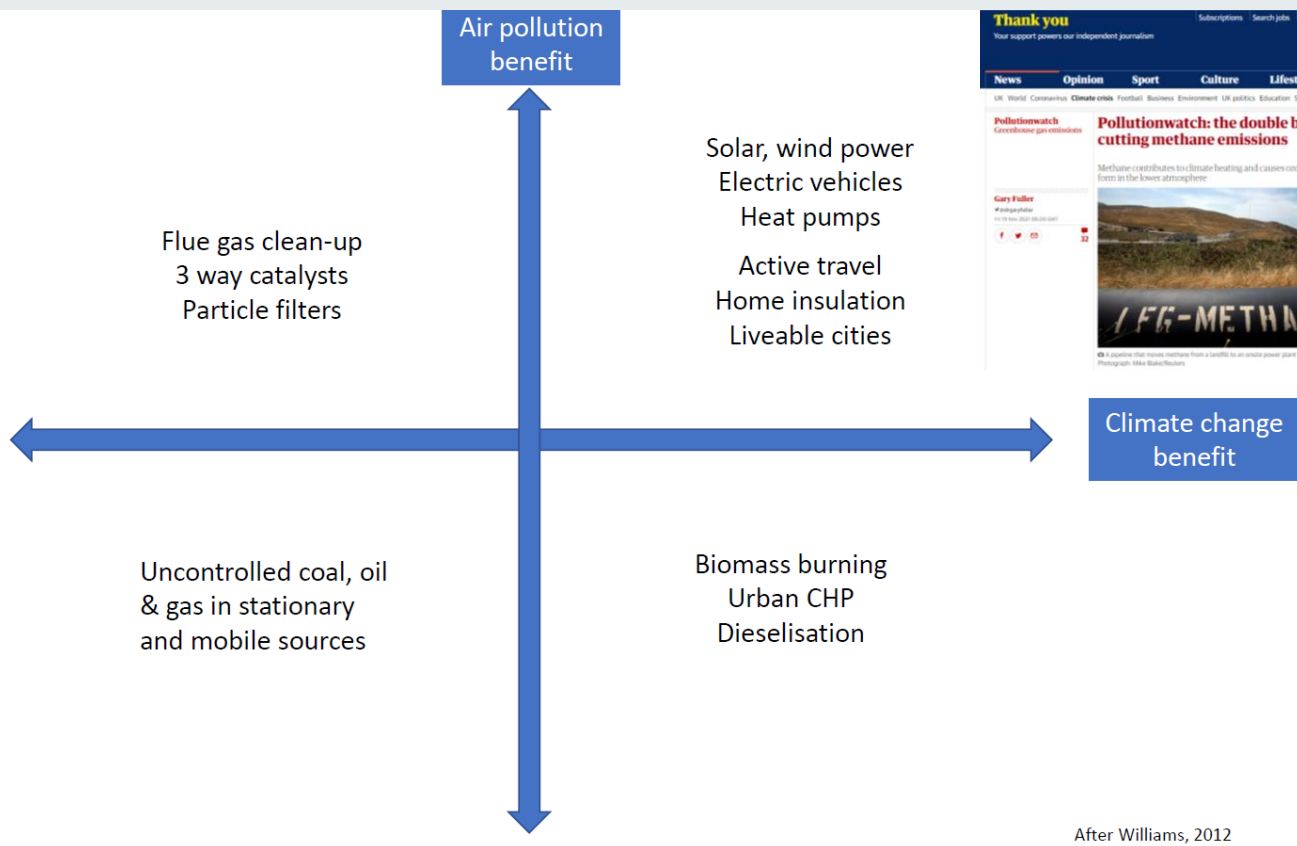


* Harvest residues that would have been burned during harvesting. Black C deficit, yellow = uncertainty range, green = C benefit for wood burning

Reducing sources (looking beyond traffic and industry)



Tackling air quality and climate change together



After Williams, 2012



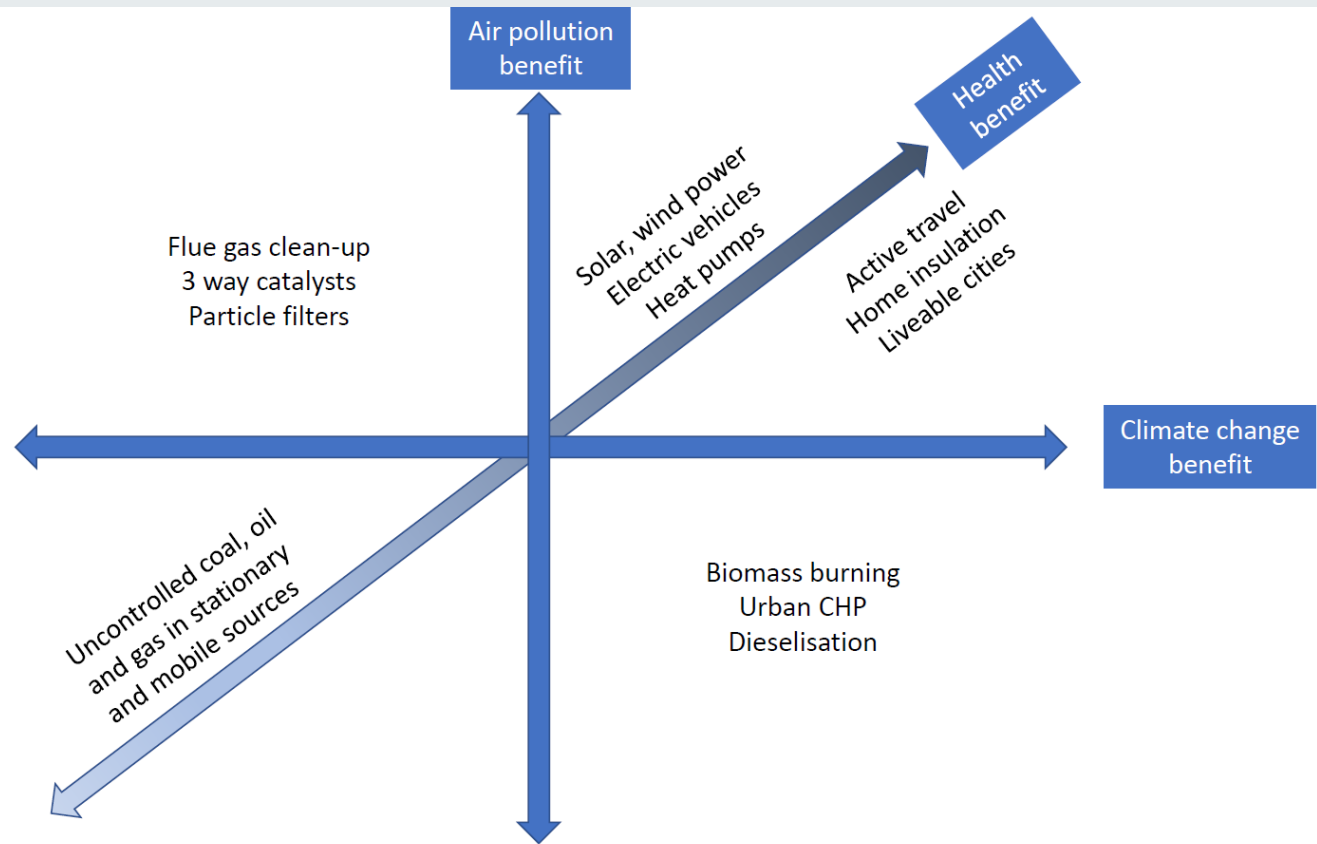
Tackling climate change: what is the impact on air pollution?

Carbon Management (2012) 3(5), xxx-xxx

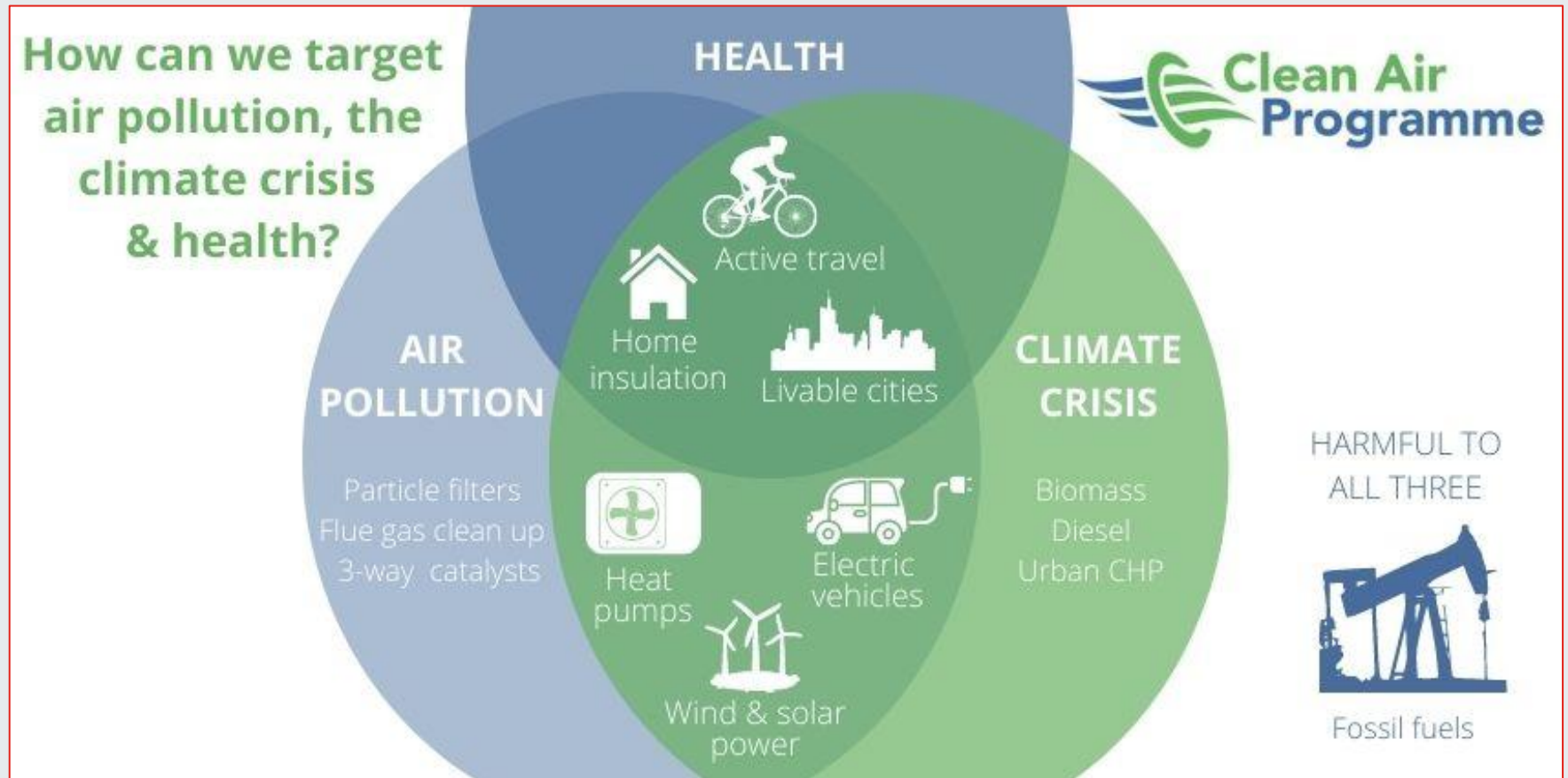
Martin Williams*



Tackling air quality and climate change together



Tackling air quality and climate change together



Low carbon, smog free, socially inclusive, bio-diverse, healthy cities....



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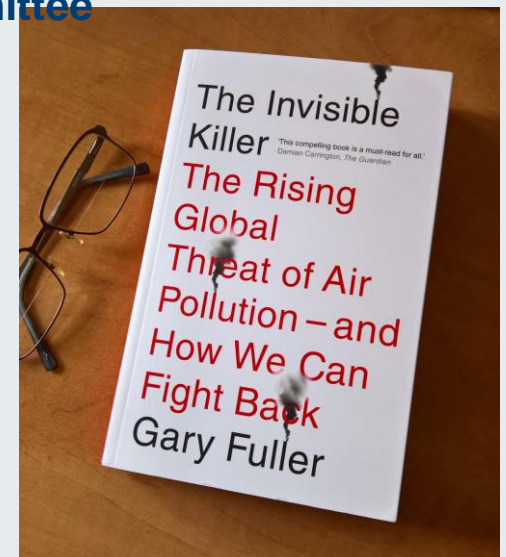
@drgaryFuller

www.londonair.org.uk

Keep the home fires burning? Wood burning and air pollution

**Hammersmith & Fulham Council
Climate Change and Ecology Policy and Accountability Committee
28th March 2023**

 **Clean Air
Programme**
www.ukcleanair.org/



Three important studies on air pollution and health

Almost 60,000 peer reviewed papers since 1932

Half of these published in the last decade.

London 1952

- it took a disaster for air pollution and health to be finally connected

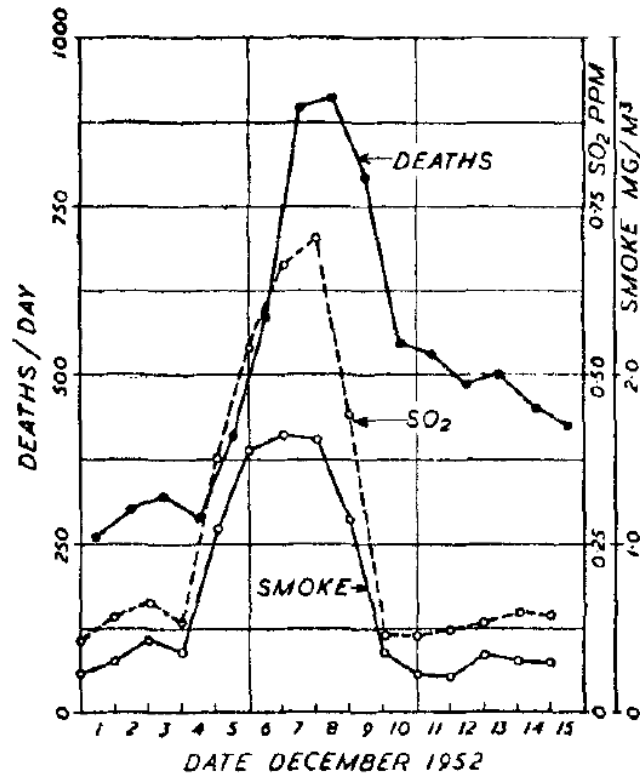


Figure 1. Daily air pollution and deaths.

Air pollution aspects of the London fog of December 1952

By E. T. WILKINS
D.S.I.R., Fuel Research Station, Greenwich

MoH report (1954) – 4,000 deaths
Bell et al 2001 - 12,000 deaths

They have no memorial except in the 1956
Clean Air Act and a book (last slide)



Then in 1993 - the six cities study

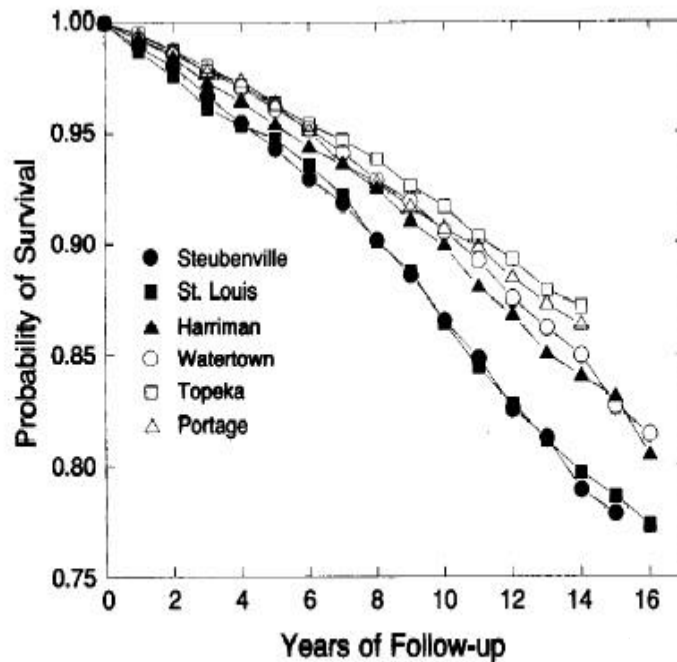


Figure 2. Crude Probability of Survival in the Six Cities, Acc to Years of Follow-up.

The New England
Journal of Medicine

©Copyright, 1993, by the Massachusetts Medical Society

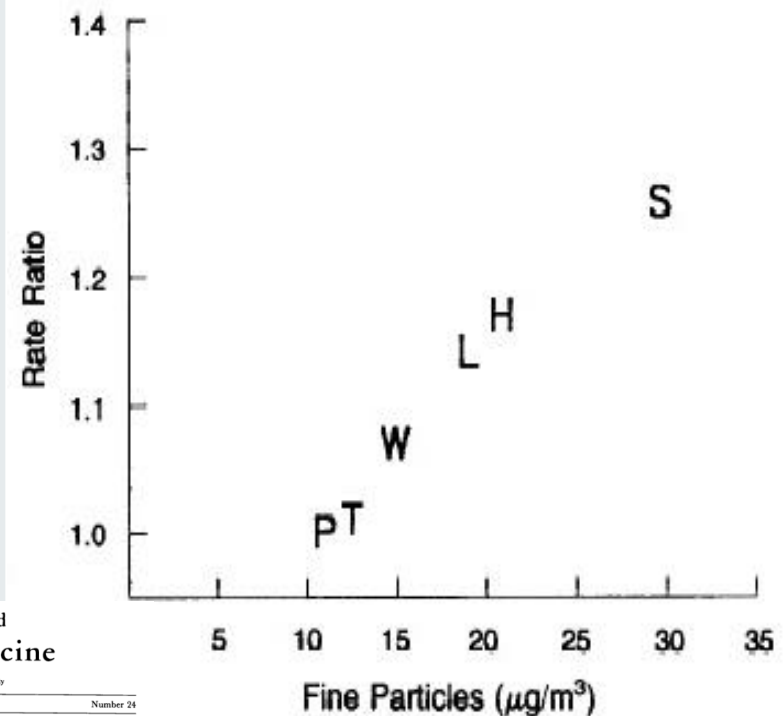
Volume 329

DECEMBER 9, 1993

Number 24

AN ASSOCIATION BETWEEN AIR POLLUTION AND MORTALITY IN SIX U.S. CITIES

DOUGLAS W. DOCKERY, Sc.D., C. ARDEN POPE III, Ph.D., XIPING XU, M.D., Ph.D.,
JOHN D. SPENGLER, Ph.D., JAMES H. WARE, Ph.D., MARTHA E. FAY, M.P.H.,
RODOLPH G. FERRIS, Jr., M.D., and FRANK E. SPEIZER, M.D.



Today, health evidence does not support a threshold

Health effects found to the lowest levels measured and well below current EU & UK Limits 20-25 $\mu\text{g m}^{-3}$, US limits of 12 $\mu\text{g m}^{-3}$ and the Env Act target of 10 $\mu\text{g m}^{-3}$ for 2040!

WHO set new Guideline of 5 $\mu\text{g m}^{-3}$ in 2021.

