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REVIEW PAPER

The impact of the 1952 London smog event and its relevance for current wood-smoke abatement strategies in Australia

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ABSTRACT

There is a certain complacency about air pollution in rural towns in Australia. An image of crystal clear skies seems to dominate general perceptions, and few locations actually monitor air pollution levels. Nevertheless, where measurements have been made, particulates have been shown to be the major type of air pollution, and they do reach levels expected to impact on human health. In this article, the contemporary attitudes and behaviour of the government and the population in rural and regional Australia are shown to have a strong resemblance to those that were prevalent prior to the smog events in London in December 1952. Wood smoke poses similar significant health issues in many countries. Insights obtained from the London events, together with more recent research results, are applied to the Australian situation to suggest policy options that are likely to be successful in overcoming the health effects of particulate pollution.

Implications: The contemporary attitudes and behaviour of the government and the population in rural and regional Australia are shown to have a strong resemblance to those that were prevalent prior to the smog events in London in December 1952. Insights obtained from the London event of 1952, together with more recent research results, are applied to the Australian situation to suggest policy options that are likely to be successful in overcoming the health effects of particulate pollution.

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Introduction

In 1952, domestic and industrial coal fires blanketed thick smoke across London for just over four days, contributing up to 12,000 deaths in the immediate weeks and months afterwards. Despite awareness of the dangers of coal smoke prior to 1952, smoke abatement campaigners were met with opposition, and government authorities were slow to impose tight restrictions on smoke emissions.

Demands for heat in remote areas of the world are commonly satisfied by using local fuels – mostly wood but sometimes coal, peat, or other combustibles. As in London in 1952, the smoke emissions from these activities are offensive both for their visible presence and their health impacts. The latter are becoming increasingly important as medical studies continue to reveal new risks due to both short-term exposure and to long-term accumulated damage (Capistrano et al. 2017; Naeher et al. 2007; Sood et al. 2018). The areas of the world affected are not limited to countries with limited resources. For example, reliance on wood burning is common not only in Asia and Africa, but also in exurban areas of North America and in many parts of Europe, particularly Central Europe (Chafe et al. 2015; Sigsgaard et al. 2015). The issues that arise constitute an evolving issue of societal health risk that need to be addressed, but the necessary regulatory and control steps are often not supported by public opinion. The matter has come to a head in Australia, where, wood smoke accumulates in many Australian towns and cities during the winter months, contributing to chronic and sometimes deadly health issues among residents. As in London prior to 1952, there is a general resistance to domestic wood-smoke abatement among the general population and local governing authorities in Australia.

The matter of smoke pollution and the imposition of remedial regulations rose to a level of unprecedented public awareness following the infamous London smog episode of 1952. Here, the history of this extreme example of local pollution and its effects are reviewed, with emphasis on how the lessons learned might constitute guidance as authorities strive to address the emerging issues of smoke and consequent health risks affecting (as an example of contemporary relevance) small Australian urban areas.

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The history of the 1952 London smog event and the impact of the 1956 (British) Clean Air Act has been widely documented and reviewed, particularly at the 50th and 60th year anniversaries (Brimblecombe 2006; Greater London Authority 2002; Heys 2012; Laskin 2006; Longhurst et al. 2016). Bell and Davis reassessed the London smog event using new indicators for respiratory morbidity and mortality to demonstrate that original mortality estimates were under-estimated (Bell and Davis 2001). Studies of smog in other parts of the world have also been compared to the smoke event of 1952 to understand why it caused so many deaths (Martin 2016). Regarding wood smoke, Naeher provides a comprehensive study of its negative effects on health (Naeher et al. 2007). Others, such as Robinson, have studied the environmental and human health impact of wood smoke emissions and what can be done to reduce it (Robinson 2011). Research into the psychology of wood-fire heaters has demonstrated that positive affection toward wood heaters contributes negatively towards wood-smoke abatement (Bhullar et al. 2014; Hine et al. 2011). This paper contributes to the literature by directly comparing the circumstances of the London smog event and attitudes towards smoke abatement prior to 1952, with current attitudes and smoke abatement strategies regarding wood-fire heaters and smoke emissions in Australia. Although the events in London involved mostly coal smoke with a different chemical composition from wood smoke, and occurred almost 70 years ago among a post-war population, the attitudes to smoke pollution and steps taken to improve the air quality in London are relevant to the Australian context today. By gaining a better understanding of the attitudes toward smoke abatement in the UK, it was anticipated that lessons learned from the catastrophic 1952 event may contribute to current wood-smoke abatement strategies that seek to improve air quality, general health and ultimately avoid unnecessary deaths of Australians and residents of other countries from wood-smoke pollution.

Prior to 1952

The impact of air pollution in London was recognised hundreds of years before the devastating smog event of 1952.

In 1661, John Evelyn presented a treatise to King Charles II, in which he suggested that smoke pollution is not only visibly objectionable, but would shorten the lives of people living in London. He argued that the constant presence of coal smoke in London "renders her less healthy", "really offends her", and "darkens and eclipses all her other attributes" (Evelyn 1661, p.5). Regarding the health of its citizens, he described the smoke as "so universally mixed with otherwise wholesome and excellent air, that her inhabitants breathe nothing but an impure and thick mist accompanied with a fuliginous and filthy vapour, which renders them obnoxious to a thousand inconveniences, corrupting the lungs, and disordering the entire habits of their bodies, so that catharrs, phthisicks, coughs and consumptions rage more in this one city than in the whole Earth besides" (Evelyn 1661, 5). Evelyn's objections were contrary to "Learned Society", including the College of Physicians who considered the smoke "rather a preservation against infections". While he acknowledged that domestic chimneys do emit some pollution, it was industries such as brewers, dyers, soap and salt-boilers, lime-burners and the like, that contributed the majority. As such he recommended that these trades be removed "5 or 6 miles distant from London below the River of Thames". Evelyn claimed that this "would produce so considerable a cure, as men would even be found to breathe a new life as it were, as well as London appear a new city" (Evelyn 1661, 13–16).

With the industrial revolution, smoke pollution became an increasing concern. A Select Committee was established in 1819 by parliament to investigate smoke emissions from steam engines and furnaces, and whether they could be operated in ways less harmful to public health. The findings by this committee were attributed by Lord Ashby in 1974 as the beginning of a long process that culminated in the (British) Clean Air Act of 1956 (Greater London Authority 2002). Throughout the 1840s the Select Committee recommended various actions be taken to prevent black smoke from furnaces and private dwellings (Greater London Authority 2002). In 1851 the City of London secured power to control smoky furnaces and two years later, this authority was extended to the whole urban area. Throughout the mid to late-1800s various Acts such as the Smoke Nuisance Acts (1853, 1856) and Public Health Acts (1875, 1891) gave increasing authority to the police and later the London County Council to monitor smoke emissions and impose fines (Greater London Authority 2002).

Anti-smoke societies became more prolific from the mid-1800s. Their aim was to increase public awareness of the harmful impact of air pollution through publishing books, pamphlets, posters, smoke abatement exhibitions, lectures and conferences. They promoted the economic benefits of more efficient fuels, and in the 1900s saw potential in converting raw coal into cleaner fuels such as gas, electricity and coke. Such

organisations included the Manchester Association for the Prevention of Smoke (1842), Leeds Smoke Abatement Committee (1890), the London-based Coal Smoke Abatement Society (1899), and the National Smoke Abatement Society (1929) (Mosley 2017).

Although there was a growing concern for the negative health impact of air pollution, such campaigners were met with resistance. In 1922, the Chairman of the Smoke Abatement League of Great Britain, Ernest Simon, remarked that "the smoke abater is universally regarded as an amiable and unpractical faddist" (Mosley 2009, 276). Smoke was perceived as a positive sign of progress and national economic prosperity, with phrases like "where there's muck, there's brass" and smoke is the "incense of industry" (Mosley 2017, 2). The domestic open hearth was regarded as the centre of family warmth, comfort and wellbeing. Despite the promotion of cleaner gas and electricity appliances in the early 20th century, it was usually only the middle and upper classes that could afford them. Coal appliances were half the cost of their cleaner fuel alternatives. In 1945 George Orwell defended "wasteful, dirty and inefficient" coal fires by stating that gas and electric fires were dreary in comparison and appliances should be judged by the "pleasure and comfort that one gets out of them" (Mosley 2017). As such, legislation for smoke abatement was poorly enforced because government agencies were reluctant to interfere with citizens' freedom to enjoy their home fires (Mosley 2017).

Despite historical awareness of the health dangers of smoke and the efforts of the smoke abatement campaigners in the 19th and early 20th centuries, public understanding of the dangers of air pollution remained low, and government authorities were slow to enforce emission reductions. Sadly it took the devastation of the 1952 London smog event to change public perception and move the government to enforce tighter restrictions on air emissions with the (British) Clean Air Act of 1956.

The 1952 London smog event

A number of circumstances prior to the London Smog event of December 1952 contributed to its deadly impact. November and early December that year had been very cold. This led to households burning larger quantities of coal to keep warm (Met Office UK 2011). After World War II, local residents only had access to cheaper, low-grade coal that contained a high sulfur content which produced a toxic sulfur-rich smoke. The respiratory and general health of the population was low after the war due to poor nutrition and the nearly universal habit of cigarette smoking among post-war men, placing them at higher risk of lung disease (Bates 2002; Laskin 2006).

On the morning of the 5th Dec 1952, the sky was clear and the air near the ground was cold and moist. An area of high pressure was centred over southern England and in the Thames Valley an inversion layer developed that trapped the cold moist air (Greater London Authority 2002). The air beneath this inversion not only contained water droplets but, according to the Met Office UK, huge quantities of impurities including 1,000 tonnes of smoke particles, 2,000 tonnes of carbon dioxide, 140 tonnes of hydrochloric acid, 14 tonnes of fluorine compounds and 370 tonnes of sulphur dioxide (Met Office UK 2011). By evening, the fog had become extremely dense reducing visibility to 10m (Chandler 1965).

These conditions persisted from the 5th-9th December, during which the visibility was so poor, public transport was stopped and people were forced to walk in the toxic conditions. Witnesses recall residents groping their way along streets, unable to see (Laskin 2006). Some cattle at the Smithfield Show died, and an opera at Sadler's Wells theatre was cancelled due to poor visibility inside the building (Greater London Authority 2002). The city came to a near standstill.

David Bates, a physician running a chronic lung disease clinic in London at the time, recalls that the death toll wasn't understood until 3 weeks later. As registrars tallied the number of deaths during this period, it was realised that around 4,000 more people died in London during those 4–5 days of fog than the usual number for that time of year (Laskin 2006). Bell and Davis (2001) estimate that between December 1952 and February 1953, there were 12,000 extra deaths in London due to the acute and persisting effects of the 1952 London smog event.

Initially the Ministry of Housing did not believe that any further legislation needed to be added to the current 1936 Public Health Act (Brimblecombe 2006). But public concern persisted and the parliament established the Beaver Committee to investigate the nature, causes and effects of air pollution, assess current preventative measures, and make recommendations for government action (Longhurst et al. 2016). In 1954 they recommended there be a Clean Air Act that moved beyond the current measures that focussed on industrial emissions, to include domestic smoke as well (Brimblecombe 2006).

The British Clean Air Act of 1956

The main components of the 1956 British Clean Air Act (UK Government 1956) included:

- The prohibition of dark smoke from a chimney of any building,

- emissions from any new furnaces to be smokeless as far as practicable,
- the potential requirement to install a device that measures and records smoke density from a building with a furnace or boiler,
- the minimisation of grit and dust from furnaces,
- new furnaces be fitted with an approved apparatus to collect grit and dust,
- new industrial buildings to have chimneys that meet a required height,
- the establishment of smoke control areas whereby it was an offence to emit smoke from any chimney of any building within this zone,
- compensation for adaptations made to fireplaces of private dwellings within these smoke control areas,
- compensation for churches and charities within smoke control areas that make adaptations to existing fireplaces, and
- the establishment of a fineable offence for smoke emissions that create a nuisance to inhabitants of the local neighbourhood.

This Act had more clauses than the previous Public Health Act, and extended legislation to domestic smoke. The impact on people's freedom of choice and the limited availability of smokeless fuel at the time was a concern for the government (Brimblecombe 2006). Implementation of the Act was slow across the country, particularly in the north of England, where coal burning was very much part of the culture. Local authorities also found the burden of making the changes and inspections quite costly (Mosley 2017). To accelerate the rate of change, in 1968 the government amended the (British) Clean Air Act, requiring local authorities to submit smoke control programmes, particularly those that had been slow to implement the Act (Mosley 2017). It also extended the required chimney height of coal and gas burning industries to allow better dispersion of pollutants (Heys 2012).

Results of the clean air acts

The British Clean Air Acts of 1956 and 1968 tightened controls on emissions and made significant difference to air quality in London and across Britain. Its emphasis on black coal smoke meant improvements were clearly visible. However, other factors also contributed to better air quality at this time. From 1957 there was a decline in the use of house coal, as oil became a cleaner, more popular fuel. After natural gas was discovered in the North Sea, a program from 1967 to convert boilers to gas was implemented (Greater London Authority 2002). In the 1960s, with improved technology and availability, the main fuel source for home-heating changed from coal to electricity and gas (Brimblecombe 2006). The oil crises of the 1970s also made gas a more affordable fuel for industrial and commercial users. Thus a number of factors, in addition to the Clean Air Act, contributed to the dramatic improvement in London's air quality.

In Mosley's study of the use of visual images and advertising in British smoke abatement, he argued that part of the success of air quality improvement can be attributed to the commercial advertising of gas and electricity companies. These corporations sought to sell not only their own products, but also the ideal of smokeless cities alongside the economic and health benefits of efficient and modern fuel technologies (Mosley 2016). Such campaigns sought to change people's attitude as well as behaviour.

Prior to the London smog event of 1952, the dangers of poor air quality were well known. Yet those who sought to bring change through lobbying the government, advertising, exhibitions and so forth, were met with opposition. Domestic open hearth coal fires were a relatively cheap source of heating and created a cosy, warm, family centre within the home. For many, industrial smoke was the sign of national economic success. While the Public Health Act did impose some restrictions on industrial smoke emissions, the government was slow to implement tight limits on industry and restrictions on people's personal freedom. Unfortunately it took the death of thousands of Londoners for the government to implement more rigid restrictions. The British Clean Air Acts of 1956 and 1968, along with improvement in cleaner fuel technologies such as electricity, and accessibility to natural gas and oil, all contributed to the dramatic improvement in air quality within the UK. It is noteworthy that the improved air quality and health status were linked to a shift out of particulate-generating domestic heating based on coal.

Wood smoke in Australia

The London smog event of 1952 was due largely to the combination of abundant black coal smoke in the atmosphere and a temperature inversion that permitted pollution to accumulate. Although its chemical composition differs from coal smoke, wood-smoke emissions today in many Australian rural towns and cities create a similar health hazard.

Wood smoke contains pollutants, such as polycyclic hydrocarbons (PAHs), benzene, nitrogen oxides, carbon monoxide, and respirable particulates (<10μm diameter) that can be harmful to human health (Naeher et al. 2007). Exposure to wood smoke can lead to

decrease in respiratory function such as shortness of breath, congestion, wheezing, coughing, and chest tightness. It may also increase the risk of asthma, stroke, heart attack, and cancer (AAQG 2015; Naeher et al. 2007). Wood smoke also contains fine particulate matter less than 2.5μm in diameter ($PM_{2.5}$) which can become lodged deep in the lungs and cause major health concerns (Naeher et al. 2007).

Many towns in rural Australia, as well as some coastal areas, experience temperature inversions similar to the event in London in 1952. As the earth's surface cools at night, the air in contact with the ground becomes colder than the overlying polluted air. The warmer layer creates a cap that inhibits convection and dispersal of air. As such, cold, moist air becomes trapped, and air pollutants are concentrated. Local topography also contributes to restricting the movement of air, particularly in towns and cities located in valleys, or surrounded by hills. Such areas include Armidale (520km north of Sydney, NSW), the Hunter Valley (245km north of Sydney, NSW), Launceston (Tasmania) and Sydney (NSW). The impact of wood-smoke pollution is increased in cold climate towns where household heating by wood burning fireplaces is more prevalent.

The NSW EPA claims that domestic wood smoke contributes 19% of annual $PM_{2.5}$ particulate pollution in the Greater Metropolitan Region of Sydney, and 47% annually in the wider Sydney region itself. In the month of July, when wood-smoke emissions are highest, domestic solid fuel combustion contributes 75% of $PM_{2.5}$ particle pollution (NSW EPA 2018).

In Muswellbrook and Singleton (both in the Hunter Valley of NSW), wood-smoke emissions are the most significant contributor of $PM_{2.5}$ in winter months (Hibberd et al. 2013; NSW EPA 2013). Similarly, Armidale regularly exceeds $PM_{2.5}$ limits in winter. During the wood-heating season of 2015, central Armidale experienced 34 days where the daily average $PM_{2.5}$ levels exceeded 25μg/m^3 (Robinson 2016). Robinson, Monro, and Campbell (2007) had already noted that there is extreme spatial variation in $PM_{2.5}$ particle levels in Armidale, with some observations up to three times such official levels. In August 2018 *The Northern Daily Leader* reported that Armidale had twice exceeded the National Air Pollution standard since May, with $PM_{2.5}$ levels between 2.5 and 3.8 times the acceptable limit (Murphy 2018).

In 2009, it was estimated that nearly 30% of households in Launceston and the surrounding Tamar Valley used open fireplaces or wood burners as their primary source of heating. Prior to the 2000s, PM_{10} levels in Launceston regularly exceeded the National Environmental Protection Measure limits (Bennett et al. 2010). Johnston et al. (2013) show that average winter PM_{10} concentrations dropped from 43.6 μg/m^3 (1994–2000), to 27.0 μg/m^3 from 2001–2007. This dramatic improvement in air quality has been attributed to the successful smoke abatement initiatives introduced in Launceston between 2001 and 2004.

Attitudes to wood fires in Australia

Many Australians hold a positive affection towards wood fires. Despite a decline in wood heater use from 1999 to 2008 (16% to 10% of households) (ABS 2008), the Australian Bureau of Statistics shows that this trend plateaued at 10% from 2008 to 2014 (ABS 2011, 2014).

To observe how residents of Armidale (NSW) justify their use of wood fire heaters, Reeve et al. (2013) conducted six focus groups between 2008 and 2009. Participants described the positives of wood heaters as "warming", "comforting", "cosy", "welcoming", and creating a positive "ambience". This study also found strong positive cultural associations with wood heating such as its connection with the land, physical activity from collecting and chopping wood, and childhood memories of family social activities. The Australian Home Heating Association, a body representing over 250 wood heater manufacturers and companies associated with the wood fire industry, states that wood heating has both consumer and environmental benefits. They claim it is cost-effective, provides ambience, and a place for the family to gather, while its environmental benefits include sustainability, and less greenhouse gas emissions than other forms of home heating (AHHA 2018b). Recent draft legislation by the Tasmanian government (TAS EPA 2018) to tighten restrictions on household wood-smoke emissions, met with an emotive backlash from the Tasmanian Barbecue Society. They argue such legislation restricts the Australian way of life (i.e. the freedom to have a barbecue in the backyard), may create tension between neighbours, and that barbecue smoke creates a natural mosquito repellent (Compton and Lehman 2018).

Current smoke abatement strategies

Given such positive attitudes towards wood heating, it is no surprise that smoke abatement policies that have focused on education in relation to the health risks of wood smoke have achieved limited success. Hine et al. demonstrate that positive emotional association with wood fires overrides rational information regarding the health risks, and therefore undermines educational intervention (Hine et al. 2007). In a similar study,

Bhullar et al. (2014) revealed that people with positive emotional attachment to wood burning heaters were less likely to see any risks associated with wood smoke and more likely to oppose mitigation policies. However, "public friendly" policies that don't threaten people's "right to burn" such as public education and rebates for wood heater upgrades were more positively viewed by all sectors of the community. They suggest that presenting the scientific facts regarding health risks of wood smoke are not sufficient to alter people's attitudes, but what is needed is information that impacts people's affections. The graphic and negative portrayal of the risks and consequences of cigarette smoking is cited as an example of a successful campaign to change behaviour (Bhullar et al. 2014).

While the costs of cleaner energy sources such as gas and electricity continue to rise, wood burning will be perceived as a cheaper alternative source of heating. However, wood smoke poses a significant cost to public health. Khan et al. assessed the economic cost of wood smoke pollution in Armidale, NSW, and discovered a significant increase in respiratory illnesses treated at GP clinics following high wood-smoke days. Based on direct medical costs of GP visits, drugs, and estimated time loss of wages, their findings conservatively estimate the average daily economic cost of wood smoke related respiratory symptoms treated at GP clinics to be $1666 (Khan, Parton, and Doran 2007). According to Todd, the health effects in Australia of PM_{10} emissions cost $2.88 billion each year (Todd 2013). Robinson suggests that increasing awareness of the public health cost of wood heaters might drive the development of cleaner, more efficient heating systems such as solar or wood pellet heaters (Robinson 2011).

Hine et al. have shown that while both education in the correct use of wood burners and the use of technology to increase burning efficiency did have some effect on reducing smoke emissions in Armidale, education regarding the health risks of wood smoke did not have a significant impact (Hine et al. 2007). This observation was reinforced by the Australian Air Quality Group who noted that air quality in Armidale actually worsened from 1999 to 2015, highlighting the long-term ineffectiveness of such local council initiatives (AAQG 2018a). In 2016, a study of attitudes to wood smoke in Armidale revealed that only 34% of respondents agreed that wood smoke was a serious health problem (Robinson 2016). Educational programs to inform people about health risks and encourage correct use of wood heaters, has made little impact on air quality in Armidale.

In 2013 and 2014 the NSW EPA distributed leaflets in the Muswellbrook region to inform residents of the health impact of wood smoke to the community and how to operate wood burners with greater efficiency. However, $PM_{2.5}$ measurements for that period show the initiative had little impact on air pollution (Robinson 2016). Research commissioned by the NSW EPA in 2016 suggested a multi-pronged communication approach, targeting the different attitudes to wood smoke pollution, in an effort to change the behaviour of wood heater users in the Upper Hunter. This was considered to be more effective than just encouraging owners to change to an alternative form of heating (NSW EPA 2016). According to Michael Johnsen, the NSW Member of Parliament for Upper Hunter, the Wood Smoke Reduction Programs conducted in Muswellbrook and Singleton during 2016–2017 had resulted in 38 wood heaters replaced and 150 chimney flue cleaning rebates issued (Johnsen 2018). In 2018 the Muswellbrook and Singleton Councils received an $84,000 grant from the NSW Environment Protection Authority for a wood smoke reduction campaign. This included offering a $50 rebate for professional flue cleaning and $1500 rebate to replace an existing wood heater (Muswellbrook Shire Council 2018). Upper Hunter air quality data for winter 2018 shows that $PM_{2.5}$ levels were generally within the same range as previous years (2011–2017) (OEH 2018). Dry dusty conditions due to drought in 2017 and 2018 have made it difficult to discern whether the wood smoke reduction program has had a significant impact.

Relative successful smoke-abatement in Launceston

Smoke abatement strategies in Launceston, Tasmania have demonstrated significant success. Between 1991 and 1993 a detailed study of the air quality of Launceston was carried out. This was followed by a state-wide marketing campaign to promote electricity as a clean, affordable alternative to wood heating which in turn led to an increase in electricity as a source for domestic heating (Johnston et al. 2013). However, in 2001 a number of initiatives led to a more significant reduction in wood smoke emissions in Launceston.

The Targeted Educational Program was a relatively low-cost and highly effective campaign that involved identifying, through visual estimates, homes with excessive chimney smoke. A friendly card was dropped in the letterbox to inform and encourage offending households to rectify the situation. A follow-up letter outlining possible penalties was issued if the home continued to contravene smoke regulations. Results showed that more than 80% of households improved their fireplace operation after the first card was issued.

Between 2001 and 2004 there was a dramatic improvement in household smoke emissions as the threat of a fine proved an effective deterrent (Ling 2004).

During the same period, the Launceston Wood Heater Replacement Program was carried out. This resulted with a reduction in the number households using wood stoves from 66% to 30% at the end of the program, with electricity becoming the primary energy source for heating (Johnston et al. 2013). A program to promote more efficient operation of wood heaters, through media advertising and school-based education also contributed to improved air quality during this time (Johnston et al. 2013).

Ling suggests the dramatic improvement of smoke emissions 2001–2004 may also partly be attributed to weather conditions, and an improvement in particulate matter emissions by industry. However, he considers the personal nature of the targeted educational program of specific cards and letters as more effective than broad-scale media advertising (Ling 2004).

These initiatives resulted in a marked difference in Launceston's air quality from 2001. Johnston et al. (2013) report a significant decrease in winter deaths from respiratory and cardiovascular disease (by 28% and 20% respectively). It seems that the removal and replacement of wood heaters created the largest impact on improved air quality in Launceston.

Discussion

There are many similarities between Australian's attitude to wood fire heaters today and views about coal-fires in London prior to the 1952 smoke event. While the London event also included smog from industrial sources, the meteorological phenomenon that allowed the accumulation of pollution in London also occurs in many Australian towns, creating dangerous wood-smoke conditions. Many parts of Australia where wood smoke has been identified as a major pollutant exist in low-lying geographical regions that regularly experience temperature inversions that allow smoke to accumulate, reducing air quality.

There were a number of historical developments that contributed to the success of the 1956 British Clean Air Act, such as improved technology and greater accessibility to cleaner fuel sources such as gas and electricity. However policy, such as smoke-free zones, was also influential.

Current attitudes in Australia to wood smoke and the use of wood heaters bear similarities to attitudes to coal smoke and smog in London prior to 1952. As with domestic coal fireplaces in London homes, wood fire heaters in Australia are perceived to create a cosy, warm ambience within the home, and a central place for families to gather. Burning wood, both inside the home and outside on the barbecue has cultural and nostalgic connections and is often characterised as the Australian way of life. Just as the British government was reluctant to restrict the freedom of its citizens prior to 1952 with many local authorities slow to implement the 1956 British Clean Air Act, so local governments in Australia are often reticent to impose tight restrictions on wood heater use and smoke emissions due to the risk of offending constituents. Would smoke-free zones ever be possible in towns that pose the greatest health risks from wood smoke? Sadly it took the death of thousands of Londoners to prompt the government to impose such radical measures.

Education on the health risks of wood smoke needs to engage people's hearts if it's to change their affection for wood fires. As solar power technology and linked batteries improve and becomes more economical, it could be feasible that wood-fire heaters are replaced by flame-effect electric heaters which can also create the positive ambience, cosiness and central gathering place in the home that Australians desire. Initiatives in Launceston from 2001 have shown that education that's personal can be effective, but perhaps the most significant factor in Launceston's improved air quality is the outright removal of wood heaters.

As cheap coal was an economic source for heating the home in Britain after World War II, in Australia wood is considered more economic than gas or electricity (AHHA 2018a; Bhullar et al. 2014), and is readily available in rural areas. In this context, an imaginative combination of policies may be necessary. In Denmark, Ryan Lund has suggested a pollution tax on new wood heaters that could fund subsidies to replace old wood heaters with cleaner energy sources, as well as home insulation and solar panels (AAQG 2018b). Perhaps this type of measure could be adopted by Australian governing authorities.

As with the smoke abaters in the UK prior to 1952, those who seek to impose restrictions on wood heaters in Australia today also face unpopularity. However, if the health risks are so evident and detrimental, then education about these health risks must continue. From the sociological research it seems that people's hearts must be engaged along with their minds for this to be successful. Firmer financial incentives may also contribute to changing behaviour. Whatever policy is adopted, the evidence points to the need to reduce the number of domestic sources of particulate pollution (domestic coal fires in London in 1952; domestic wood heaters in Australia today).

Conclusion

This paper set out to review and compare attitudes and events surrounding the 1952 London smog event with Australian wood-smoke issues, and to consider any relevance for current smoke abatement strategies.

The dangers of London's regular smog episodes were well understood prior to the event in 1952 which killed thousands. However authorities were slow to impose restrictions on smoke emissions due to the unpopularity of such policies. In Australia, wood smoke is known to be a significant health risk causing severe respiratory and cardiac issues. Yet social attitudes towards wood fires remain positive, and tight restrictions on smoke emissions are unpopular.

The British Clean Air Act of 1956, combined with improved technology, better access to clean fuel sources, and a shift away from particulate-generating domestic heating radically improved air quality in the UK. But it took a devastating event to impose such restrictions. If wood smoke poses such dangers to human health, campaigns must continue in Australia, and other locations across the world where wood heating is commonly used, to educate the population of these risks and encourage governing authorities to take firmer action. Moreover, from this review, the following additional policies should be considered to help reduce current wood smoke pollution levels:

- Financial support for further Australian studies on the concentration of $PM_{2.5}$ within homes that regularly use wood for heating and those that don't, to assess the real dangers for households.
- Continued education about the risks of wood smoke that seeks to engage the heart as well as the mind. To increase effectiveness, methods of education should employ various types of media, including messages to individual households, and messages should be presented in an engaging way.
- A national levy on the sale of new wood heaters which might help discourage their purchase, and help fund subsidies to remove existing ones.
- Government grants to encourage further research into efficient, clean, and cost-effective heating sources.
- Establishing smoke-free zones within towns or parts of cities that regularly suffer high concentrations of wood smoke. As with the UK, this would require compensating households in various ways, such as subsidies to switch from domestic wood heating to less polluting systems.
- New local government planning regulations in particular towns to prevent construction of new houses with wood heaters and to ensure that wood heaters are removed on the sale of a house.

The deaths of so many innocent people in 1952 could have been prevented if governing authorities were willing to take seriously the known dangers of London's air pollution. The health risks of wood smoke in Australia and many other parts of the world are well-documented. As such, campaigns to encourage the general public and governing authorities to restrict smoke emissions and improve heating sources must continue if we are to avoid unnecessary health issues and smoke-related deaths.

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