

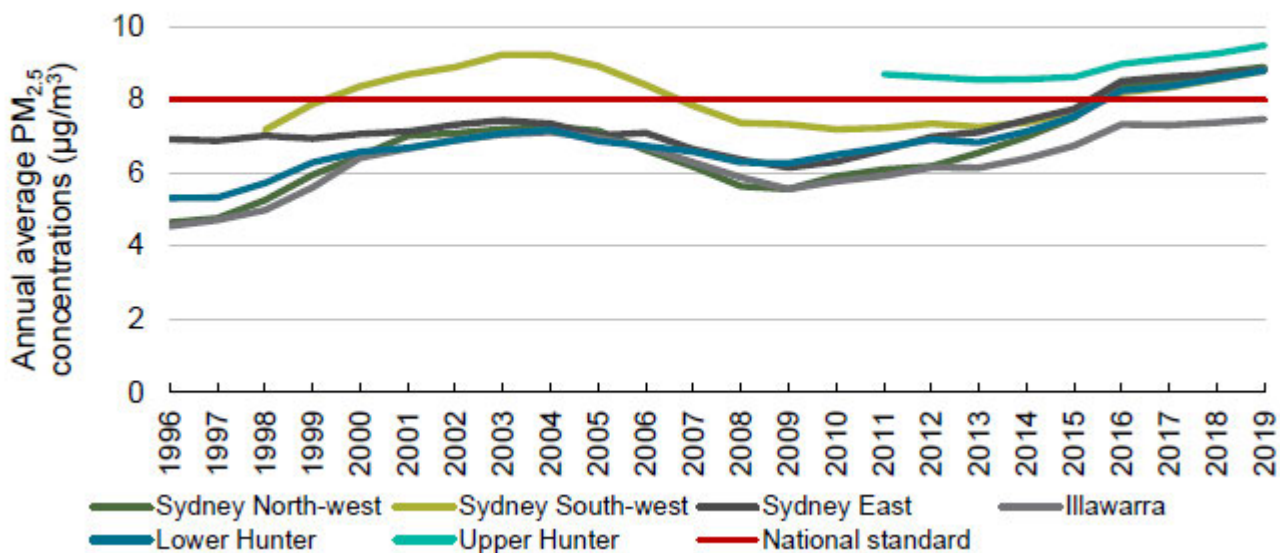
# NSW POEO (Clean Air) Regulation Consultation

## New England Greens Armidale Tamworth, May 2022

### Summary

- The NSW Greens Health Policy recognises the importance of illness preventions to improve population health, including “a reduction in unnecessary air pollution such as wood heating pollution estimated to represent an \$8 billion health problem in NSW that causes 100 premature deaths in Sydney and many more in regional and rural NSW”.
- The proposed changes do not address the MAJOR source of NSW’s hazardous air pollution – domestic wood burning. Without urgent efforts to tackle this problem, the current trend of increasing PM2.5 pollution will continue, and NSW will have no chance of meeting the 2025 National Air Quality Standards, let alone the World Health Organisation Air Quality Guidelines.

NSW Clean Air Strategy 2021–30: Draft for consultation



- The proposed changes do not address the harm and suffering of NSW residents exposed to other people’s wood heater pollution, including the examples below (*from Asthma Australia’s submission on the draft NSW Clean Air Strategy, except where stated*)
- 1) “I don’t know why they haven’t been totally banned in residential areas in major cities and large towns, my mother lives in Tamworth and when I was there in July, the smoke from the wood-fire heaters was so bad, luckily I don’t have asthma but it still made me unwell with a headache and sore throat.” Newcastle resident.
- 2) “These wood-fire heaters don’t have a place in a city where people live in close proximity, just a cluster of a few homes with one can have a large impact on a lot of people in the neighbouring area. I used to live in Kenthurst (suburb of Sydney) and every winter people in the area would be affected and complain about the smoke to the local council.” Macquarie Park (Sydney) NSW.
- 3) “The bushfires we had late last year and early this year were horrendous and I can think of a few people with asthma and a neighbour who had lung cancer who were all suffering terribly because of the smoke and down in Camden (suburb of Sydney) that happens to some people every year in the winter months because of number of homes that have wood-fire heaters, even if you have the flu it really affects you.” Sydney, NSW
- 4) “In my area there are some older homes that have wood heaters and sometimes the smoke is really thick and noticeable, I don’t have a medical condition like asthma but if I did I would be very upset having to live in that unhealthy environment during winter, so I agree with the last point, there should be regulations that new

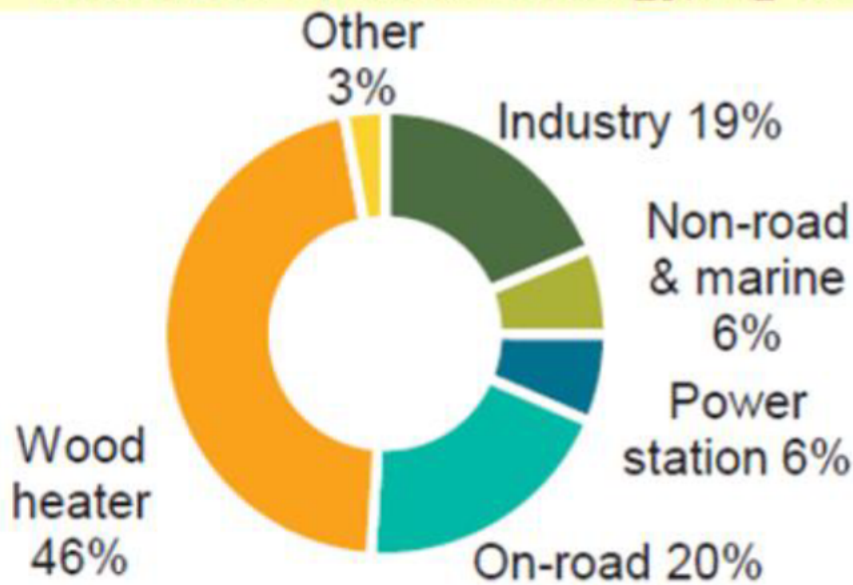
wood heaters can't be installed in metropolitan areas like Sydney, or if that is going too far, then only wood heaters that are approved by government and don't emit much smoke should be permitted." Sydney, NSW

- 5) "I am sure there are some regulations in place now that I think local governments set and enforce, but I'm not exactly sure about them because I haven't bothered to check, but the way things are in my area over the last 4-5 years, the smoke in winter is definitely getting worse and something needs to be done, like not allowing them (wood-fire heaters) to be installed in build up areas." Newcastle, NSW
- 6) "I have severe eosinophilic asthma and the woodfire smoke is just another unavoidable irritant that causes me flareups. I grew up in Armidale, NSW which is a synonymously cold place, it's in a valley on top of a mountain and the smoke from woodfires sits there in winter creating a haze over the city and causing a lot of grief for asthmatics and those with respiratory issues."
- 7) "I was hospitalised many times due to my Asthma when I lived in Armidale, but I thought once I moved to Sydney that things would be better. I moved several years ago into a unit block that is next to an old heritage house. I live on the second floor that looks out to their roof and during winter the smoke from their wood-fire is unbearable."
- 8) "We have blocked out the air vents in our unit and rarely open the windows during wintertime, but the smoke is still unavoidable and unnecessary. Sydney is a high-density city where heating is only required for a small portion of the year, yet we still allow people to burn wood fires, it's absurd." Sydney resident
- 9) "I live in Armidale, the wood smoke capital of Australia. Our PM2.5 count goes through the roof each winter. But it doesn't matter. There's an entrenched group of wood fire diehards who refuse to listen to reason. I despair of our wood smoke problem being resolved, and as a result I'll be leaving town because my lungs deserve better." RNDrive, 10 May 2022: 1 min 6 secs.

<https://www.abc.net.au/radionational/programs/drive/should-we-be-phasing-out-wood-fires-at-home/13875610>

- The proposed changes do not comply with Better Regulation Principle 3 (RIS, page 53) that requires the impact of government action to be properly understood by considering the costs and benefits of a range of options. The failure to consider highly cost-effective and beneficial options in the RIS such as recommendations 1 & 2 below violates Better Regulation Principle 3. This failure should be corrected as a matter of urgency.
- **Recommendation 1.** The POEO needs a major upgrade informed by a benefit cost analysis evaluating whether new wood heaters with estimated health costs of thousands of dollars per heater per year should be permitted on residential blocks smaller than 2 hectares that have electricity grid connections. In the interim, local councils need improved guidance and legislation to manage the installation of new wood heaters, including requirements to consult neighbours whose health might be impacted by the pollution.
- **Recommendation 2.** NSW residents whose health is being damaged by other peoples' wood heater pollution are largely unable to protect themselves ([Asthma Australia study](#)). The POEO needs major revisions to include effective provisions to assist residents who are currently suffering damage to their health or lifestyle because of other peoples' wood smoke. Councils should be advised that video evidence (which is entirely consistent with the current POEO act) is acceptable evidence of excessive smoke. Other evidence, including validated PM<sub>2.5</sub> measurements from community monitoring should also be considered acceptable.
- **Recommendation 3.** The POEO should set out how to effectively enforce the requirement that "all wood heaters must be installed in accordance with the Australian Standard for installation of wood heaters AS/NZS 2918, which requires the installation of the wood heater flue in such a manner as to prevent smoke penetration through windows or other openings of neighbouring residences." Videos of smoking chimneys and measurements of increased PM<sub>2.5</sub> pollution at the victim's property, adjacent to windows, doors or other openings that would allow the smoke to penetrate indoors when the offending wood heater is being used should be considered sufficient evidence that the installation does not comply with AS/NZS 2019.

## Weighted-Population Exposure, PM<sub>2.5</sub> Sydney, Draft NSW Clean Air Strategy, Fig 13



1. Wood heater pollution is the major contributor to air pollution health damage and is responsible for an estimated 46% of population-weighted exposure to PM<sub>2.5</sub> pollution in Sydney – least 100 premature deaths, with health costs of thousands of dollars per wood heater per year, as reported in the draft NSW Clean Air Strategy.

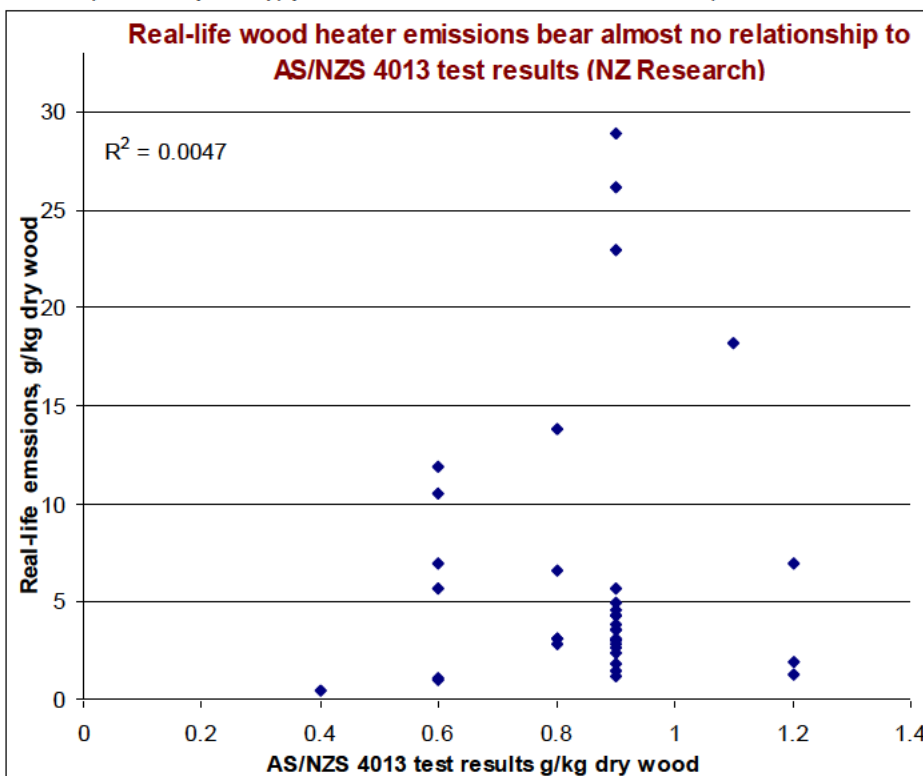
### 2. A brand new wood

heater in the GMR has estimated health costs of \$48,528 – \$80,844 over 15 years. The chart shows real-life emissions of 37 wood heaters with AS4013 ratings below 1.5 g/kg. The averaged of 6.6 g/kg, eight times worse than their average AS4013 rating of 0.85 g/kg, and bear almost no relationship to real-life emissions ( $R^2 = 0.0047$ ). Consequently, previous amendments to the POEO, based on emissions from an unrepresentative test,

are unlikely to make a significant difference to real-life pollution.

Table B2 (page 63) of the RIS, shows an estimated damage cost per tonne of PM<sub>2.5</sub> in the Greater Sydney Metro Region (GMR) of \$245,813 in 2021.

Consequently, a brand new wood heater, installed in the Sydney GMR has estimated health costs (in today's money) of \$48,528 over the next 15 years, if it burns 2 tonnes of firewood per year, and \$80,844 if it burns 3.43 tonnes per year (average for Sydney, Table 2.2 of the Federal Government's Consultation Regulation Impact Statement, 2013[1]).



Modern, efficient, modern reverse cycle air conditioners (also called heat pumps) move the sun's warmth from outside to inside homes, and can deliver 5 or 6 times as much heat to the home as they use in electric power. They are now the cheapest and most environmentally friendly heating option, with substantially lower running costs than buying firewood. Running costs (a few hundred dollars per year) pale into insignificance compared to the health costs of thousands of dollars per wood heater (new or old) per year.

Consequently, every new wood heater installed in urban areas, in cities, towns or villages, is adding to the damage to public health from air pollution. Unless a reasonable person is likely to believe that health costs of



thousands of dollars per heater per year (imposed mainly on other people, especially those living nearby) justify the relatively small costs of switching to reverse cycle heating for homes with electricity grid connections, the current draft POEO should have a major revision to include a benefit-cost analysis of whether new wood heaters should be permitted on residential blocks under 2 hectares with electricity grid connections.

Families have a right to be protected from the unacceptable pollution, e.g. the 7% increased risk of young children needing hospital emergency treatment for each additional modern wood heater per hectare (Box 1). People also have a right to be protected from additional exposure to pollution that is known to increase the risk of heart attacks, strokes, dementia, covid19, lung diseases, asthma, premature & low birth-weight babies, reduced IQ & behavioural problems such as anxiety and attention deficit when children start school, and worse academic performance as teenagers (Box 1).

**Box 1. Pollution from one or two nearby wood heaters (even brand new ones) can have serious impacts on health (information provided by the Australian Air Quality Group, AAQG)**

**1. One additional modern wood heater per hectare -> increase risk of hospital emergency treatment in children <3 yrs**

Also, as noted previously, NZ research demonstrated significant harms from wood heaters meeting stricter requirements than the 2019 Australian 'standard'. The "Growing up in New Zealand" study found that even a single additional modern woodstove per hectare (an area 100 metres x 100 metres) increased by 7% the risk children under 3 would need hospital emergency treatment for everything except accidents.

**2. Increased risk of hospital admissions for heart failure (the leading cause of hospitalisation for adults > 65 years**

Tasmanian researchers found that hospital admissions for heart failure (the leading cause of hospitalisation for adults aged over 65 years) started to increase as soon as PM<sub>2.5</sub> exceeded 4 ug/m<sup>3</sup>, a tiny fraction of the current Australian PM<sub>2.5</sub> standard of 25 ug/m<sup>3</sup>. The researchers noted that the main cause of elevated PM<sub>2.5</sub> in Tasmania is biomass smoke from wood heaters during winter and from bushfires and planned burns at other times of the year.

**3. A 1 ug/m<sup>3</sup> in wood smoke pollution found to increase in the risk of dementia by 55% - Armidale's average was 7 times this level.** A Swedish study estimated PM<sub>2.5</sub> exposure from traffic and wood stoves (the major source of local emissions) to show that a 1 ug/m<sup>3</sup> increase in wood smoke pollution increases dementia risk by 55%. In Armidale, annual population-weighted exposure to wood smoke averaged 7 ug/m<sup>3</sup> and 9.65 ug/m<sup>3</sup> at one location in south Armidale, many times higher than the 1 ug/m<sup>3</sup> found to increase the risk of dementia by 55%, suggesting that Armidale residents are likely to suffer a significant increase in dementia because of wood stove pollution.

**4. Harvard review – 10 ug/3 PM<sub>2.5</sub> increase during early childhood increases risk of autism by 64%**

Other research shows significant detrimental impacts on unborn and young children. A review of the published evidence by Harvard researchers found that the risk of Autism Spectrum Disorder increased by 64% with exposure to 10 micrograms of PM<sub>2.5</sub> per cubic meter of air (mcg/m<sup>3</sup>) during early childhood and by 31% during prenatal periods. During the prenatal period, the greatest risk was found during the third trimester.

**5. Armidale Study – average life expectancy reduced by almost a year – 210 life years lost every year – estimated costs of over \$10,000 per heater per year.** A peer-reviewed research paper, published in the Medical Journal of Australia, concluded that wood heater pollution increases population-weighted PM<sub>2.5</sub> exposure by 7.0 ug/m<sup>3</sup> with increased exposure of 9.65 ug/m<sup>3</sup> in some locations (e.g. south Armidale). Using the Global Exposure Mortality Model, average life expectancy is reduced by almost a year. Those who died in 2018 would have been expected to live collectively for 210 more years if Armidale households used other forms of heating. The estimated cost of the lost years of life amounts to \$33 million annually, over \$10,000 per wood heater per year.[2]

**6. Increased Covid Risk.** Many studies show that all fine particle ( $PM_{2.5}$  pollution) increases the risk of Covid, including wildfire smoke. This includes studies in Northern Italy, where household wood heating is a major source of  $PM_{2.5}$  pollution, and wildfire smoke. The size of the effect is quite staggering. A [study published in 2022](#)[3] in a British Medical Journal (Occupational & Environmental Medicine) concluded that an increase of  $1 \mu g/m^3$  in the annual average  $PM_{2.5}$  exposure increased the risk of Covid by 5.1%, implying a 36% increase in Armidale from wood smoke pollution.

**7. Increased risk of cancers.** [Recent international research shows that PAH \(polycyclic aromatic hydrocarbon\) emissions from wood burning stoves cause almost half the cancer risk from air pollution in cities](#)[4]. The National Pollutant Inventory shows that wood stoves are also the major source of PAH in Australia. For example, the ACT, wood stoves (used as main heating by less than 5% of households) are the [largest source of PAH \(16,000 kg\), with the second largest motor vehicles emitting less than half the PAH \(7,300\) and lawn mowing \(690 kg\) a distant third](#).

**8. Lower birthweights, smaller head circumferences, increased carcinogen-DNA adducts (a biomarker associated with increased cancer risk) in umbilical cord blood, a 5 point reduction in IQ when the children started school, increased risk of behavioural problems such as anxiety and attention deficit and reduced inhibitory control and academic achievement from exposure to PAH (main toxins in wood smoke)**  
Another study by researchers at Columbia University, New York, measured exposure PAH in pregnant women and tested the children over the following years. Several PAH are listed as known human carcinogens, including benzo[a]pyrene (BaP), which is also found in cigarette smoke and was featured in TV advertisements that claimed “every cigarette is doing you damage”.

The study involved pregnant women recruited between 1998 and 2003. These women were between 18 to 23 years old, non-smokers, non-drug users, and in good health. Prenatal exposure to PAHs was determined from air sampled in the women’s home environment during the third trimester of the pregnancy. The children were divided into two groups, based on the mother’s PAH exposure during the third trimester of pregnancy. The low exposure group has PAH measurements below the median of  $2.26 \text{ ng/m}^3$  and the high group exposure above the median.

Children of mothers in high exposure group had lower birthweights, smaller head circumferences, increased carcinogen-DNA adducts (a biomarker associated with increased cancer risk) in umbilical cord blood, a 5 point reduction in IQ when the children started school, increased risk of behavioural problems such as anxiety and attention deficit, reduced inhibitory control and academic achievement as adolescents.

The NSW EPA report: ‘Ambient Air Quality Research Project (1996–2001) Dioxins, Organics, Polycyclic Aromatic Hydrocarbons and Heavy Metals’ reports PAH measurements for Armidale, showing a relatively safe background level of  $0.28 \text{ ng/m}^3$  in summer, but a whopping average of  $8.62 \text{ ng/m}^3$  and a maximum daily average of  $24.0 \text{ ng/m}^3$ , much worse than the  $2.26 \text{ ng/m}^3$  in the Columbia University study. These results again imply that pollution from just one or two wood heaters can have significant and long-lasting impacts on the health of people living nearby.

**8. More information.** Two really good videos are: WHO: Breathe Life 80 sec video: [How air pollution impacts your body](#). *Air pollution is an invisible killer that lurks all around us, preying on the young and old. Learn how it slips unnoticed past our body's defences causing deaths from heart attack, strokes, lung disease and cancer.*[5]  
UNICEF 170-sec video: [What does Air Pollution  \$PM\_{2.5}\$  do inside children's body and brain?](#)[6] Recent research shows air pollution affects every organ in the body and has been [associated with auto-immune diseases](#). [7]

### **Additional Information (provided by the AAQG)**

A [nationally-representative survey of 25,000 people](#) was commissioned by Asthma Australia in November 2021. It found that people exposed to woodfire heaters are largely unable to protect themselves. Only 28% of the general population and 18% of people with asthma said they are able to protect themselves from woodfire heater smoke when present. Several examples of the failure to protect public health in NSW are shown in Box 2.



Research shows that just one [additional modern woodstove per hectare \(an area 100 metres x 100 metres\) satisfying the current Australian Standard increased by 7% the risk children under 3 would need hospital emergency treatment for everything except accidents.](#)

Most reasonable people would consider this to be an unacceptable increase in risk for people living nearby. Families have a right to be protected from the unacceptable health consequences of increased pollution, including increased risk of needing hospital emergency treatment in young children, and increased risk of heart attacks, strokes, dementia, covid19, lung diseases, asthma, premature & low birth-weight babies, reduced IQ & behavioural problems such as anxiety and attention deficit when children start school, and worse academic performance as teenagers (Box 1).

The only legislation available to local councils to manage wood heater pollution is the POEO, but, as demonstrated by the evidence in Box 2, it is hopelessly ineffective. The chances of a council officer being able to witness a 10 metre plume of smoke, especially on dark evenings or nights are close to zero. Consequently, the current legislation provides no practical way to protect public health.

Without such protection, victims of other people's wood heater pollution suffer tremendous hardship, unless they can afford to move house, and even then risk more of the same if their new neighbours install wood heaters.

There is a great deal of evidence to support the NSW EPA's statement: *"If you can see or smell smoke from your wood heater then you are causing a problem for yourself, your family and your neighbours."*

<https://www.epa.nsw.gov.au/your-environment/air/reducing-wood-smoke-emissions>

Rather than let families suffer in silence, or cynically ask the EPA to remove from their website this true, relevant and important information about the health damage from wood heater pollution, the NSW Government should take this opportunity to upgrade the POEO. Alternatively, other urgent steps should be taken to allow the major health damage from wood heater pollution to be addressed speedily and effectively.

## **Local councils lack powers & resources to manage wood smoke pollution**

Item 9, page 1 of the Summary highlights Armidale Council's inability to manage the health damage from wood smoke pollution and that it is driving people away, as well as reducing average life expectancy by almost a year – 210 life years lost every year, with estimated costs of over \$10,000 per heater per year (Box 1, item 5).

## **Reduced wood heating ->Less Global Warming**

Compared with the alternative of letting trees grow, chopping down trees and burning them in enclosed wood heaters speeds up global warming, as explained in this 30 second video from the prestigious New Scientist



magazine: [‘Log-burning stoves are harming our health and speeding up global warming’](#). In fact, the ability to reduce the oxygen flow in an enclosed wood heater results in the emission of short-lived climate pollutants (SLCP) including methane, black carbon and carbon monoxide, which, in the 20 years after emission, will cause many times the global warming than heating an identical house with an efficient reverse cycle system. According to the Climate and Clean Air Coalition the [best path to net zero is to cut Short-lived Climate Pollutants](#). Even the CO<sub>2</sub> emitted by burning the wood causes more harm than other forms of heating: [“Throughout the many decades before the replacement forests can grow enough to remove the extra carbon dioxide from the atmosphere, the previously added gas will thaw more permafrost and melt more ice, make ocean acidification worse,](#)

accelerate global warming, speed sea-level rise, increase the incidence of extreme weather, worsen drought and water stress, and hurt crop yields—effects that will persist for centuries or longer.”

## As well as being more environmentally-friendly, reverse cycle heater-air-conditioners have lower running costs than buying firewood



Heat pump water heater:  
**1** part of electricity produces  
**4.5** parts of hot water.

How? **3.5** parts of renewable heat  
go in here.



In Australia, heat pump  
water heaters receive  
renewable energy certificates,  
just like solar PV.



Energy Expert Dr Tim Forcey explains in [this webinar](#) in February 2022 that heat pump hot water systems are eligible for renewable energy certificates because it takes just 1 unit of electricity to generate 4.5 units of hot water. Modern, efficient, modern reverse cycle air conditioners (also called heat pumps) can do even better. They, too move the sun's warmth from outside to inside homes, and can deliver 5 or 6 times as much heat to the home as they use in electric power. They are now the cheapest and most environmentally friendly heating option, with substantially lower running costs than buying firewood.

### Renewable energy in the home: 3 forms of solar energy



1) Solar PV  
(20%)

2) Hot-water  
heat pump  
(30%)



3) Space-  
heating heat  
pump (50%)



Some years ago, the Christchurch Clean Heat Project replaced wood heating in 1973 households with heater-air conditioners (and improved insulation when needed); the average increase in electricity use was just 1%.

## Reverse cycle heater-air-conditioners create comfortable, convenient homes

Reverse cycle units have other advantages, such as thermostatic control, timers and even remote control via the internet, enabling the unit to be turned off after leaving home and turned on again at an appropriate time to take advantage of low-cost solar energy and ensure the home is at a comfortable temperature when the occupants arrive at the house.

As well as the traditional wall mounted units, there are floor mounted units, including some that provide radiant heat as well as warm air.



## Reduced wood heater pollution -> reduced risk of Covid, Flu & other Respiratory Infections

Wood smoke exposure reduced the ability of the lungs to fight infection.[8] [Many studies also show that all fine particle \(PM<sub>2.5</sub> pollution\) increases the risk of Covid](#), including wildfire smoke. This includes studies in Northern Italy, where household wood heating is a major source of PM<sub>2.5</sub> pollution, and wildfire smoke. The size of the effect is staggering. A study published in 2022 in the British Medical Journal concluded that an increase of 1 µg/m<sup>3</sup> in the annual average PM<sub>2.5</sub> exposure increased the risk of Covid by 5.1%[3]. With 46% of population-weighted PM<sub>2.5</sub> exposure attributed to wood heater pollution, and even higher proportions in rural cities such as Armidale, NSW has a significant wood heater pollution problem, which is therefore expected to increase Covid cases by 36%. Even mild Omicron infections can result in debilitating long Covid, as shown by this example of [a double-vaccinated 28-year old male](#).



Observational studies show that air pollution worsened the 1918, 1957-58 and 1968-69 flu pandemics. In China, the risk of dying from SARS more than doubled at high levels of air pollution.

## **Reduced wood heater pollution -> Increased Bushfire Resilience**

The 2019-20 bushfires were associated with 417 excess deaths in Eastern Australia [1] Tackling this pollution would result in a healthier population at the end of winter, with healthier lungs and appropriate knowledge (e.g. the benefits of HEPA filtration) and consequently increased resilience to face future bushfires.

The New South Wales parliamentary inquiry into the health impacts of the recent bushfires and drought was told about the tragic death of 19 year old Courtney Partridge-McLennon. *"...we don't have air quality monitoring the same way that metropolitan areas do. You can look outside and use common sense and go, it's pretty smoky out there but the understanding of what the levels are, if they're hazardous don't exist for regional NSW."*

<https://www.9news.com.au/national/asthma-bushfire-season-inquiry-family-whose-daughter-died-give-evidence/dadc3d8a-1686-4c4e-9f95-4f720f82dd9f>

If Low-cost air-pollution monitors such as those used in Armidale in 2018 are used by councils to check compliance with AS/NZS 2019, they could also provide accurate warnings of hazardous bushfire smoke and help prevent such tragedies in future. Alerting residents to the presence of bushfire smoke would allow them to reduce the penetration of harmful smoke into their homes by closing doors and windows and switching on HEPA filtration.

## **Reduced wood heater pollution -> Increased Productivity**

In cities such as the ACT, domestic solid fuel burning (used as main heating by less than 5% of households) is the major source of PAH, accounting for 16,000 kg of PAH per year, over twice the 7,300 kg of PAH emissions of all vehicles in the ACT. Box 1 describes the research linking exposure to PAH to a 5 point reduction in IQ when the children started school, increased risk of behavioural problems such as anxiety and attention deficit, reduced inhibitory control and academic achievement as adolescents.

Dr Tedros Ghebreyesus, director general of the World Health Organization drew attention to the problem of long-lasting impacts, advising in October 2018 that: *"exposure to air pollution during pregnancy can damage a developing baby's vital organs including the brain, heart and lungs and lead to a range of conditions including asthma, heart disease and cancers ... Air pollution also negatively affects brain development during childhood, lowering children's chances of success in school and employment possibilities later in life"*.

A critical review of 69 studies of the effect of air pollution on cognitive function concluded that: *"the evidence reviewed has been consistent in reporting associations between chronic exposure to air pollution and reduced global cognition, as well as impairment in specific cognitive domains including visuo-spatial abilities. Cognitive decline and dementia incidence have also been consistently associated with exposure to air pollution."*

Even short-term increases in PM<sub>2.5</sub> pollution have been shown to affect cognitive performance and productivity, including the probability of making a wrong move in chess and football player performance.

Reducing wood smoke pollution will therefore lead to improved performance and productivity at work.

## **Reduced wood heater pollution -> Safer Community**

PM<sub>2.5</sub> air pollution, including wildfire smoke pollution, is also linked to increased violent crime rates. Reducing woodsmoke PM<sub>2.5</sub> pollution will therefore contribute to lower violent crime rates and a safer community.

## **Informed Communities are needed for informed decisions**

Good information is required for good decisions. The Centre for Air pollution, energy and health Research (CAR) report 'Cleaner air for Australians' (CAFA) (11 March 2022) noted that *"In the community, little is known about the significant pollution and health issue of wood heater smoke."*

For example, PM<sub>2.5</sub> is generally considered the most hazardous air pollutant. Despite the information in the draft NSW Clean Air Strategy, many people have no idea that a very small proportion of Sydney households using wood heating are responsible for nearly half of population-weighted exposure to PM<sub>2.5</sub> pollution.

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3. Veronesi, G., et al., *Long-term exposure to air pollution and COVID-19 incidence: a prospective study of residents in the city of Varese, Northern Italy*. Occupational and Environmental Medicine, 2022: p. oemed-2021-107833.
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